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MACHINING LOCOMOTIVE FRAMES

PRACTICE AT THE JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD

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THE frame of a locomotive may be called the foundation or backbone, as it holds in position the driving and reversing mechanism, spring rigging and other important parts which form the running gear. The complete frame is composed of right and left sections which extend longitudinally from either the cylinders or "bumper" at the front, to the foot-plate at the rear of the fire-box. These sections are not always composed of one continuous piece, but are often formed of two or three parts which are joined or spliced together by tightly fitting taper bolts. The general arrangement of the frame depends, of course, upon the design of the locomotive. When the frame is erected, the two sections or halves are bolted to the cylinder castings and they are further stiffened and held in alignment by cross-ties and braces. This matter of bracing is very important, as a rigid structure is necessary to withstand the severe strains to which the frame is subjected. As the driving wheels are held in position by the frame, the latter not only receives heavy fore-and-aft thrusts, but also severe lateral strains, especially when the locomotive strikes a curve at high speed; consequently, if the frame is weak and yielding, a fracture is only a question of time, and, from the beginning, there is likely to be more or less trouble with the driving wheel journals and rod bearings because the running gear is not held in alignment. Designers have had considerable difficulty in providing adequate frame braces on locomotives equipped with the Stephenson valve mechanism, because of the room required between the frames for the eccentric rods, links, etc. This difficulty, however, has been largely overcome by the extensive use of the Walschaerts valve gear which is located entirely outside of the driving wheels and permits braces to be used without interfering with the valve motion, and at a point where they are needed most.

The machining of a locomotive frame would be a rather difficult proposition for the average machine shop, because of the size of the work and its unwieldy proportions, but in a modern locomotive shop, the operation is commonplace. At the Juniata shops of the Pennsylvania Railroad, the methods of handling this class of work are of exceptional interest, principally because of the high standard of efficiency maintained for the various machining operations. While this work is comparatively rough, if judged by the toolmaker's standards, considerable accuracy is necessary for certain surfaces, but the framework from start to finish is particularly noteworthy as an example of rapid machining rather than skillful and accurate work. The Juniata shops have, under normal conditions, a capacity for building a complete locomotive every day, and this rate is sometimes exceeded, so that the machining of frames is an everyday occurrence. Practically all of the locomotives built in these shops at the present time, are equipped with cast-steel frames instead of wrought-iron frames which were used almost exclusively a few years ago. Frames that are cast are much cheaper than the forged type and another advantage of using cast steel is that pads or other projections can be easily and neatly formed on the frame pattern.

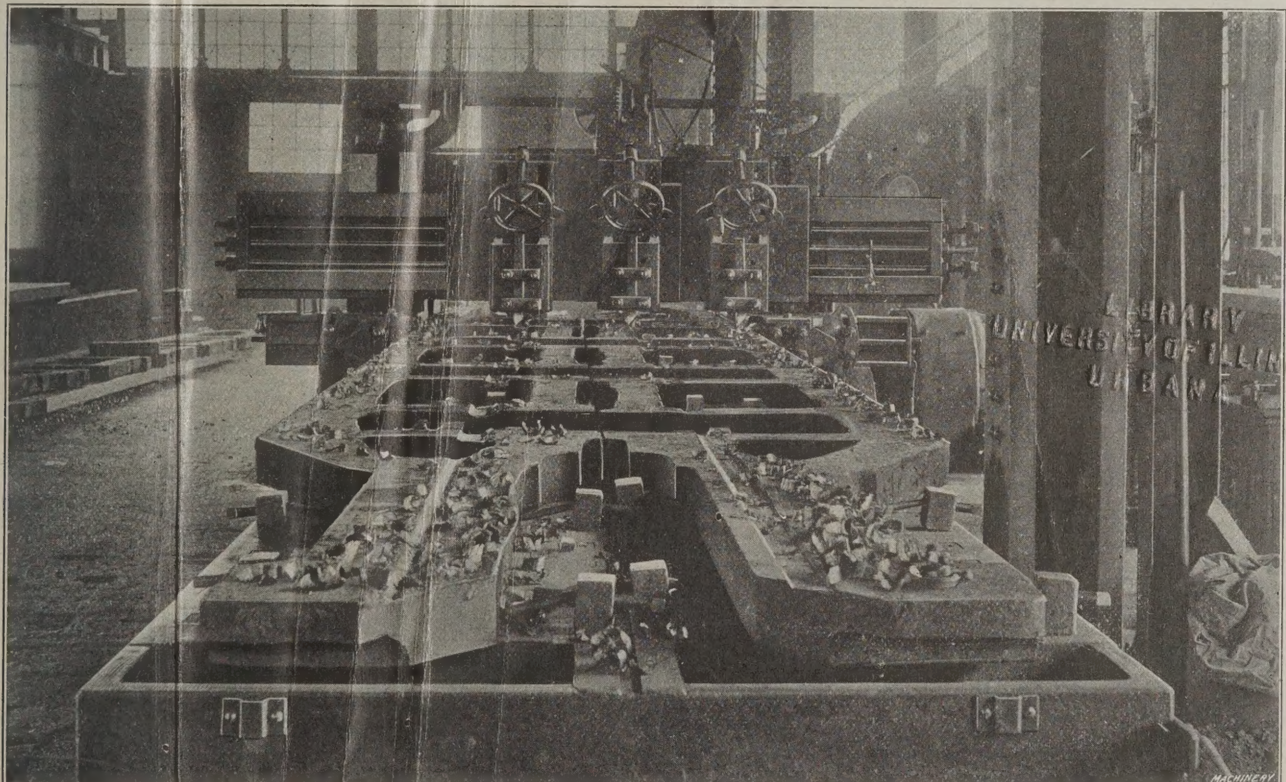

Fig. 1. Planing Two Frames simultaneously on a Powerful Planer equipped with Five Tools

Straightening and Planing the Frames

The cast-steel frames are usually warped more or less as they come from the foundry, owing to unequal cooling, and

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it is necessary to straighten them prior to machining. This straightening is done under a large steam hammer as indicated in Fig. 2. The frame is heated sufficiently to insure a permanent "set" when straightened, and it is made approximately straight by giving it a few blows with the hammer. The work is then ready for the first machining operation which is that of planing the sides and edges. Two frames have spongy, sandy spots, blow-holes or similar defects on the cope side, a generous allowance is left for planing in order to remove all porous material. Owing to the power of this machine, very heavy cuts can be taken without difficulty, as indicated in the illustration Fig. 1. The planer is motor-driven and sometimes as much as 90 horsepower is required for driving, owing to the heavy "hogging" cuts,

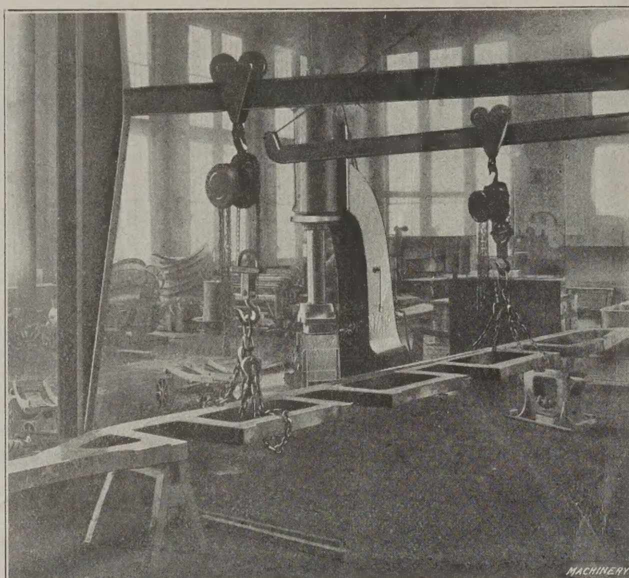

Fig. 2. Where the Warped Frames are straightened prior to Machining

Fig 3. Cast-steel Locomotive Frame on its Way to the Shop

or sections are planed simultaneously on a very rigid planer having five tool-heads. A view of this machine taking a roughing cut over the sides of two frames is shown in Fig. 1. The work is held on the platen by screw-stops and toe-dogs or "spuds" which are placed in an inclined position to force the work down. Stops are also set against the frames at the most advantageous positions to take the longitudinal thrust which are taken in the tough cast steel. When roughing, the tools frequently cut to a depth of from ½ to ¾ inch with a feed of 3/16 inch. The average depth of cut for the five tools, however would be somewhat less than the figures given. After the three heads on the cross-rail are started, the right and left side-heads are set for planing the edges. The work is set up for rough planing the first side, with the top edge

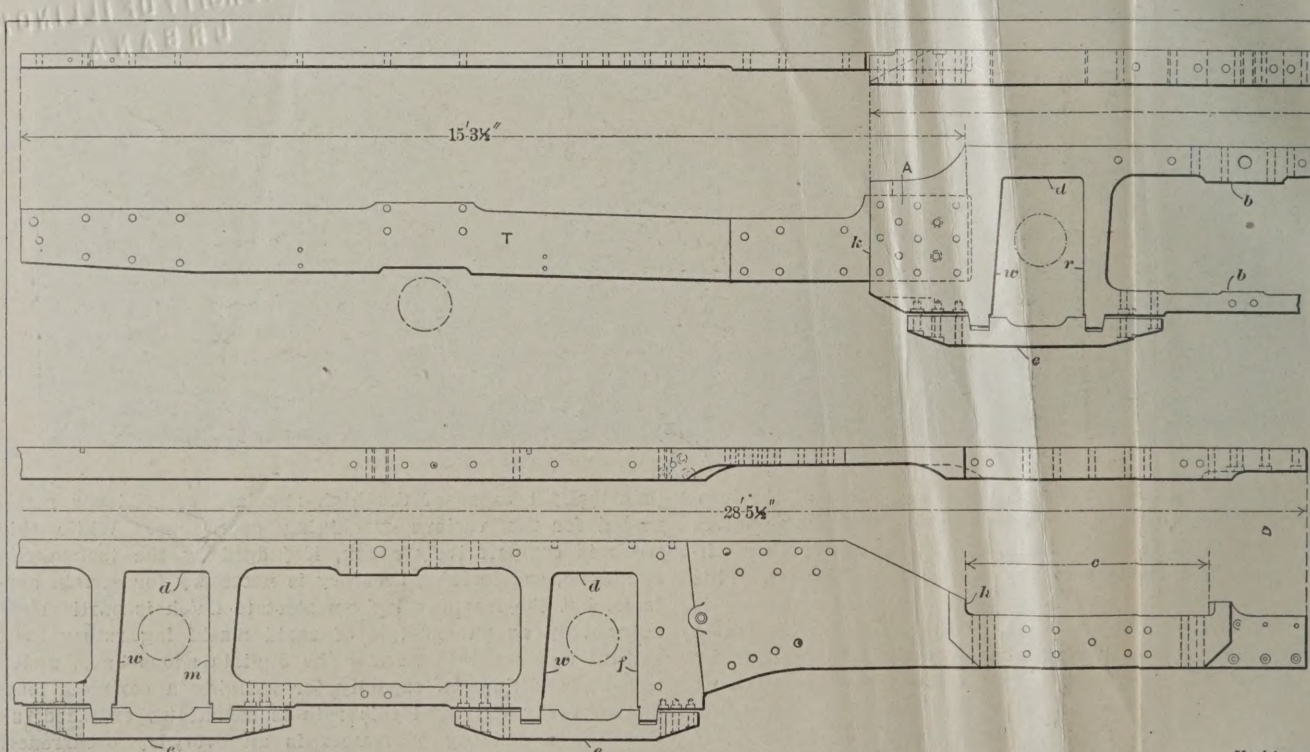

Fig. 4. Frame for a Passenger Locomotive of the 4-6-2 Type

of the cut. Part of the time, all five planing tools are at work, the three tool-heads on the cross-rail being used to plane the sides of the two sections, while the right and left side-heads plane the edges. The three upper tools are started so that each rough planes about one-third of the surface formed by the two castings. In this way the roughing is, of course, done in much less time than would be required if an ordinary two-head machine were employed. As many of these castings of each section outward. This is done so that the top edges can be finished with reference to pads for braces or brackets which are located on the inside of the to and bottom rails of the frames. After the roughing cuts on one side are completed, the finishing cuts are taken with brad flat tools which are given a feed varying from 1 inch to ¼ inch per stroke. Only two of the cross-rail heads are use for finishing, so that each frame can be planed by a contiuous cut in order

to obtain a smooth surface free from ridges. The frames are next turned over for roughing and finishing the opposite side, which is the position of the work illustrated in Fig. 2. The opposite edge of each frame is now in the outward position, thus permitting the ends of the pedestals to be rough planed. The finishing tools are set for planing the second side by means of a post or height gage to which the cutting edges are adjusted. In this way the proper thickness is quickly obtained, although a fixed caliper gage is used to check this dimension. After the sides have been finished in this manner, a frame of the type illustrated in Fig. 4 is planed at *A* for the reception of the trailer frame *T* which fits into a pocket as shown. This pocket is finished to the correct width and depth in another machine, and this completes the planer work.

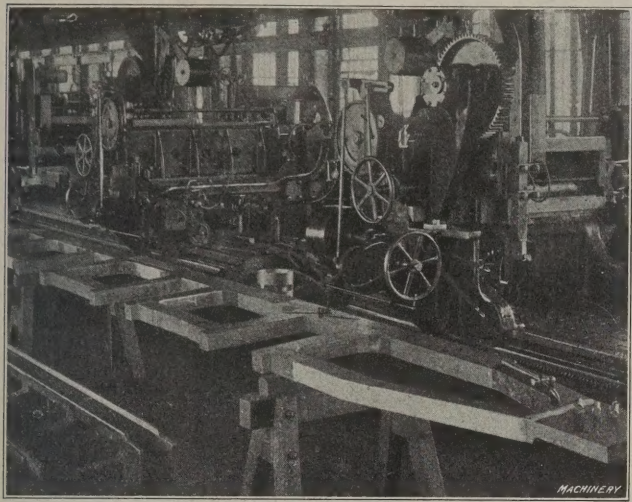

Fig. 5. Frame mounted on Horses for Laying-out Operation

Laying Out the Frames

The frames are next laid out for slotting, though this operation is only necessary for every fifth or seventh frame (depending on the size) owing to the method of slotting them in stacks, as will be explained later. The work is placed on horses (as shown in Fig. 5) and steel templets are used to give the required outline. One of these templets conforms to the shape of the pedestal jaws and another gives the outline for the cylinder fit at the front end. Before placing the templets on the frame, the surfaces on which finished lines are to be scribed, are moistened with water and then coated with a soft red stone called "keel." This leaves a dull red finish on which the scriber lines are easily seen.

The templets are aligned by the planed edge of the frame and they enable the required outline to be quickly scribed on the finished surface. A number of bolt holes which cannot be drilled to good advantage by the use of jigs are also laid out by the use of templets which have small holes corresponding in location with the holes to be drilled and these are transferred to the work by using a light punch. After the templet is removed, two concentric circles are stamped around each center with special punches similar to those shown in Fig. 6. These punches have V-shaped annular ridges which form neat rings or grooves, one of which represents the size of the hole while the other remains as a "witness" to show whether or not the hole has been drilled central. The punches are made in various sizes and they are much superior to the old method of scribing and dotting a circle, when laying out holes.

Slotting the Frames

The slotting operation, which is the next in the regular order, is performed by the large machine shown in Fig. 7. A stack of from five to seven frames (the number depending on the size), can be slotted simultaneously, so that it is only necessary to lay out the one which is to be placed on top. As the illustration shows, the machine has three slotting heads. These can be traversed longitudinally along the bed by power and each slotting ram has a rapid power cross-movement, so that different heads can be easily and quickly adjusted to the required position. In setting up a stack of these frames, each section is placed against angle-plates at the rear which are in line with the slotter bed. All the frames are first adjusted longitudinally in order that the faces of

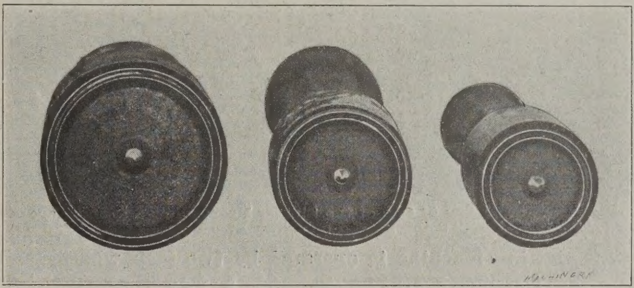

Fig. 6. Special Punches used for laying out Holes

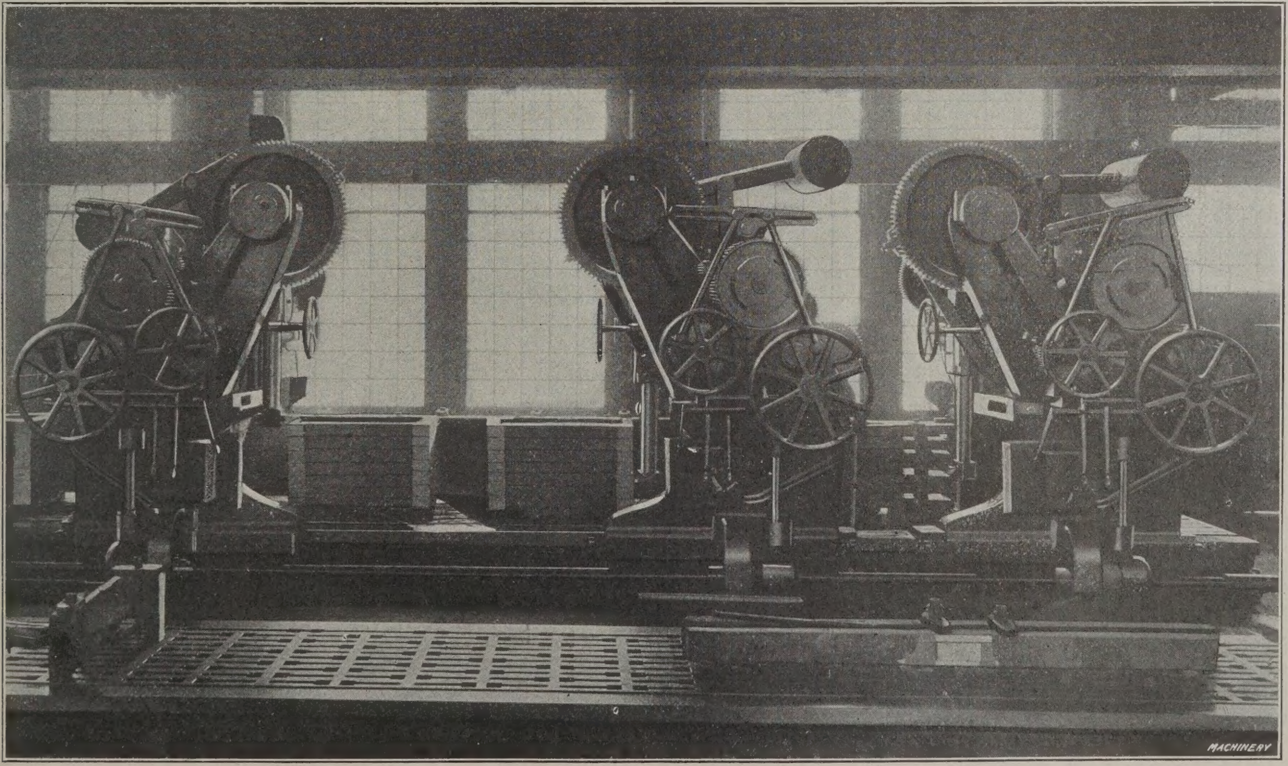

Fig. 7. Large Three-head Slotter used for Slotting the Jaws of Locomotive Frames

all jaws will true up when the top frame has been planed to the lines previously scribed. The crosswise position of the work is then checked by testing the alignment of the lower frame with the bed. When this lower section is accurately located, the frames above are set by it in a crosswise direction by using a large square.

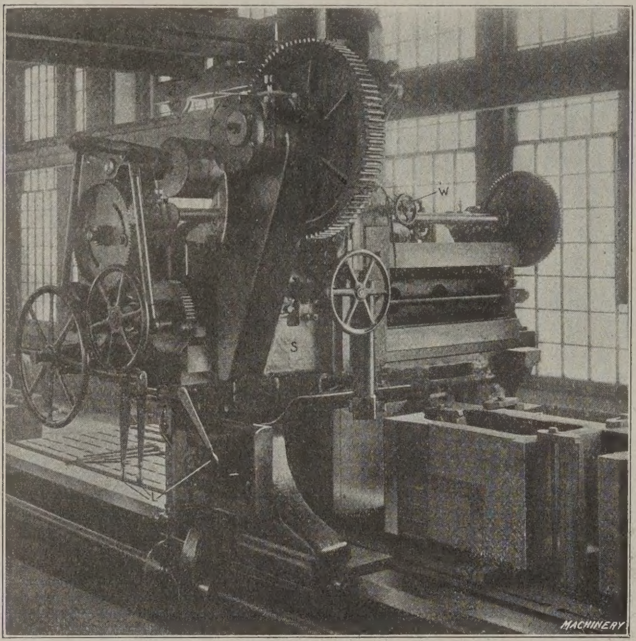

Fig. 8. Detail View of One of the Slotter Heads—Seven Frames are being slotted simultaneously

This slotting machine is operated by two men who proceed with the slotting operation in such a way that the three heads are used simultaneously as much as possible. The method of machining a stack of three-jawed frames similar to the type illustrated in Fig. 4, will illustrate how the machine is handled. One man begins slotting the shoe face *m* of the middle jaw, while the second man is rough planing the pocket *c* for the cylinder. When the first man has slotted the face of jaw *m*, he moves to the front and begins slotting shoe face *f*. In the meantime, the second man starts a finishing cut over surface *c*, and then begins work on the bracket pads *b* with the third head. The reason why the first man moves from the central jaw to the front, is that he is then in a position to watch the slotting head which has been started on a finishing cut along pocket *c* by the second man. In this way the two men shift from one point to another, the order of the operations depending, of course, on the arrangement or design of the frames being machined.

Fig. 8 is a detailed view, showing one of the three slotter heads. The slotting ram and its reciprocating mechanism is carried by a slide *S* which can be traversed laterally along the cross-rail shown. The rapid-traverse movements of this slide and also the power movements for shifting the entire head longitudinally along the bed, are controlled by the vertical levers *L* seen at left end of cross-rail. This view shows the slotting tool just beginning a cut across the front or shoe face of the jaws. After the shoe faces *f*, *m* and *r*, (which are square with the top of the frame) have been slotted, the tapering wedge faces *w* are finished. As those familiar with the construction of locomotives know, one side of the frame jaws is made tapering to provide an adjustment for taking up lost motion between the driving-wheel boxes and the frame shoes. It might also be mentioned, incidentally, that the rear jaws are given this taper rather than the front ones, because the latter are subjected to a greater pressure when the engine is running ahead and it is better to have this pressure against a vertical surface than one that is tapering. The taper or wedge side is planed, on this particular slotter, by swiveling the cross-rail on which the ram is mounted, to the required angle as indicated by suitable graduations. The slotting operation also includes the finishing of the top surfaces *d*, as well as the lower ends of the pedestals for the braces *e* which are bolted across each pair of jaws. In order to strengthen the frames, all corners have large fillets, and when these are being formed the slotting tools are turned by swiveling the tool-bar about its axis, the handwheel *W* (Fig. 8) being used for this purpose.

The most important part of frame slotting, from a standpoint of accuracy, is that of planing the square shoe faces, which must be finished the right distance from each other, within close limits, because these are the surfaces which determine the location of the driving-wheels when shoes of a standard thickness are used. Gages are used for measuring these distances, the front and rear jaws being gaged from the central one which is machined first. The distance between shoulder *h* and face *f* is also carefully gaged, as this shoulder bears against the cylinder saddle and determines the longitudinal position of the frame. The jaw faces of the right and

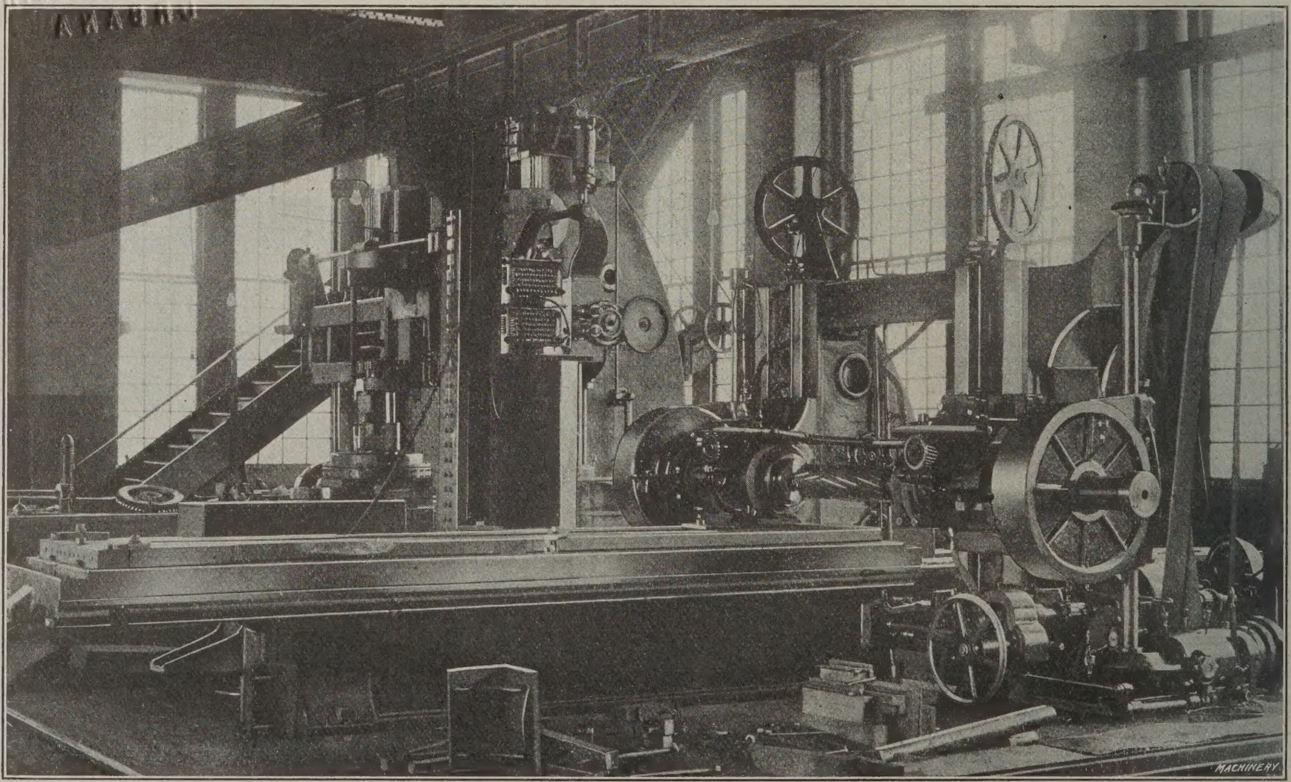

Fig. 9. Horizontal Milling Machine on which Trailer Frames are milled

left frame sections, must lie in the same plane and any irregularity in the location of shoulders h would affect the position of the jaws. The end k of each main section is also finished to provide a surface for locating the jig used for drilling the bolt holes for the trailer frame splice. Surface k is machined to a given distance from face r as shown by a fixed gage.

Milling the Trailer Frames

One of the most interesting operations on the frames is that of machining the section T, Fig. 4, called the "trailer"

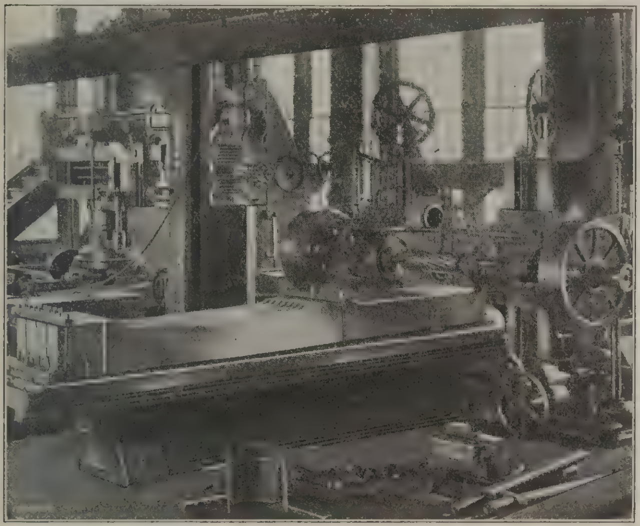

Fig. 10. Eight Trailer Frames set up for Milling the Edges

or rear frame. Of course, it will be understood that these trailer frames are only used on locomotives of the passenger type having trailing wheels, which differ from the drivers in that they simply carry weight and are not connected by the side-rods. The trailer frames are forged and they are finished on the sides and edges in the powerful horizontal milling machine shown in Fig. 9. These forgings are not made very close to the finished size, because with the

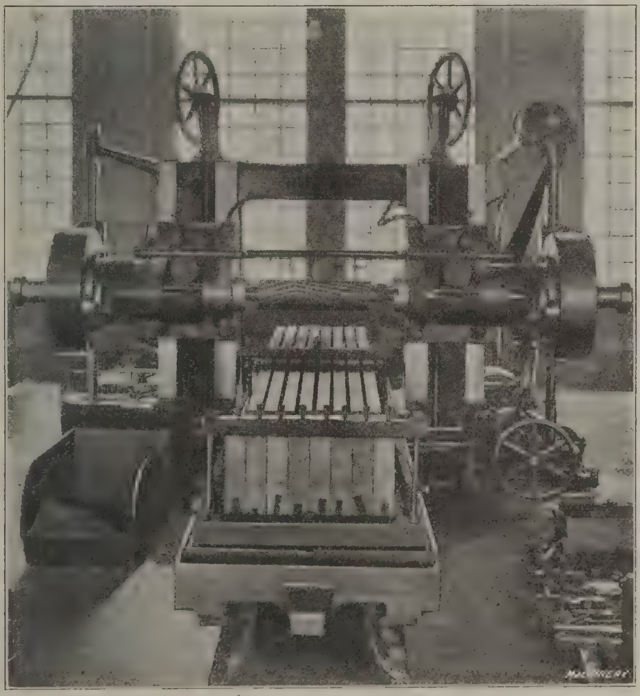

Fig. 11. End View of Trailer Frames and Milling Machine

improved milling practice, the metal is removed so rapidly, that it would not be economical to forge too close to the finished dimensions. The amount of metal removed in machining these frames is indicated by the fact that a rough frame weighs about 2212 pounds, whereas one that is finished weighs only 1725 pounds. The frames are first milled on the sides, two being placed on the machine, at one time as illustrated in Fig. 9. The work is shimmed up with liners or thin wedges and it is held by ordinary clamps as shown. A stop-bar is placed across the outer end to take the thrust of the cut. As the milling cutter advances, the clamps are shifted from one point to another. The cutter used is 33 inches wide, and when the edges are being milled, practically the entire width of this cutter is in use. It consists of three 11-inch units having inserted blades which are held in accurate helical grooves, giving a constant cutting angle for the full width of the blade. These cutters are made in the Juniata shops and they are partly responsible for the efficient milling practice in connection with frame and rod work.

After both sides of all the frames in a lot have been machined, the edges are milled to the proper contour. At the present time, eight of these frames are milled on the edges simultaneously. The way the work is set up is indicated in Figs. 10, 11 and 12. Two broad clamps are placed across the top and the frames are held laterally by screw-stops along the sides. The rear clamp is provided with eight set-screws which insure a bearing on each frame section. The outer frame on the operator's side, has lines showing the required outline for the finished edges. These lines are transferred from a steel templet before the frames are placed on the machine. The frames are first set up as shown in Fig. 10, and then they are turned over for milling the opposite edges. As section F, Fig. 13, and middle section I, are tapering,

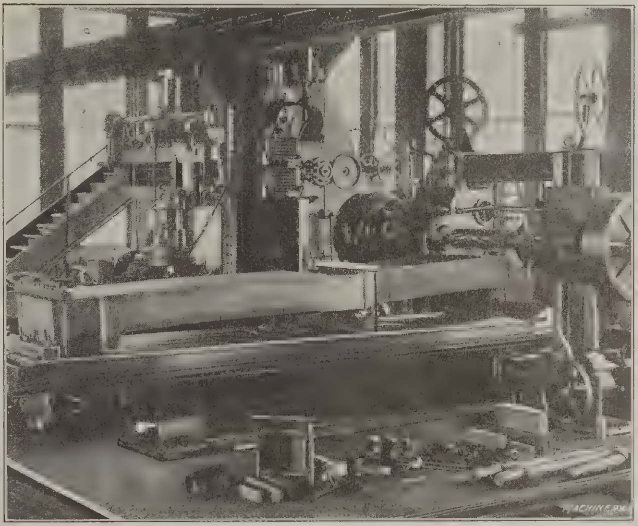

Fig. 12. Stack of Trailer Frames blocked up for Milling Taper End

it is necessary to block up the work as indicated in Fig. 12, in order to secure a straight tapering surface. This particular illustration shows the frames set for milling the tapered end F, Fig. 13. The irregular outline at the center and the radius at the wide end, are formed by adjusting the milling cutter vertically by hand as the work feeds forward.

In order to show how rapidly these rough forgings are machined to the proper size and shape, we shall give the actual time required for milling the various surfaces of the frames and the approximate depth of the cut. The various surfaces to which the data refers are marked in Fig. 13 by letters, and the lengths in each case are also given. Part A having a length of 5 feet, 8½ inches is milled in 56 minutes, and the average cut varies in depth from ½ to ⅜ inch. Of course it will be understood that the time specified is for eight frames, so that if we only consider one frame, section A is milled in 7 minutes. The time taken for section B is 21 minutes and the depth of cut varies from ¾ to ⅞ inch. The time for section C is 1 hour 6 minutes, depth of cut ¾ to ⅞ inch; section D, time 43 minutes, depth of cut ⅝ inch; section E is finished by planing prior to milling operation; section F, time 1 hour 40 minutes, depth of cut ½ to 2½ inches; section G, time 28 minutes, depth of cut ⅜ to 1 inch; section H, time 41 minutes, depth of cut, 1½ to 2½ inches; section I, 34 minutes, depth of cut ¼ to ⅞ inch; section J is finished by planing; section K, time 1 hour 15 minutes, depth of cut ⅛ to ½ inch; section L is finished by planing; section M, time 55 minutes, depth of cut ⅛ to ⅜ inch; section N is finished by planing. The time given for milling the sides

K and M is for two frames. The amount of metal removed from the edges of the eight frames is approximately 1356 pounds, whereas 2542 pounds are removed from the sides, giving a total of 3898 pounds. The total time required for milling the edges is 6 hours 29 minutes and for the sides, 8 hours 40 minutes, giving a total cutting time of 15 hours 9 minutes for eight frames, so that the amount of metal removed per hour of cutting time is approximately 257 pounds. It should be mentioned that the foregoing figures do not cover the time required for setting and clamping the work on the machine.

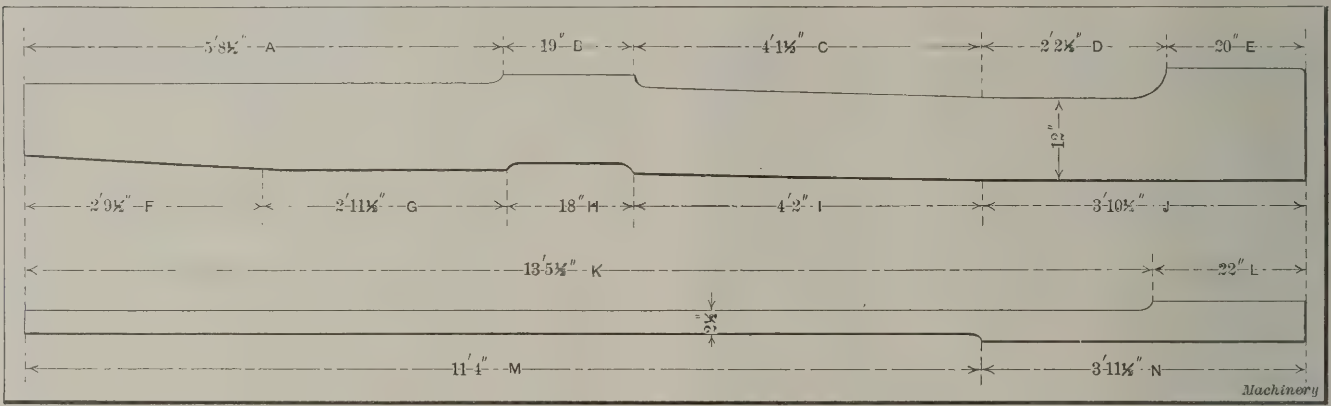

Fig. 13. Diagram showing Lengths of Milled Sections—Data covering Time and Average Depth of Cut is given in Text

Drilling and Finishing the Frames

There are a great many parts attached to the frames, such as brackets for the spring and brake rigging, stiffening braces, pedestal braces and many other parts, all of which require bolt holes, so that the drill press work is quite extensive, as is indicated in Fig. 4. Three large radial drilling machines are used for this work. The frame is first set up for drilling all the side holes, as shown in Fig. 14, and it is then placed in a vertical position for drilling the pedestal-brace bolt holes. Most of the holes are drilled by the use of plate jigs which are located by previously machined surfaces and, in some instances, by lines drawn for this purpose when the frame is laid out. High-speed steel drills are used and these are flooded with soda water so that very rapid work is possible. As it is important to have accurately fitting frame bolts, the various holes are finished by reaming at the time the frames are erected, as will be described later.

After the frames are drilled they are removed from the machine shop to the erecting department, as the work has now progressed to the point where it is ready for assembling. Before referring to this last step in connection with the framework, attention should be called to the fact that all of these different operations are performed progressively, the work being advanced from one machine to the next without making any retrograde or backward movements. This is also true of other classes of work, the machines being arranged, as far as possible, so that the work moves along in a direct line as it passes from the stock pile to the various machines and, finally, to the place where it is to be assembled. When we consider how many parts are incorporated in a single modern locomotive and then remember that approximately one such locomotive is being built daily at the Juniata shops, the importance of direct methods and their bearing on the rate of production can readily be appreciated.

When the frames reach the erecting department all corners are rounded by pneumatic hammers (as indicated in Fig. 15) before assembling. The chisels used for this work are shown in Fig. 16. They are shaped somewhat like a gouge but have a concave cutting edge. The corners are finished to the required radius by a single cut and almost as smoothly and neatly as could be done in a planer with a form tool. Two frames which have been finished in this way and are ready for the erecting gang, are shown in Fig. 17. This rounding of corners gives the frames a finished appearance and also makes it much easier to handle them, as all sharp edges have been cut away. It is also thought that a frame having round corners is less liable to fracture than one having square

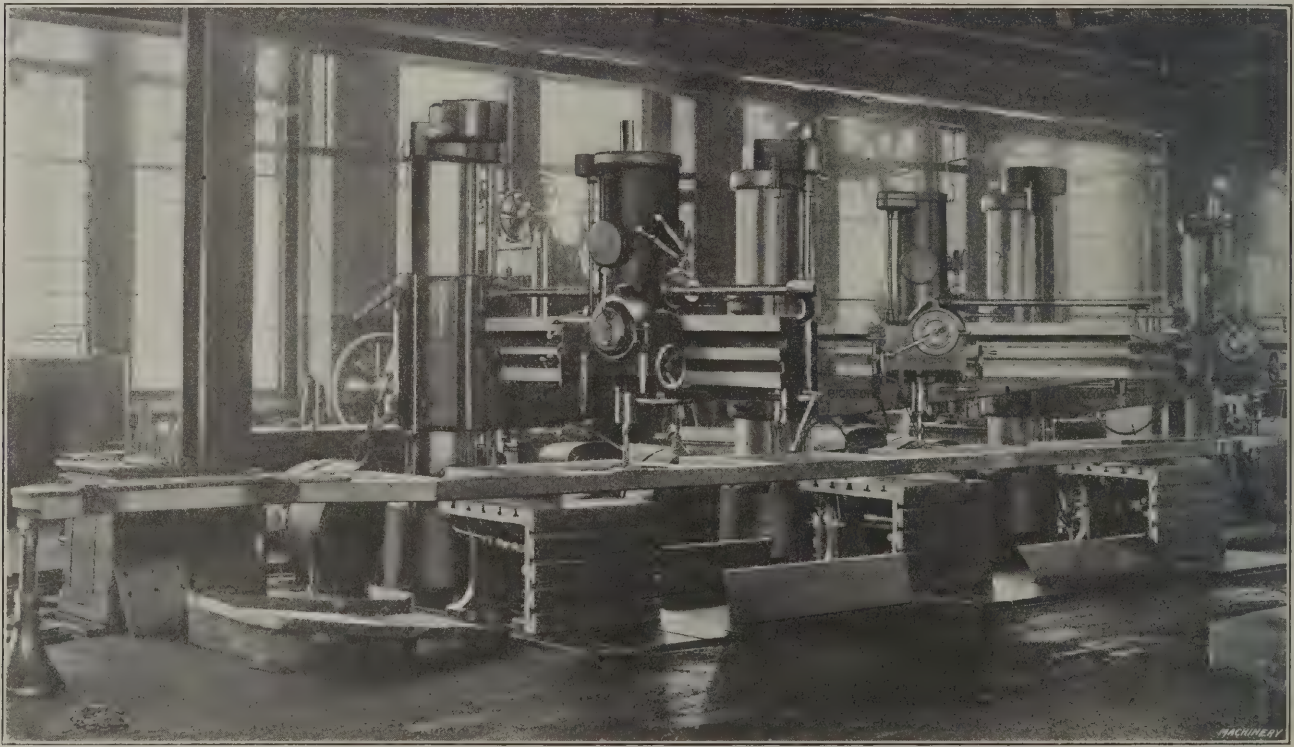

Fig. 14. Gang of Three Radial Drilling Machines used for Locomotive Frame Work

ragged corners, the theory being that a minute indentation at the corner may, in time, develop into a fracture.

The main frame and the trailer frame (in this particular case) are next aligned and the bolt holes for the splice at *A*, Fig. 4, are reamed. After the splice bolts are inserted, the right and left frame sections are tied together by the different cross-

Fig. 15. Rounding the Corners of a Frame prior to Erecting

braces, and this is the first step in erecting a locomotive. The two sections are mounted on blocks and jacks and they are then set level and parallel with each other. The various cross-ties and braces are temporarily clamped in position for reaming the previously drilled holes. As all the parts are accurately drilled, the holes are usually in close alignment so that little reaming is necessary to produce a smooth hole which will insure an even bearing throughout the length of the bolt.

The reaming is done by means of an air motor, and the time required for reaming a hole and driving a bolt "home," is a matter of seconds rather than minutes. The reamer is entered into the hole and the motor driving chuck is applied to the end. As the reamer only has a taper of 3/32 inch per foot (which is the standard for all frame bolts) it is quickly fed to the required depth. The reamer is then backed out while it rotates in the same direction, and the chips are

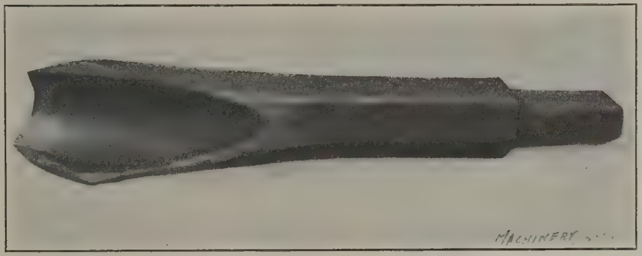

Fig. 16. Gouge-shaped Chisel used for Rounding Corners

blown from the hole by turning the air exhaust of the motor into it. A standard bolt is next inserted and driven home by a few blows of the sledge. This entire operation of reaming the hole, cleaning it and driving in the bolt, is done in a suprisingly short time. As these men are constantly at this work, they have become very expert. No gages are required for reaming, as the workmen know just how far to feed the reamer in for any given bolt. When a hole is being reamed, the motor is held by two men, while a third man measures the distance between the reamer driving chuck and the frame in order to determine when the reamer has reached the required depth. When a reamer becomes too dull to work effectively, it is sharpened in a special grinding machine. The importance of keeping the reamers in good condition can best be appreciated by those who have tried to true up a hole with a dull reamer. Before the erection of the frames is complete, they must be bolted to the cylinder castings which form the principal support at the front. Fig. 19 shows an assembled frame after the cylinders, braces, guide-yoke and other parts connected with the spring and brake rigging, have been attached. When the work has reached this stage, it is only a matter of a few hours when the frame will be buried behind the driving wheels of the assembled locomotive. Those who are interested in locomotive erection are referred to the article on this subject by Mr. Ralph E. Flanders, published in the railway edition of MACHINERY for June, 1910.

Turning Frame Bolts

The method of turning the frame bolts used in assembling the frames, is interesting, owing to the rapidity and simplicity

Fig. 17. Frames after the Chipping is completed

of the operation. The machine used resembles an ordinary four-spindle drilling machine, as will be seen by referring to Fig. 18. The spindles are equipped with chucks having hexagonal pockets, not unlike a socket wrench, which fit the heads of the bolts and cause them to revolve while the body is being turned. The turning is done by cutter heads located in the

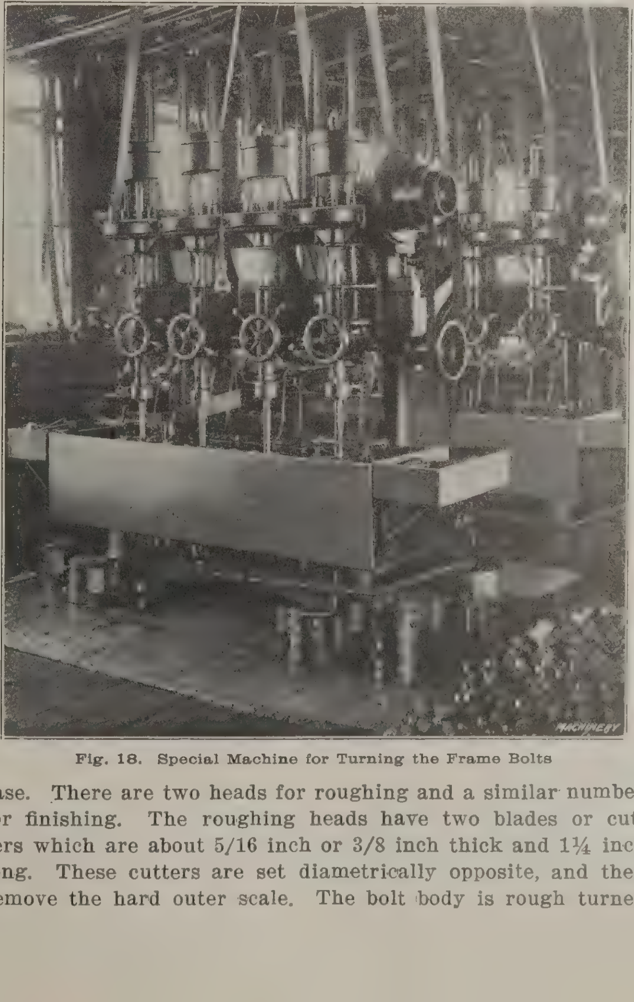

Fig. 18. Special Machine for Turning the Frame Bolts

base. There are two heads for roughing and a similar number for finishing. The roughing heads have two blades or cutters which are about 5/16 inch or 3/8 inch thick and 1¼ inch long. These cutters are set diametrically opposite, and they remove the hard outer scale. The bolt body is rough turned

close to the finished size, but this first operation leaves it straight or of one diameter throughout. The work is then placed in a finishing head. These heads also contain two cutters which differ from those used in the roughing heads in that they are as long, or longer, than the bolt body and are set to turn the bolt body to the required taper. The turning

Fig. 19. Frame after Cylinders, Braces and other Parts have been assembled

operation, in each case, is performed by feeding the revolving bolt down through a cutter head just as a drill would be fed through its work. Several of these cutter heads may be seen at the base of the machine. They are mounted in floating holders so that they can adjust themselves to the bolt being turned. Very rapid work can be done in this machine and one man keeps the four heads in operation. The threading of the bolts is done in regular bolt-threading machines.

* * *

The production of gold in 1910 amounted to $96,055,214. The total building construction in Chicago in 1910, including new buildings, additions and alterations, amounted to $96,932,700. *The sum of these two figures* lacks more than twenty-two million dollars of the actual destruction by fire in the United States of buildings and contents during 1910. Careful observation of the operation of automatic sprinklers leads to the inevitable conclusion that at least half of the $214,003,300 which went up in smoke could have been saved if the principal buildings which burned had been adequately protected by this form of fire prevention apparatus.

PAWLING & HARNISCHFEGER HIGH-SPEED CRANE TROLLEYS

The Pawling & Harnischfeger Co., Milwaukee, Wis., is the builder of the high-speed crane trolley here illustrated. These trolleys are of the "man-riding" type, that is, they have a cage for the operator, though this is not shown in the illustration. The travel speed of the trolley is about 700 feet per minute and the hoisting speed, with a 5-ton load, 250 feet per minute. The trolley is of the "inside running" type and it operates on a plate girder cantilever arm as indicated in Fig. 1, which shows two of these high-speed hoists handling rails at the wharf of the Texas City Transportation Co. The cantilever arm can be moved longitudinally about sixty feet beyond the face of the dock and over a boat tied to the wharf, as the illustration shows. This construction was adopted owing to the impossibility of moving a hinged apron of the ordinary construction, past the rigging of large sailing vessels. The extension of the cantilever arm also permits loading and unloading lighters tied on the outside of a

Fig. 1. Cranes at Wharf of Texas City Transportation Co.

ship. A 100-horsepower mill type motor is used for hoisting, and a 35-horsepower railway motor carrying a foot-brake, for the traverse movement. The load is sustained by a disk motor brake of large proportions and of a new design which will permit a quick adjustment of the air gap.

The special feature of the hoisting mechanism is the arrangement for taking the hook off the hoisting rope and slipping the same rope into a single-rope grab bucket of the latch open type. Rope guards are arranged on the bucket in such a way that they can readily be opened when inserting the hoisting rope which is also the closing line of the bucket. A novel application of a single line bucket of this type is to

Fig. 2. High-speed Hoist built by Pawling & Harnischfeger

use it with a set of holding lines like those used on a two-line bucket. The holding line is wound upon a drum operated by a motor which is just large enough to keep the slack out of the rope when raising or lowering. In this way it is possible to discharge the bucket at any desired height by means of a large foot-operated band brake on the holding drum. When the bucket is fully open and therefore latched, the foot-brake is released and the weight of the empty bucket is again placed on the closing line. The bucket can then be lowered without closing until it strikes the stock pile. This design was developed in order to concentrate the entire capacity of the hoist motor on a single drum which is also used for the hook service. When the bucket is not in use, the holding line is disconnected and wound up on its drum which then remains at rest. The holding drum motor has about the same function as the spring in a curtain roller in that it tends to run ahead of the hoist motor when going up and to lag behind when lowering; therefore, the holding line is never slack and it is impossible to jerk the line when the bucket is discharged. In connection with the hook service, a lifting magnet of 2½ tons capacity is used. The feed cables for this magnet are wound up and "paid out" by a small motor-operated winding drum. The operation of this cable take-up is exactly the same as that of the holding drum mechanism, the cable being always under a slight tension whether raising or lowering.

* * *

EFFICIENCY IN CYLINDRICAL GRINDING*

By F. B. JACOBS†

Anyone who has followed the progress made in cylindrical grinding for the last ten or fifteen years, will admit that the present-day grinding machine, which owes a large part of its success to the modern grinding wheel, has been one of the prime factors in cutting down the cost of production, by furnishing a rapid and efficient method for accurately finishing the component parts of high-grade machinery. To follow the development of the grinding machine from the crude toolpost grinder of the early sixties, to the present-day self-contained grinder capable of finishing such work as chilled rolls for steel mills, piston-rods for marine engines, and an endless variety of work of like nature that heretofore was finished by the slow process of turning, would without doubt be very interesting. For the present, however, let us merely consider a few of the methods employed by up-to-date concerns for obtaining the maximum output from the grinding machine.

The thoroughly up-to-date machinist who looks over the advertisements in the leading trade papers has probably noticed that the manufacturers of grinding machines are not at all bashful in their claims for the efficiency of their machines, and that several makers of grinding wheels play a close second. But notwithstanding all that has been published concerning the efficiency of grinding machines and grinding wheels, the average shop foreman seems to be perfectly satisfied as long as the operator of the grinding machine turns out work that is nicely finished, in just a little shorter time than it could be done by obsolete methods.

There are several reasons for this condition of affairs: One is that the average shop foreman served his time before the introduction of modern grinding; another is that the majority of grinding machine operators have made themselves believe that because they are employed on accurate work, they should be a long time in doing it. Among other reasons are the improper selection of wheels, slow traverse speeds of work, running the wheel too far over the ends of the work, grinding long work without backresting, setting the reverse dogs for each individual piece, and neglecting to use the automatic cross-feed. These are by no means all of the reasons for curtailed production. However, they are the most important to be considered in the problem of producing accurately ground work at minimum costs.

The average shop foreman who served his time long before the introduction of modern grinding methods, has had no practical experience concerning them. For this reason he is satisfied with results that otherwise would be more closely investigated. The makers of grinding machines and grinding wheels are at the present time getting excellent results and high efficiency with their products, and there is no good reason why the average shop foreman cannot get the same results, if local conditions will permit.

As mentioned, the average grinding machine operator seems to have the idea that because he is employed on accurate work, he should be a long time in doing it, feeling his way along carefully, and at the end obtaining the finish by the slow and out-of-date method of letting the wheel "grind out." In justice to the thousands of operators employed on grinding machines, it should be stated that the amount of time "killed" on the grinding job by "soldiering" is insignificant when compared to the time wasted through lack of knowledge concerning modern methods. In nine cases out of ten, the grinding machine operator did not have a competent man to "break him in" on the job. He had to work out his own salvation. It was a case of making good or getting fired. Therefore, he is not wholly to blame if he chose what seemed to be the easiest way of doing his work accurately. Another mistake, and one which is quite common in some localities, is to have the operator run two cylindrical grinding machines at once. The result is that one of the machines is running on a "blind" feed about half of the time. This may look all right, but it must be remembered that overhead expenses are going on while production is at a standstill. The practice recommended by the most successful makers of grinding machines, is that one operator should run but one machine at a time, in order that the machine may produce the maximum of work.

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "The Field for Grinding—A Comment," July, 1911; "Rough Turning vs. Rough Grinding of Crankshaft Pins," March, 1911; "The Field for Grinding," January, 1911; "Precision Grinding," January, 1911; "Grinding Economy," July, 1910; "Grits and Grinding Chips," June, 1910, engineering edition; "Economy in Grinding," May, 1910; "Cylindrical Grinding," May, 1909; "Helps and Don'ts for Grinding," August, 1908; "Grinding and Grinding Machines," April, 1908; "Precision Grinding," September, 1907, engineering edition.

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* * *

THE HUMOR OF RUNNING RAILWAY TRAINS ON TIME

The idea of arranging railway timetables so that trains can actually run on time seems very funny to the London *Globe*, judging from the article published in its columns a few months ago regarding the West of France State Railway. Why it should be so funny to make the actual running time of trains agree with published schedules used and relied on by the traveling public is not clear to us. Perhaps this is only another manifestation of a queer sense of humor that is said to pervade the British Isles. An extract from the article which was headed "Railway Humor," follows:

"A novel method of promoting closer harmony between railway timetables and the actual running times of trains has been adopted by the West of France State Railway. That the trains on most of the French lines rarely ever run to the scheduled time has long been notorious, but it appears that this little inconvenience has been satisfactorily overcome by the administration of the line mentioned above, and that in the simplest manner imaginable. If the trains will not run according to the timetable, what could be easier than to revise the timetable so as to keep pace with the lagging trains? Here is a scheme that the subtle "Bradshaw" probably never dreamt of, and hence, no doubt, its grim retention of that bewildering maze of mathematical facts—as they ought to be. For "Bradshaw" is no respecter of speed—or the lack of it. If a train is supposed to run from London to Birmingham in three hours, "Bradshaw" simply says so, and there's an end, even if the trains run twenty minutes late on each trip. But they have recently started arranging these matters better in France.

"The new winter timetable of the West of France State Railway is not based on preceding issues, but upon the actual times occupied by trains in their respective journeys during recent months. This system is certainly much easier than going to all the trouble of accelerating the service, and has besides the extra advantage that the trains on that line at least will no longer be late. Whereas hitherto the stipulated times of departures and arrivals were purely mythical, they will henceforth be statements of fact, unless, of course, it should again become necessary to apply additional brake power to the—timetable."

If this be humorous let all the countless travelers, who have wasted valuable hours at railway stations waiting for trains, join in one wild guffaw of laughter! Make timetables truthful? How ridiculous!

THE MANUFACTURE OF STEEL BALLS*

ROUGH GRINDING, HARDENING, AND FINISH GRINDING

By ROBERT H. GRANT†

In the article on ball making in the February number of MACHINERY, the methods of making the blanks and preparing them for the dry grinding were explained. In the present article the grinding and hardening operations will be dealt with. The old English method of grinding the balls was mentioned in the previous article, the balls being ground between two circular plates, the upper one of which was revolved by hand. The increased demand for balls in the bicycle industry soon brought about improved methods for grinding, the first step being to fasten the top plate to the spindle of a drill press, while the bottom plate rested on the table of the machine. In this way work was produced very much faster but no better quality was obtained than formerly.

Fig. 1. Battery of Early Type of Ball Grinding Machines

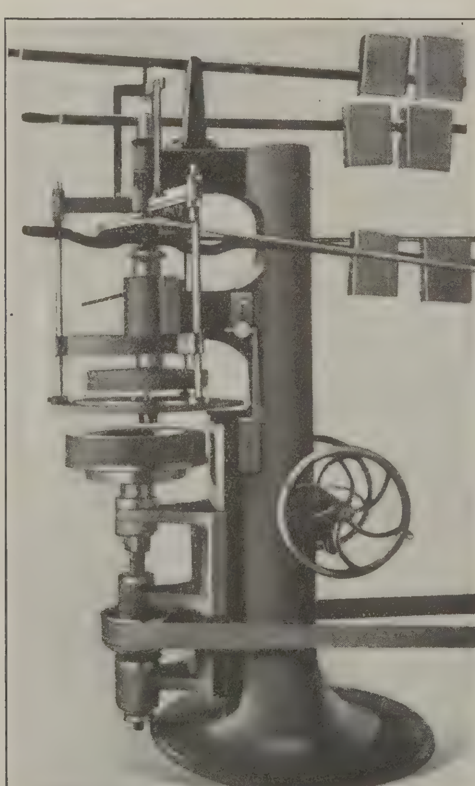

Fig. 2. Richardson's Ball Grinder

About the time when the first steel balls were manufactured in this country, special grinding heads of a much more substantial character were devised. Fig. 1 shows a row of oil grinders, such as were first made in this country. The head is made in the form of a goose neck, and has three bearings. The lower, or main, bearing has a quill the same as a drill press, with a rack cut in it. A lever with pinion teeth cut on the end meshes with this rack and provides the means for raising and lowering the head. The spindle, which has a large faceplate fastened to the lower end, carries the upper grinding ring, which is fastened to the faceplate by three screws. The main drive is through a set of bevel gears on the countershaft directly over the spindle of the machine. A vertical shaft transmits the power from the countershaft to the spindle. As all the blanks at this time were either pressed or forged, instead of being turned, the amount of stock to be removed was considerably more than it is when turned ball blanks are used. For this reason the time required for grinding ¼-inch balls was from one-half to three-quarters of an hour, and if the rings were badly worn the balls would come out of the grinder considerably out of true. It was, therefore, necessary to devise a better and quicker process—a rough grinder—for removing the surface of the balls. It is especially necessary to remove the surface to some depth when the balls are forged, as the outside is then apt to be decarbonized.

The Richardson Rough Grinder

The first rough grinder for balls, as far as the writer knows, was made by Mr. Henry Richardson, president of the Waltham Emery Wheel Co., Waltham, Mass., in 1877. Mr. Richardson, in speaking of this machine, has mentioned a few interesting facts about his experiments along this line. He took a regular 16-inch bastard file and ground a 90-degree groove in the center, almost the entire length of the file. The groove was ground clear through the file so that it would allow a 5/16-inch ball to project through to such an extent that the ball could be ground by a wheel without the latter touching the file. An emery wheel was then fastened to the faceplate of a lathe, and the file was clamped to the carriage in a vertical position. A plate with an elongated slot, which could be moved up and down on the tailstock spindle, was then made. The file with the balls was now placed against the emery wheel, and the plate on the tailstock was placed against the balls. The lathe was then started. The balls at once began to move in the V-groove in the file, and by moving the plate on the tailstock spindle up and down, the balls were turned in all directions, producing in a very short time a blank which was a comparatively true sphere.

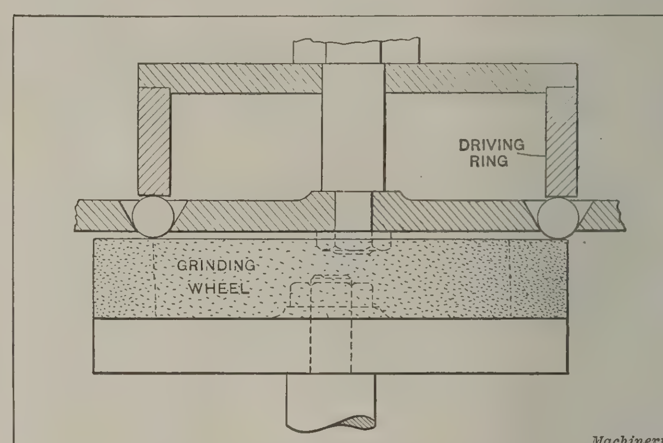

Fig. 3. Diagrammatical View of Principal Arrangement in the Richardson Ball Grinder

Mr. Richardson then made a trial machine which worked very satisfactorily, but as a photograph of this machine was never made, no record of its appearance is preserved. In 1878 he went to England and sold the English patents to Mr. Wm. Bown. A sample machine, as shown in Fig. 2, was made at this time. The patent held by Mr. Richardson did not, however, properly cover the invention, so that he was unable to get full returns for his efforts. The only claim of any im-

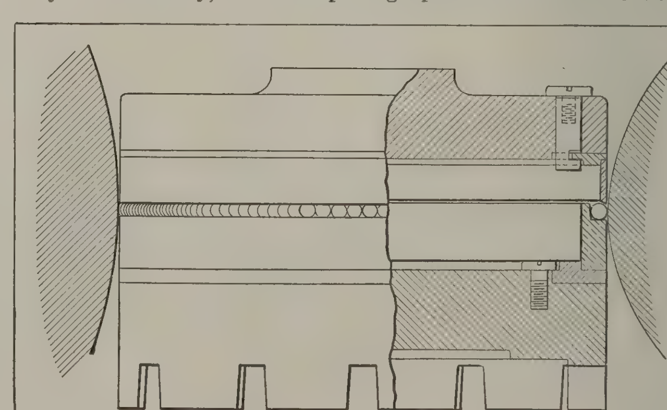

Fig. 4. Principle of the John J. Grant Rough Grinder—U. S. Patent No. 535,794

* See MACHINERY, February, 1912: "The Manufacture of Steel Balls—Making the Blanks."
† Address: 912 Oakland Ave., Ann Arbor, Mich.

portance which he held was as follows: a ring of balls in a V-groove, revolved by a driving ring and exposed to an emery wheel. This claim was the direct result of his experiments, and by itself was very far-reaching. It gave the ball makers, who soon began to spring up all over the country, a great deal of trouble in their efforts to "go around" it.

As shown in Fig. 2, the emery wheel is placed on the lower spindle which is mounted in the movable head; this head is operated by the handwheels at the rear of the machine. The emery wheel is eccentric with the top ring, so that the whole surface of the wheel will successively come in contact with the balls. This keeps the wheel in perfect shape. The V-groove in which the balls rest is formed by two annular rings or plates (see diagrammatical view in Fig. 3); the outer one is held and adjusted by three long bolts (shown in Fig. 2), while the inner plate is fastened to a rod which passes through the drive shaft to the top of the machine. This inner plate is operated by the middle lever shown, so that the balls thus can be "dropped" when finished. The driving ring which revolves the balls is adjustable in an up and down direction by means of the lower lever, and is clamped in the proper position by the small lever on the main bearing.

upper or driving ring was so thin that it was possible to grind but a few balls before the emery wheel would wear it away. As shown in Fig. 4, the balls were held at the periphery of the stationary ring in a V-groove. The drive ring was extended over the balls far enough to drive them, and was driven by a pulley on the spindle which held the drive ring. The speed was not over 60 revolutions per minute. A saddle, which was stationary on the base of the machine, carried the emery wheel heads, each head having two wheels, so that the surface coming in contact with the ball would be as wide as possible. The driving pulley was placed between the emery wheels, all being driven from the same countershaft. The upper or drive ring could be raised by a lever at the top of the machine, and the lower ring could be revolved by throwing out a latch with a foot lever. This allowed the machine to be loaded and unloaded very rapidly. Notwithstanding the fact that this machine was very slow, as compared with the Richardson machine in which the emery wheel was on the balls at all times, it was successful, and it was possible for the Simonds company to produce a ball better than those produced by any other manufacturers, and the company, therefore, soon controlled the ball trade.

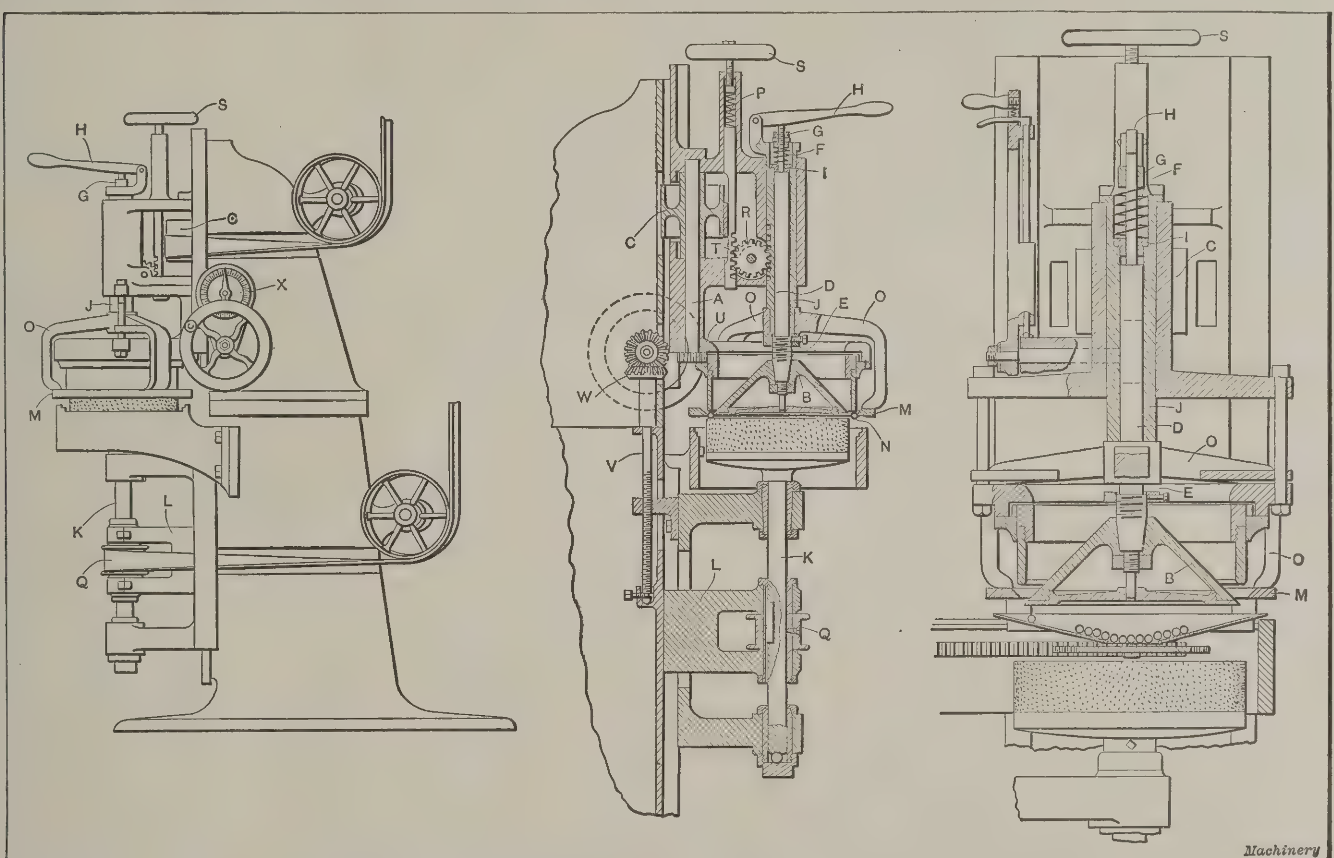

Fig. 5. Robert H. Grant Dry Grinding Machine—U. S. Patent No. 520,019

This driving ring runs in the opposite direction to the emery wheel; the latter is run at a peripheral speed of approximately 5000 feet a minute.

On account of the fact that the outside of the balls run faster than the inside, as they are driven around by the drive ring, the balls assume a spiral motion, thereby exposing all sides to the emery wheel. An approximately accurate sphere is thus produced.

The John J. Grant Rough Grinder

In 1888 when the Simonds Rolling Machine Co., of Fitchburg, Mass., was grinding balls by the old English method, it could only produce balls which were true within 0.003 inch. This accuracy was considered sufficient at that time. Mr. John J. Grant, who was at that time employed by this company, and who had improved the Simonds rolling machine, proceeded to devise a machine which made it possible to produce balls far superior to any ever made. The principle of his first machine, which was a rough grinder, is shown in Fig. 4. This machine produced excellent work, but was very slow in its operation, as the balls had to travel one-half of the circumference of the groove in the ring without coming in contact with the emery wheel. On balls of smaller sizes, the

In 1891, the Grant Anti-Friction Ball Co. was formed by Mr. J. J. Grant, and a great many experiments in the dry grinding of balls without the V-path and drive ring were undertaken, but the experiments were not successful. It was, therefore, necessary to buy Mr. Richardson's patent, and around this was built the most successful dry grinder ever produced.

The Robert H. Grant Dry Grinder

In Fig. 5 are shown general and sectional views of the grinding machine designed by the writer, as originally made. It will be seen that the Richardson path is used in a modified form. The drive ring is driven through a gear on the drive ring holder, this gear, in turn, being driven by pinion U which is fastened to the shaft A. This shaft carries pulley C at its upper end. The cone B has a plate with hardened segments screwed to its lower end which form the inner part of the race N. The cone is fastened to the shaft D which is adjustable by collar E. On the upper end of the shaft is a spring F which is compressed between the collar I and the adjustable sleeve G. By means of the lever H, the shaft D can be lowered, thereby allowing the balls to drop into a receptacle after being ground, as shown in the view to the right. On the

rear of the quill J, which carries the shaft D, is cut a rack in which pinion R works. The shaft T which operates pinion R is adjusted by the spring P, controlled by the handwheel S. On the lower part of the quill J is fastened the spider O which carries the ring M, to which are screwed the hardened segments forming the outer path.

It will be seen that when the rough forgings are placed in the V-path, the driving ring is stationary, but the inner ring can vibrate on account of the action of the spring F. The outer ring M is permitted to vibrate slightly through the means of the spider O, quill J, pinion R and spring P. In this way the rough forgings will be ground only on the high spots until the balls become round.

The loading and unloading is done without stopping. When the balls are finished, the emery wheel is lowered and a pan is pushed under the path of the balls. The handle H is pulled down, thus allowing the balls to fall into the pan. The spider O is then lowered by means of the lever on the end of the shaft carrying pinion R. This allows the balls to be ground to be fed into the path N, and permits the grinding to commence without interruption.

The emery wheel, which is eccentric with the path of the balls, so as to allow the balls to successively cover the whole surface of the wheel, is carried by the lower head. The spindle K carries the pulley Q which is driven by a belt running over idlers to the countershaft above. Head L is raised and lowered by the screw V and the bevel gears W. The indicator X, having a pointer as shown, is connected to this mechanism, and shows the operator how many thousandths inch more he must remove from the balls. With the introduction of this machine the cost of making balls was cut in two, and the quality obtained was far superior to anything which had so far been produced.

The Hawthorne Method of Rough Grinding

About the time when the writer had designed the machine just described, the Hawthorne Mfg. Co., of Bangor, Me., decided to enter into the manufacture of steel balls. This company originally manufactured boot calks and other lumbermen's supplies. Some articles were manufactured for this concern by the Simonds Rolling Machine Co., and representatives of the company frequently visited the Simonds plant. They observed the great number of balls that were beginning to be used in this country, and hence concluded to enter into this field. The first grinder employed by this company made use of sand instead of emery. A bed of sand had been found in which the grit was so hard that it would cut the surface of a ball and last for a considerable length of time before being pulverized. The grinding was done in a closed path in which water and sand were used freely. The sand was fed from bins overhead, and washed out by water when pulverized. This was a very cheap process, as far as the grinding material was concerned, but did not produce a perfectly spherical blank. The oil or finishing grinders had to be relied upon to round up the balls, and a great many seconds and thirds were produced. The process was applicable, however, to the small balls mostly used at that time, nearly all balls being employed in bicycles. For larger balls, such as are now used in automobiles and other machines of the present day, these machines would have been useless.

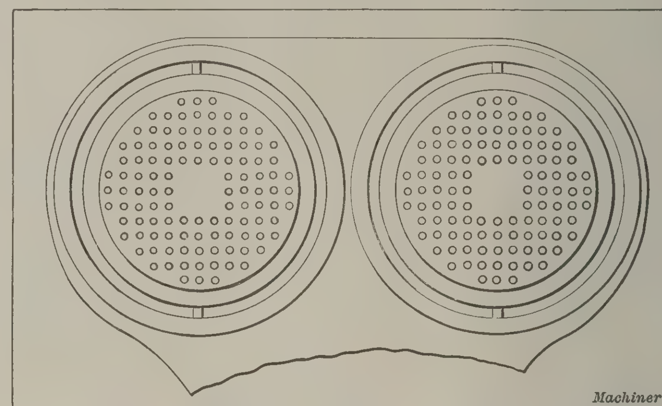

Fig. 8. Arrangement of Balls in the Putnam Grinder

The Putnam Ball Grinding Machine

About 1899, Mr. H. M. Putnam, who for several years was connected with the Simonds Rolling Machine Co., started the Fitchburg Steel Ball Co., and invented a dry grinder, as shown in Figs. 6, 7 and 8. This machine, which had to be constructed without the Richardson path, was made in the following manner: The lower plate A which corresponds to the drive ring, was driven through the tube B which carries the pulley C. The plate D which is countersunk as indicated at E, Fig. 7, (see also Fig. 8) is made from saw steel and hardened; it is then forced onto spindle F which carries pulley G. The cylinder H is adjustable by means of the screw thread K, and can thus, by means of handwheel O, be raised or lowered by the operator so that the balls will come in contact with the emery wheel L. This wheel is fastened to the upper spindle N, which

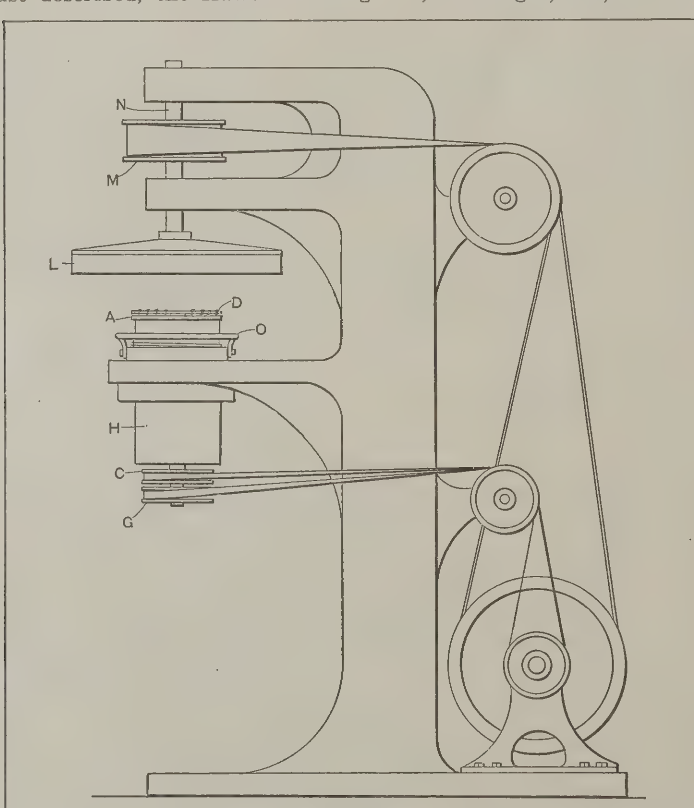

Fig. 6. The Putnam Dry Grinder—U. S. Patent No. 664,823

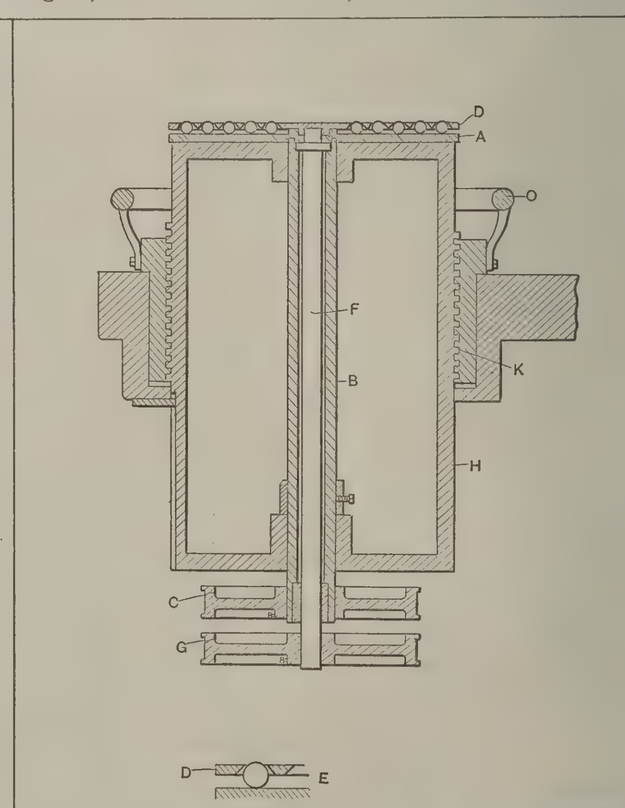

Fig. 7. Details of Principal Parts of the Putnam Grinding Machine

is driven from pulley M by a belt passing over two idler pulleys to the countershaft on the floor, as shown. This machine is very simple, but it does not grind an accurate ball on account of the balls being at various distances from the center, thereby giving them different rates of speed. The outer balls are ground faster than those at the center, and thus balls of all kinds of diameters and degrees of accuracy are produced. The balls are not held firmly in the path as in the Richardson grinder, but are simply confined in the countersunk holes so that they will not be thrown from the plate. This allows the ball to take its own course, and it becomes badly out of round

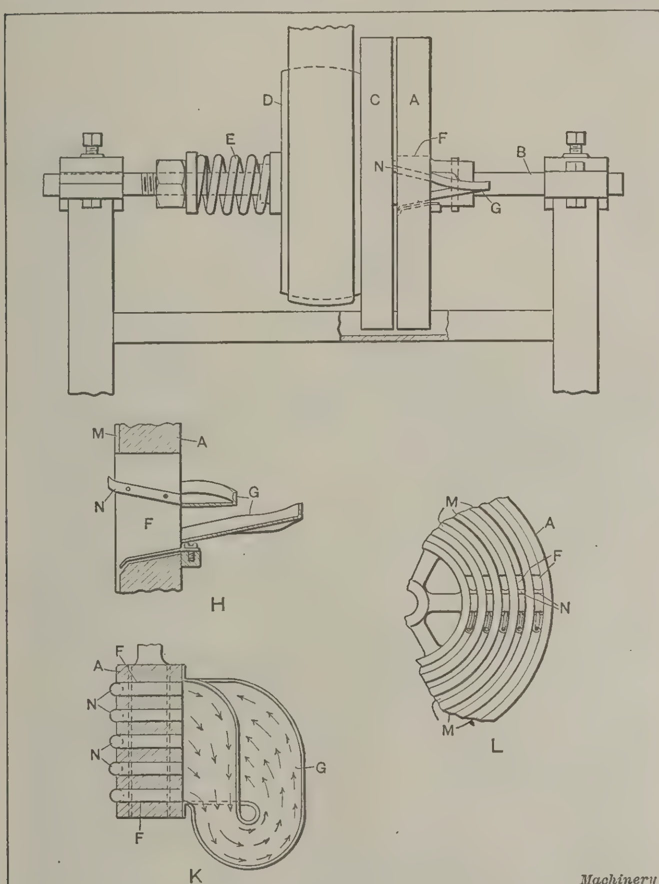

Fig. 9. The Hoffmann Ball Grinding Machine—U. S. Patent No. 803,164

during the grinding process. The writer is of the opinion that this machine might have been improved, but the company discontinued business soon after the machine was built.

The Chicago Steel Ball Co.'s Grinder

About the same time the Chicago Steel Ball Co., of Chicago, Ill., brought out a dry grinder which had several good features, and which was somewhat similar in operation to the well-known Hoffmann machine which will be described in detail in the following. The Chicago Steel Ball Co.'s machine had the emery wheel and the drive wheel placed in a vertical position. There were several concentric circular paths on the drive ring, and the balls were transferred from one into another, thus giving the balls a different spiral motion on account of being at various distances from the center. This machine ground a very accurate ball, but on account of its poor construction and the poor method used for transferring the balls from one path to another, it was but little used, and, therefore, had no particular influence on ball manufacturing methods.

The Hoffmann Grinder

What may be considered as one of the best ball grinding machines constructed was invented in 1905 by Mr. E. G. Hoffmann, who was at that time connected with the Hoffmann Ball Co., in England. This machine required several years for its development, but when completed it produced a very accurate ball, and is greatly appreciated by ball manufacturers.

In the article on ball manufacture published in the February number of Machinery, the Hoffmann ball turning machine was described. The blanks produced by this machine are accurate, and but little grinding is required on them. These balls, therefore, are especially suited for grinding in the Hoffmann grinder, as this machine is very slow, and cannot be used to advantage on pressed blanks or forgings, unless they have been previously rough ground by some other process. The machine is automatic, and requires little or no attention, except for gaging the balls at intervals during the grinding. The machine requires from three to five hours for removing 0.001 inch on a ½-inch ball.

In Fig. 9, diagrammatical illustrations of the Hoffmann machine as originally designed, are shown. Pulley D is driven by a belt from the countershaft, and revolves upon a stationary shaft B. The pulley is fastened to the disk C which has a series of grooves in its face. Plate A, which also has a series of concentric grooves to correspond with those on disk C, is stationary and is fastened to shaft B. The balls are placed in the machine so as to fill all the concentric grooves, spring E forcing disk C against plate A, thus holding the balls in place. The machine is then started, and the balls, by means of the mixer and interchanger shown in two views at H and K, are changed from one groove to another.

As indicated at H, K and L, slots F are cut through the stationary disk, a slot being directly opposite each of the grooves M. In each slot is placed a finger N which projects slightly beyond the bottom of the groove into the corresponding groove in the rotating disk C. The function of the finger is to stand in the path of the balls so as to positively dislodge each ball from the groove as it reaches the point where the finger is located. Each finger discharges the ball from the corresponding groove upon a table G which affords a surface upon which the balls may roll, and which also directs the balls back toward the grooves below the fingers, the table being slightly inclined toward the lower portion of the slots F. It will be seen that this keeps the balls moving from one groove to another so as to place them at

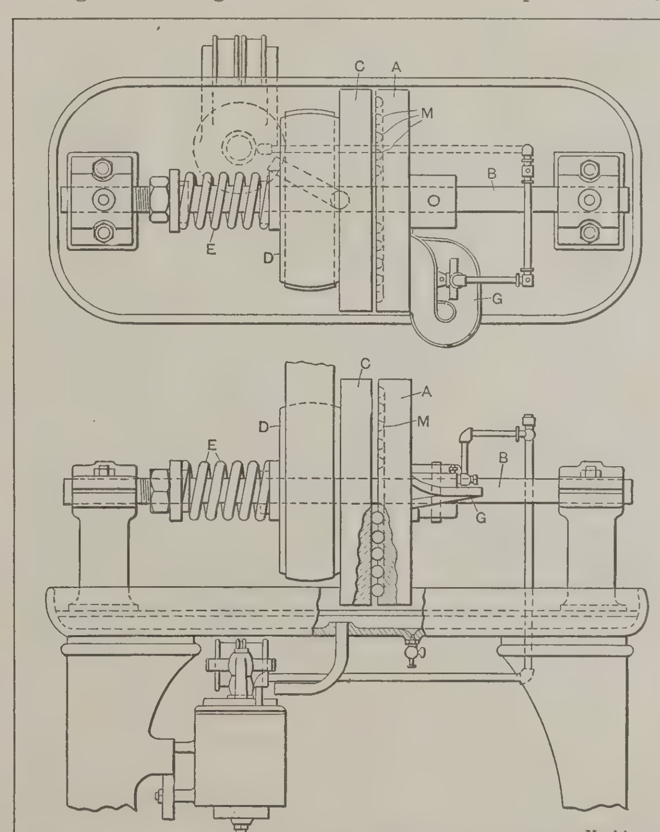

Fig. 10. Improved Hoffmann Ball Grinding Machine—U. S. Patent No. 868,926

different distances from the center at each revolution of plate A. This results in the grinding of a very accurate ball.

The grinding is done with oil and emery introduced in the required quantities upon the table G, and fed into the machine by the balls. This machine was further improved by the introduction of an emery wheel in place of the grinding ring C. The improvement was very marked, as the grinder C, when made of cast iron, was apt to be spongy, and softer in some spots than in others; it would, therefore, quickly wear out of shape. The replacing of this disk by the emery wheel overcame these difficulties. Kerosene oil is used to keep the grooves clear of the loose particles of abrasive material, and

prevents the balls from being badly scratched or cut. A very peculiar fact about this grinder is that the emery wheel is run at only 75 revolutions per minute, instead of at the peripheral speed of 5000 feet, generally required by emery wheel manufacturers.

Annealing and Hardening

After the balls have been rough ground so as to remove all scale and decarbonized surface resulting from the forging operation, they are taken to the hardening room where they are first annealed. This annealing removes any internal stresses caused by forging or other methods of blanking. The

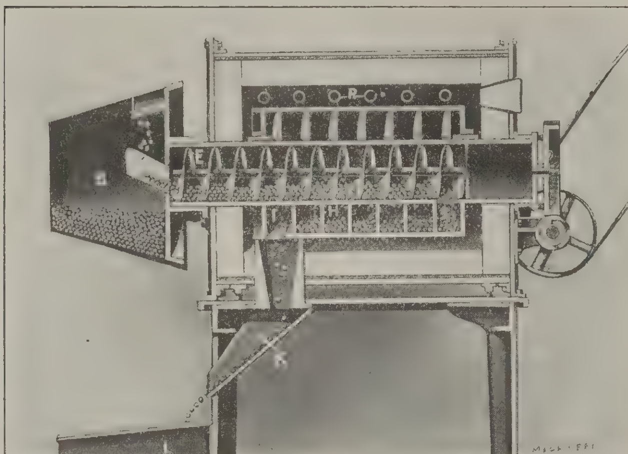

Fig. 11. Section of Ball Heating Furnace, made by the American Gas Furnace Co.

process, as indicated in Fig. 11, is automatic. The balls are fed into the hopper *B* which is revolved by a worm and worm-wheel placed at the opposite end of the machine. From this hopper the balls are fed into the spiral *E* which they follow until they reach the opposite end, where they drop into the outer spiral *H*, which is revolved in the opposite direction. Finally the balls fall out of the cylinder at *I* into the funnel *K*. The machine is heated by gas with burners at *R*, thus preventing the heat from coming into direct contact with the balls and decarbonizing the surface.

After being annealed, the balls are put through the same machine to be heated for the hardening. They are heated to exactly 1275 degrees F., the temperature being determined

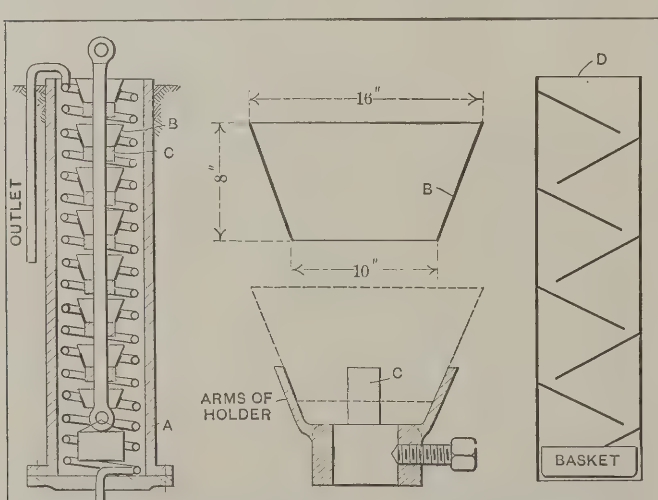

Fig. 12. Tanks used for Quenching Balls

by a pyrometer. The thermo-couple is placed near the point where the balls leave the cylinder.

The smaller balls are dropped into a reservoir of oil, while the larger ones are immersed in brine. The oil reservoir, shown at *A* in Fig. 12, consists of a length of 30-inch water pipe, one end being provided with a head strongly bolted to it so that it is water-tight. The pipe is sunk into the ground so that the top can receive the balls, as indicated at *L*, Fig. 11. Inside of this cast-iron pipe is placed a coil of 1¼ inch water pipe, in which cold water is circulated in order to keep the bath cool. A rod with a number of inverted galvanized iron cones *B*, adjustably fastened onto the rod by the holders *C*, is then placed in the bath. (Parts *B* and *C* are also shown in detail in Fig. 12.) When the balls drop into the bath in the pipe, they strike the side of the upper cone, which shoots them off at an angle until they strike the opposite side of the next cone; this reverses their direction of motion, so that they reach the basket at the bottom in a zigzag path, thoroughly cooled off. When the balls are thus cooled off, the rod with the basket at the lower end is pulled out, and the balls in the basket are allowed to drain, the oil draining back into the pipe.

The best oil for the hardening of balls is cotton-seed oil; while it is very expensive, it has sufficient body to cool the balls thoroughly, and it does not need to be replaced. It is only necessary to add to it, from time to time, due to the loss from evaporation.

The larger balls are hardened in brine. The machine shown in Fig. 11 is placed at the edge of a tank of the type shown at *D*, Fig. 12. This tank has a series of shutters made in the form of steps overlapping each other as indicated. These steps force the balls to traverse in a zigzag path through the brine in the tank for a considerable time before dropping into the basket at the bottom.

Fig. 13. General View of the Grant Dry Grinding Machine, with Samples of Largest and Smallest Balls ground in it

The largest balls are heated for hardening by being placed on the tiling of a regular casehardening furnace, similar to that made by the Brown & Sharpe Mfg. Co., and are allowed to heat slowly through to the center, the balls being revolved gradually. Two or more balls, according to size, are then placed in a wire basket and rapidly swung to and fro in the brine tank until thoroughly cooled off. All balls, as soon as they are taken from the hardening tanks are placed in a kettle of boiling soda, not only for the purpose of washing them, but also to prevent the air from coming in contact with them at a time when they are extremely hard. The balls are then placed in the drawing kettles, which are filled with oil heated to 325 degrees F.

Finish Grinding

The balls are now ready to return to the finish dry grinding department, where the same machine as shown in Fig. 5 is used (except that a finer grade of emery wheel is employed) to reduce the balls to the proper size for the oil grinders. For this finish dry grinding the inner and outer segment are ground true, so that the path formed is a perfect track for the balls.

In Fig. 13, the improved Grant machine (Fig. 5) is shown, with the two extremes in size of balls which this machine will grind. In Fig. 14 is shown the special grinding machine which is used for grinding the segments that form the path for the balls. These special grinders are very simple in construction, the wheel head being solid and the spindle on which the segment plate is fastened being driven by a worm through a shaft from a pulley in the rear. The two adjustments up and down and in and out are operated by the shafts which project in the front. By this grinding, the segments are made absolutely true, and by grinding the drive ring by the emery wheel on the machine on which it is used, the balls will make contact on three points absolutely true with each other, and hence the balls produced will be absolute spheres, ready for the final oil grinding.

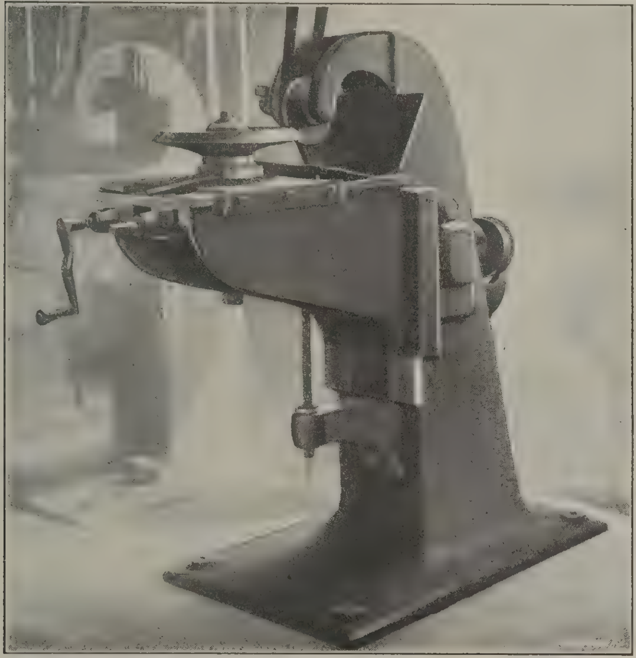

Fig. 14. Special Grinding Machine used for Grinding the Segments for the Path of the Balls in the Machine shown in Fig. 13

Fig. 17 shows the ordinary type of oil grinders. These are usually placed in groups of three. The machines are provided with a quill, on which a rack is cut for raising and lowering the head by means of the lever shown projecting at the front of the machine. The machines run about 450 revolutions per minute. The oil grinding constitutes the final finishing operation, and requires considerable skill. The operator must know just how much oil and emery to use, and how long to run the rings so as to make the balls round up.

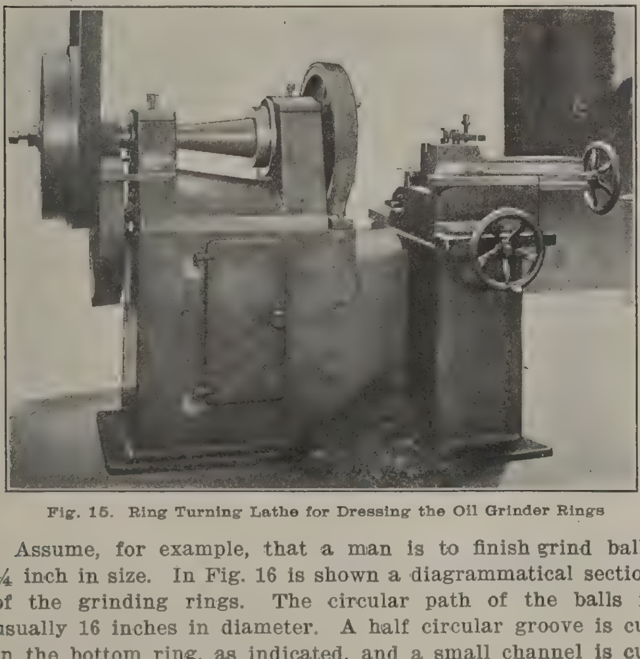

Fig. 15. Ring Turning Lathe for Dressing the Oil Grinder Rings

Assume, for example, that a man is to finish grind balls ¼ inch in size. In Fig. 16 is shown a diagrammatical section of the grinding rings. The circular path of the balls is usually 16 inches in diameter. A half circular groove is cut in the bottom ring, as indicated, and a small channel is cut at the bottom of the groove to allow the oil and emery to reach the bottom of the ball. The top ring is simply a cylinder shrunk onto a plate. This plate can be used over and over again, by merely breaking off the cylinder when used up and shrinking a new ring in place. The upper cylinder has a shallow groove in it for the balls. After the balls have been placed in the ring, the oil and emery are poured in, and the upper ring is lowered onto the balls, the machine then being ready to start. The ¼-inch balls should have 0.006 inch left for the finishing operation. The operator gages the balls and sets his clock on the head of the machine as many minutes ahead of the clock in the room as he knows will be required to obtain very nearly the final size. At this time he must stop the head and again measure the balls. The operator runs three heads, and as each head finishes its work at different intervals, he has ample time to stop any one head and take out three or four balls from different parts of the ring. After washing them in benzine, he measures them with his micrometer, testing both the size and roundness; if not to size, he replaces them and applies the required amount of oil, emery and speed, until he obtains a ball that is as nearly perfect as possible in all respects.

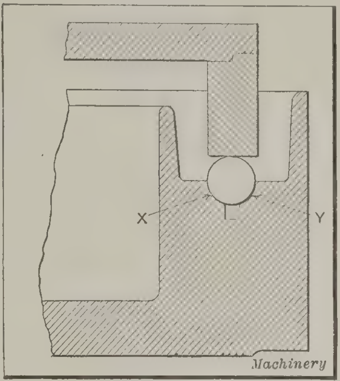

Fig. 16. Illustration of Principle of Action of Oil Grinders

The grinding ring should be of porous medium soft cast iron, as the oil grinding is merely a lapping process, and the

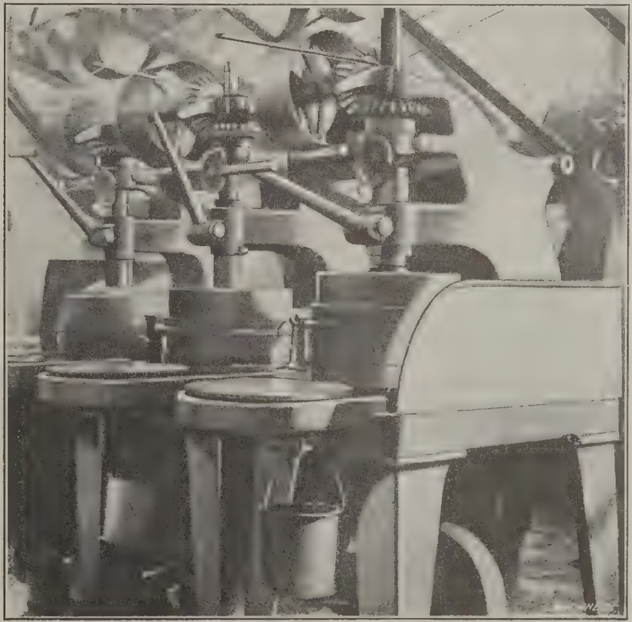

Fig. 17. The Oil Grinders

ring must wear away to allow the balls to round up. On account of the larger diameter at the outside Y than at the inside X of the balls, Fig. 16, there is a greater peripheral speed at the outside. This causes the balls to move in a spiral path as they revolve, so as to bring all points of the surface in contact with the ring. The operator, when using a new ring for the first time, must make allowance for the ring not having become penetrated with emery, and also for its being cold. Later the output can be greatly increased. The heads on the grinders must be kept in perfect alignment, so that the balls will be ground on the entire circumference of the rings.

Fig. 15 shows a special ring turning lathe for dressing the oil grinder rings. It is necessary that these rings be free from chatter marks and imperfections of any kind, so that even the first sets of balls ground by them will be perfect; otherwise the first balls would have to be classified as seconds or thirds on account of poor grinding.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

MARCH, 1912

PAID CIRCULATION FOR FEBRUARY, 1912, 25,095 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

SHOULD ENGINEERING SOCIETIES PAY FOR CONTRIBUTIONS?

The papers read before American engineering societies are of two main classes. One class describes installations of machinery and apparatus, and the considerations that had to be taken into account by the engineers in charge. These papers are generally valuable and unobjectionable, notwithstanding their advertising nature. The advertising that the concerns and engineers get from the presentation of papers is the incentive that causes them to be prepared. The other class comes from college professors, and chiefly describes tests conducted by students for their theses. The professor advertises himself and his college with little effort by giving the results of his students' investigations in a paper. These papers are legitimate and commendable when the investigations have led to results of practical value. Both classes of papers are contributed at little or no cost to the authors and mean little or no personal sacrifice.

A third class of contributions, of which there are entirely too few examples, comes from men who give their personal time and energy to the subjects of their papers. They give freely to the engineering world that which has cost them much thought and time to reduce to a form that can be generally understood and appreciated. Great credit is due them for their generosity and enterprise. But, is the brief recognition accorded these able men adequate compensation? Is not the American Society of Mechanical Engineers losing many valuable contributions that would be offered by individuals if they could afford to give the time and labor to their preparation? How can the difficulty be met except by offering compensation for the results of investigation made by men who cannot afford to give their work freely?

The society's sub-committee on machine shop practice is required to present those details of practice that can be collected and described only by the men in daily contact with the conditions of manufacturing. These men are generally paid wages much lower than the salaries of engineers, yet we ask them to contribute their time and energy for the benefit of the mechanical engineering world. Their reward is the honor of having their papers read before the society, which is probably highly appreciated, but which may be of little actual value to the individual. Will the ethics of engineering societies prevent doing what seems necessary to secure the records of the most advanced practice?

* * *

HARDENING VS. TEMPERING

A contributor to MACHINERY has written a letter in reference to the tool tempering furnace described in October, 1911, taking exception to calling it a tempering furnace when it is clearly a hardening furnace.

The exception is well taken. Every reader of MACHINERY who knows anything about hardening steel is well aware of the distinction between hardening and tempering. To harden a piece of carbon steel, we must heat it to a "cherry red," then quench it in a bath which is usually pure cold water. In the state produced by cooling in the bath the steel is too hard for use, being brittle and liable to chip or crack. The hardness is reduced by heating the piece to the temperature which experience has demonstrated to be sufficient to reduce the hardness to that consistent with the use of the tool.

Heat treatment of carbon steel almost invariably consists of two operations, first hardening and then "drawing" the hardness or tempering it to the required degree. The definition of "tempering" in the Standard Dictionary, edition of 1899 is: "To bring (a metal) to a certain degree of hardness by heat and suddenly cooling. In tempering steel, the metal is usually heated until it assumes a color, as yellow, brown, purple, or blue, and then plunged into water. The degree of heat (as shown by the color) at which the cooling takes place determines the degree of hardness."

This definition clearly shows a lack of understanding of the distinction between hardening and tempering, but in justice to the lexicographer it may be said that tempering is a term that is often loosely used to mean both hardening and tempering, that is, both operations necessary for the proper heat treatment of carbon steel, although it should not be so used by those who know and understand the true meaning of the term.

* * *

THE GROWTH OF THE MOTOR TRUCK INDUSTRY

The recent automobile shows held in New York City were startling revelations to many business men of the importance of the motor truck industry, from both the manufacturers' and users' standpoints. For several years it has been the fashion of editors, economists and others to deplore the fact that the inventive genius and manufacturing enterprise of the country apparently was almost exclusively concentrated on the improvement and construction of automobiles for pleasure. It seemed that the more useful and enduring business of commercial car building was practically neglected. While these strictures were in the main true, the developments of the past two or three years show that a substantial body of designers and builders was planning and making commercial vehicles that are satisfactorily meeting the exacting demands of business in large cities and towns.

Commercial trucks have arrived at the practical stage, and although they still have defects and undesirable complexities, the men capable of operating them are becoming available, and business concerns are using them. The expense of keeping horses in large cities grows greater every year. Stables must be located where rents are low, and this means in sections generally remote from business centers. The time lost in traveling between the stables and the warehouses is a serious item which becomes still more serious in Manhattan where stabling is available mostly in Brooklyn and Jersey City. Ferriage and bridge tolls are added costs of daily operation.

In times of weather stress, horses are subject to accidents and the ills incident to exposure. Loads must be reduced or teams doubled to move normal loads. The motor truck is subject to mechanical troubles, but its practically unlimited power, great capacity, speed and short overall length are advantages that will become more and more apparent as drivers become trained to operate trucks efficiently.

To secure greater efficiency of men and trucks, power loading and unloading facilities will be developed. These will not only accelerate the moving of freight, but will make the operation of power trucks more attractive to a desirable class of men. One of the existing difficulties is getting men competent to drive motor trucks who are willing and able to handle heavy boxes and parcels. Cranes that will lift a box from the sidewalk to the truck will make the loading quicker, easier and safer for men and merchandise.

It is interesting to reflect on the change that will inevitably develop in the personnel of truck drivers. As a class they are now known as ignorant, "horsey" and abusive men, more familiar with saloons than churches. When they become largely a class of men trained to efficiently control powerful road locomotives, the discipline of mind and body necessary to the understanding of machinery and its control must necessarily produce in them the characteristics of a more desirable class of citizens. A drunken driver of a power truck will be too dangerous to tolerate, and he must disappear.

* * *

STANDARDIZATION WORK OF THE S. A. E.

The work of standardizing the characteristics of automobile elements undertaken by the Society of Automobile Engineers is proceeding satisfactorily, notwithstanding the many difficulties that beset it. The general method followed is adjusting shapes, center distances, dimensions and capacities of accessories to common standards that will insure interchangeability, and thus make possible variations of the equipment without necessitating changes in the construction of the basic structure to accommodate them.

Standardization will enable the manufacturer and the user of automobiles to change from one make of motor car element to another at pleasure. Take for example the magneto. To secure interchangeability of magnetos, it is essential that the distance from the base to the shaft center of all magnetos shall be a standard dimension; also that the distance from the bolt holes to the end of the taper shaft, the taper of the shaft and the overall height, length and width, be common. Within these restrictions, each maker will be free to express his ideals of construction and design without interference. The advantages that should accrue from this standardization work, carried on as it is under the direction of representative automobile engineers, can hardly be overestimated.

The work of the committees also includes fixing the physical and chemical characteristics of aluminum and copper alloys, iron and steel, etc. Committees have been appointed on the following subjects: aluminum and copper alloys, ball and roller bearings, broaches, carbureters, frame sections, gear tooth shapes, iron and steel, leaf and coil springs, lock washers, miscellaneous parts, automobile nomenclature, seamless steel tubes, sheet metals, truck standards, wheel dimensions and fastenings for tires. The secretary of the society in alluding to the difficulties of the work says:

> The old-fashioned practice of wrapping a given process up in mystery, or surrounding it with a halo of secrecy still persists. Trade secrets still exist and petty jealousies still continue, and all of these prevent frankness and the accumulation of complete committee knowledge. It is not fair to ask that all trade secrets be laid before committees, nor is it necessary that trade secrets should be exposed in order to give sufficient knowledge to a committee to enable it to proceed intelligently. It is fair to ask that all personal feeling and all trade jealousy be laid aside for the benefit of all concerned. The work of our society in adopting standards has received hearty recommendation from many outside sources, and only a few comments to the effect that the society was attempting the impossible. It is probably a safe statement to make that even these unfavorable comments would not have been made had the writers of them been familiar with what the committee were really trying to do. The adverse critics have been universally those who have not come forward, attended the meetings or even read any of the material placed before them.

* * *

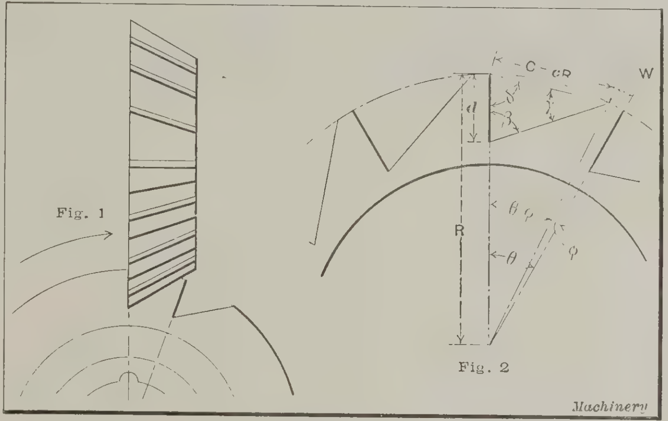
Practically all the vanadium used in the United States is obtained from Peru, South America. Extensive deposits of vanadium ore are located there and are controlled by American interests.

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS*†

By GEORGE W. BURLEY‡

The ordinary method of setting the fluting cutter when milling axial teeth in cutter and reamer blanks, parallel to the axes of the blanks, is a cut-and-try method which, while it may give fairly good results in the hands of a skilled operator, is nevertheless rather wasteful of time and, in the majority of cases, indefinite in its results. The first part of the operation is to set the fluting cutter central with respect to the axis of the blank. In other words, where the fluting cutter is a single-angle cutter—as is usual for this class of work—it is arranged so that the vertical face is in the vertical plane passing through the axis of the blank, as is indicated in Fig. 1. The next step in the operation is to arrange the cutter so as to obtain the correct depth of flute. This is done by raising, in the first place, the knee, table, and blank an amount which, under any given circumstances, experience has indicated to be approximately correct.

With the blank in this position, two consecutive grooves are milled, the movement of the blank when indexing being in the direction represented by the arrow in Fig. 1. If the width of the land formed between the two grooves is about right, the position of the blank is assumed to be correct, and all the teeth are cut with the blank in this position. If the width of the land appears to be too great, the blank is further elevated so as to deepen the grooves, the amount of additional elevation being left entirely to the judgment of the operator. If the width of the land is too small, then the blank is lowered



Figs. 1 and 2. Diagrams illustrating Method of Finding Formula for Depth of Tooth Space

slightly to reduce the depth of the cut and increase the width of the land. This is obviously an inexact method and one not calculated to produce satisfactory results.

An exact method of determining the depth of the cut required for any given conditions in regard to the number of teeth to be cut in the blank, the diameter or radius of the blank, the angle of the fluting mill, and the width of the land to be formed, can, however, be adopted, the result of applying such a method always being satisfactory. The following is a consideration of the case. The conditions are shown in Fig. 2.

Let

* With Data Sheet Supplement.

† The following articles relating to the design and manufacture of milling cutters and reamers have previously been published in MACHINERY: "Setting Angles for Inserted-tooth High-speed Milling Cutters," December, 1911; "Face Milling Cutters for Finishing," December, 1911; "Milling Radial Teeth in Cutter Blanks," November and December, 1911, engineering edition; "Recutting Milling Cutters without Annealing," December, 1911; "Method of Setting Cutter for Fluting Spiral Mills," September, 1911; "Fluting Spiral Mills," August, 1911; "Fixture for Backing off Milling Cutters in the Lathe," June, 1911; "The Making of Reamers," July, August, and September, 1911 (see also the articles referred to in a note with the July installment); "Relief of Teeth of Cutters and Reamers," May, 1911; "Milling Cutters and Their Efficiency," May, 1911, engineering edition; "Reamers for Cutting Brass," April, 1911; "Spacing the Cutting Edges of Reamers," February, 1911; "Spacing of Cutting Edges of Reamers," November, 1910; "Apparatus for Hardening Milling Cutters," June, 1910; "Nicked Tooth Milling Cutters," April, 1910; "Milling Cutters with Inserted Teeth," December, 1909; "Length of Recess in the Bore of Milling Cutters," December, 1909, engineering edition; "Lathe Attachment for Backing off Teeth of Stepped Reamers," November, 1909; "Fixture for Grinding Radius Cutters," November, 1909; "Clearance on Milling Cutters," March, 1909. (See also the references to additional information given in a note with this last mentioned article.)

‡ Address: University of Sheffield, Sheffield, England.

N = the number of teeth (assumed to be equally spaced) to be cut in the blank.

W = the width of the land to be formed on each tooth.

β = the angle of the fluting or grooving cutter.

θ = the angle subtended at the center of the cutter or reamer by each tooth.

Then

$$\theta = 360 \div N$$

and may be called the tooth angle of the cutter or reamer. Let the radius of the finished (*i. e.* ground) cutter or reamer be R; θ is the angle subtended at the center of the cutter or reamer by the circular arc from which is formed the land of width W. This land may be either flat (as when formed by a cup-wheel) or concave (as when formed by a disk-wheel), but, in each case, the width of the land is measured in a straight line. The difference between the actual width of the land ground and the arc length (Fig. 2) is exceedingly small (though, other things being equal, it will depend upon the clearance), and, therefore, in this connection negligible. As the arc W subtends an angle ϕ at the center of the cutter or reamer, the angle $(\theta - \phi)$ is the angle subtended by a chord C. The angle $\delta = 90 - \frac{(\theta - \phi)}{2}$, and

$$\gamma = 180 - \left(90 - \frac{(\theta - \phi)}{2} + \beta\right) = 90 - \left(\beta - \frac{(\theta - \phi)}{2}\right)$$

The angle ϕ in degrees is obtained from $W \div R$, which is ϕ in circular measure. The chord C is, obviously, a function of radius R; hence its value is $c\,R$, where c is a constant for any particular values of θ and ϕ (from which it can be calculated) and, therefore, of N and $\frac{W}{R}$.

Let d = the depth of the cut required. Then, from Fig. 2,

$$\frac{d}{\sin \gamma} = \frac{c\,R}{\sin \beta},$$

from which we get

$$d = \frac{c\,R \sin \gamma}{\sin \beta} = \frac{c\,R \sin \left\{90 - \left(\beta - \frac{\theta - \phi}{2}\right)\right\}}{\sin \beta}$$

$$= \frac{c\,R \cos \left(\beta - \frac{\theta - \phi}{2}\right)}{\sin \beta} \qquad (1)$$

Recapitulation

It will be seen that by means of this formula, the depth of cut required for any given set of conditions can be calculated, the steps in the calculation being as follows: ϕ is obtained from $W \div R$ (the value of which is selected according to whether it is a milling cutter or a reamer which is to be fluted, and according to the kind of work which it has to perform. For medium-sized milling cutters, the quotient $W \div R$ varies from 0.020 to 0.060, while for reamers and small cutters its value lies between 0.040 and 0.120; θ is calculated from $360 \div N$; $c\,R$ is taken from a table of chords, it being the chord corresponding to $(\theta - \phi)$; and $\cos\left(\beta - \frac{\theta - \phi}{2}\right)$ and $\sin \beta$ are taken from the trigonometrical tables. Substituting the latter three values in Equation (1), we determine the depth of cut required.

It should be noted here that the very slight rounding which is usually given to the extreme angular point of the fluting cutter has been neglected in this consideration of the problem. This is because it is not possible to deal with it in a simple manner, and also because the amount of rounding is, in the majority of cases, not sufficient to affect materially the results of our calculations.

For practical purposes, the above formula is cumbersome, and, therefore, almost useless. To make it useful and of practical value, it has been converted into another formula, namely:

$$d = x\,R \qquad (2)$$

in which x is the depth of cut for a cutter or reamer of unit radius, and is equal to

$$\frac{c \cos \left(\beta - \frac{\theta - \phi}{2}\right)}{\sin \beta}$$

This is a constant for any given set of conditions, since, in such a case, W, N, and β, and, therefore, $W \div R$, θ, ϕ, and c will have fixed values. In the accompanying Data Sheet Supplement are given the values of x for a large number of different combinations of $W \div R$, N, and β; $W \div R$ ranging from 0.020 to 0.120 by increments of 0.020; N ranging from 6 to 44 by steps of 2; and β varying from 50 to 85 degrees.

Since the radius of the cutter or reamer blank is invariably made greater than the required radius of the finished cutter or reamer—the usual allowance on the diameter being about 0.008 inch per inch of diameter*—it is necessary to modify Formula (2) in order to fit it for application to conditions actually prevailing in practice. Obviously, in this case, to $x\,R$ must be added the difference between the radius of the blank and that of the finished cutter or reamer. Hence, the formula is:

$$d = x\,R + (R_1 - R) \qquad (3)$$

where R_1 = the radius of the blank. Another form is this:

$$d = R_1 - (1 - x)\,R \qquad (4)$$

Either of these two formulas may be used in practice, the value of x being taken from the accompanying tables in the Supplement.

To illustrate the use of this method, we will take the case of the fluting of a 5-inch cutter, which is to have 36 teeth, and a land-width ratio (*i. e.*, $W \div R$) of 0.020, the angle of the fluting cutter being 60 degrees. The blank, we will suppose, has been turned to a radius of 2.520 inches. Then, by consulting the accompanying tables, we find that $x = 0.1013$, and, therefore $x\,R = 0.2532$ inch; but $(R_1 - R) = 0.020$ inch; hence, $d = 0.2532 + 0.020 = 0.273$ inch, which is the required depth, and is an amount which can be easily read off the micrometer dial of the elevating screw of the milling machine.

It may sometimes be necessary to determine the value of x for a set of data not included in the accompanying tables. In such a case, this value can be calculated sufficiently accurately by the "simple proportion" method. To exemplify the use of the tables for this purpose, let us take the case of the fluting of a cutter involving the following data:

N = 40 teeth;
β = 70 degrees; and
$W \div R$ = 0.050.

From the tables we find that when $W \div R = 0.040$, $x = 0.0494$, and when $W \div R = 0.060$, $x = 0.0402$. Therefore, when $W \div R$ equals 0.050, $x = \frac{0.0494 + 0.0402}{2} = 0.0448$ inch.

When there are differences in regard to two of the data, the determination of x is a more complicated problem than the above. Take, for example, the case where $N = 31$ teeth, $\beta = 65$ degrees, and $W \div R = 0.030$. In this case, the values of x for 30 and 32 teeth when $W \div R = 0.030$ are first calculated as above, and then their mean is taken as the required value of x. Thus, x for 30 teeth = 0.1018 (by above method); for 32 teeth, $x = 0.0911$; and for 31 teeth, $x = \frac{0.1018 + 0.0911}{2} = 0.0964$ inch.

This method of determining the value of x for intermediate combinations is sufficiently close for all numbers of teeth above 12, and all the angles of fluting cutters in general use.

* * *

The invention of a new kind of armor-plate is reported from Germany. The peculiarity of the new armor is its extreme lightness as compared with the Krupp armor, while it is said to have equal, if not greater, resisting power. The armor is made of an aluminum alloy faced with a thin hardened steel plate. The naval authorities have made tests and reported favorably upon the new armor, and gun shields made from it have been ordered for one of the new German cruisers.

* This allowance is rather too liberal for large diameters. The allowances for grinding should not be in exact proportion to the diameters, as this gives too large values for cutters of large size. However, the assumption made has no influence on the formulas or on the tables. Anyone who prefers to use a smaller allowance for grinding can do so, and yet make use of the tables.—EDITOR.

MANUFACTURE OF LINCOLN-WILLIAMS TWIST DRILLS

By CHESTER L. LUCAS*

Twist drills are such common tools about a machine shop that it is surprising how little is generally understood about the methods employed in their manufacture. Any machinist can tell how a tap is made and any good toolmaker can make one, but we seldom hear of a twist drill being made in the average shop. This no doubt is due to the special machinery necessary to mill and relieve the flutes properly; therefore the manufacture of twist drills is almost exclusively in the hands of specialists.

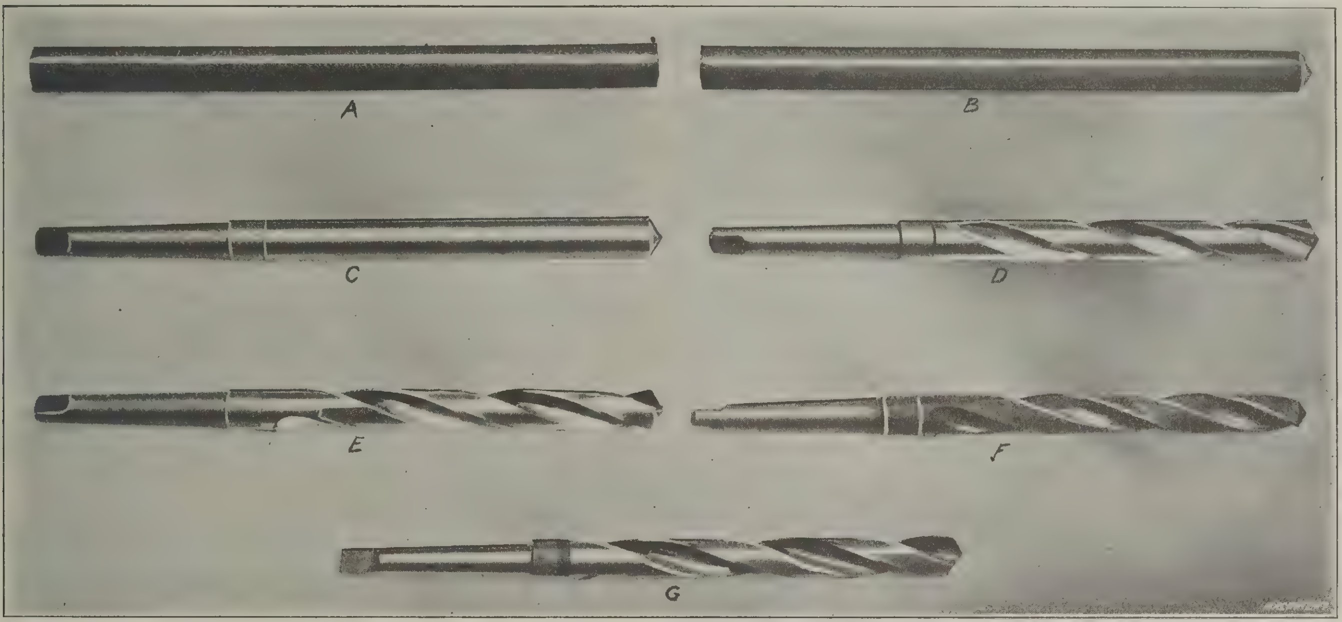


Fig. 1. Results of the Important Operations in Making a Twist Drill

One of the well-known firms in this line is the Lincoln-Williams Co., of Taunton, Mass. The company has moved into a new brick factory of modern design that is well equipped for the manufacture of twist drills. The entire factory is devoted to making this one product, involving the use of much special machinery. Through the courtesy of the management, the writer was allowed to photograph and describe some of the interesting operations connected with the work.

Preparation of the Steel

The stock room in which the steel is stored is kept locked all of the time, and access is permitted to very few men. The reason for this is to prevent the different brands of steel from getting mixed. As both high-speed and carbon steel are employed in making the various standard and special drills, and as the smaller sizes of drill rod vary but a few thousandths of an inch between sizes, the importance of this precaution is apparent.

Fig. 2. Cutting off the Stock

Fig. 2 shows the cutting-off department, where the bars are cut to lengths, one of which appears at A, Fig. 1. At the left are the cutting-off machines that cut the larger sizes of steel to length. The operator at the right is sharpening a saw for the cold-sawing machine that is used for cutting up some of the steel. For all drills, the steel is selected enough larger than the finish size to admit the turning off of all the "skin" from the outside of the stock.

The lengths of steel are next centered on one end and pointed on the other end to an included angle of 121 degrees. This end of the blank is used as the blade end of the finished drill and obviates the wasting of 1/4 inch of steel that would be necessary if centered in the usual way. The blank, centered and pointed, may be seen at B, Fig. 1. The smaller sizes of drill blanks are cut off and centered in screw machines, as illustrated in Fig. 3, and the very small drills are cut off and pointed only, no center being required. This work is done in Brown & Sharpe automatic screw machines.

Forging, Annealing and Straightening

A good many drills of the smaller sizes are made with taper shanks that are much larger than the body of the drill, usually with either No. 1 or No. 2 Morse tapers. After being cut off, the stock for such drills is forged down, reducing the blade section approximately to size. This operation is shown in Fig. 4, and of course it is obvious that this treatment improves the steel and results in a better drill.

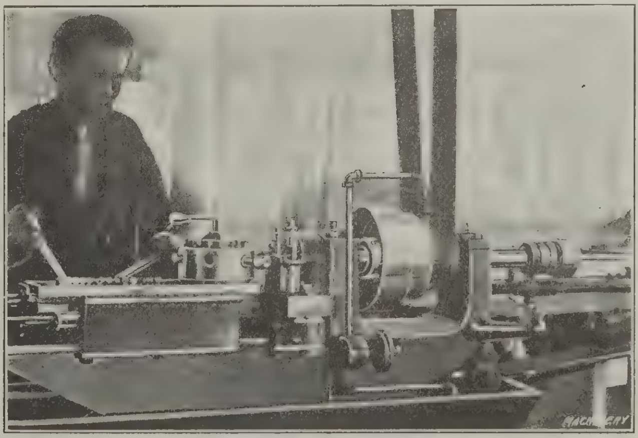


Fig. 3. Pointing and Centering the Drill Blanks

The blanks must now be annealed to facilitate the turning. Fig. 5 shows one of the large oil furnaces in which the blanks are heated. Cast-iron boxes, one of which may be seen being taken from the furnace, are filled with the lengths of steel, covered and sealed and placed in the furnace. Here they are heated slowly for a number of hours and allowed to cool very gradually.

The straightening operation is illustrated in Fig. 6. Here the operator is shown straightening forged blanks. These

* Associate Editor of MACHINERY.

blanks have been centered and pointed. He places a blank between the centers of the bench fixture *A*, gives it a twirl, at the same time noticing the high points with relation to the adjustable rest *B*. To facilitate the work, a screen *C* is placed so as to diffuse the light; when artificial light is needed, it is placed behind this screen. After locating a high point, the operator takes the drill from the centers, places it across the supports of the straightening press *D*, and bends it slightly to straighten it. In view of the fact that the work depends wholly upon judgment, it is surprising how well and how quickly the blanks are straightened. A straightening stand is used for the larger blanks. The stand is surmounted with an iron surface plate upon which the blanks are rolled. This operation shows up the high places and the blanks are straightened in a larger screw press not shown.


Fig. 4. Forging the Blanks for Special Drills

Rough- and Finish-turning

The small and medium sized drills are turned on lathes like that shown in Fig. 7. The work is held on male and female centers and driven by a dog in the usual way. The tools are made of high-speed steel, and for every turning operation in drill-making in this factory tool-holders with high-speed steel bits are employed. Each lathe performs but a single operation. One lathe rough-turns the shank; the next lathe rough-turns the blade; a third lathe finish-turns the shank and the fourth lathe finish-turns the blade. In turning, an allowance of from 0.005 to 0.007 inch is allowed for the grinding on this small and medium sized work. At *A*, Fig. 7, is a gage for testing the size from time to time. These lathes are fitted with automatic feed-releasing mechanism so that one operator may attend to four machines without trouble. This mechanism consists of a bracket *B*, bolted to the carriage; through this bracket a pin extends downward, coming in contact with arm *C* at the proper time to throw the internal half-nut out of mesh with the lead-screw at the end of the cut.

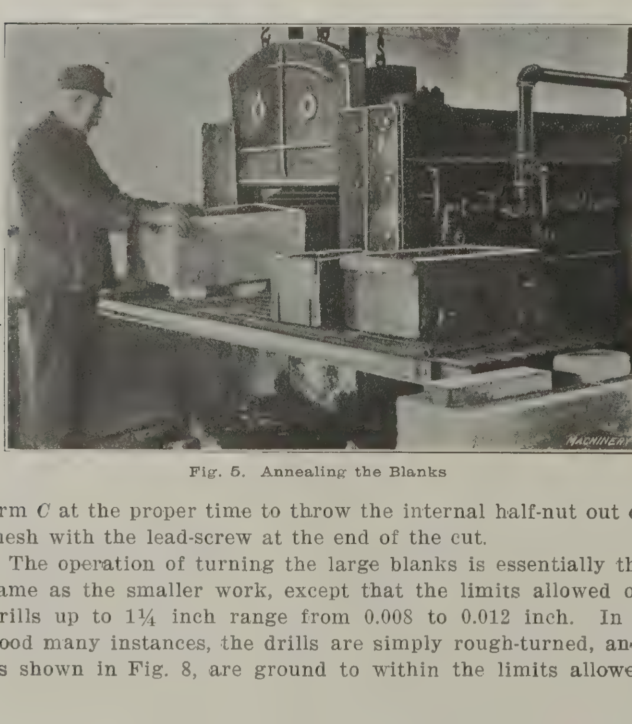


Fig. 5. Annealing the Blanks

The operation of turning the large blanks is essentially the same as the smaller work, except that the limits allowed on drills up to 1¼ inch range from 0.008 to 0.012 inch. In a good many instances, the drills are simply rough-turned, and, as shown in Fig. 8, are ground to within the limits allowed for hardening and final grinding. This is quicker than turning and leaves a good surface for the succeeding operations.

Milling the Tangs and Finishing the Ends

Fig. 9 illustrates the method of milling the tang. The drill blank *A* is held in clamp *B*, while the two cutters *C*, which are mounted at the proper distance apart, mill the tang. At *D* may be seen the worm and worm gear that are disengaged automatically at the end of the cut. It takes about half a minute to cut the tang of a ½-inch drill. The partly completed drill now appears as at *C*, Fig. 1.

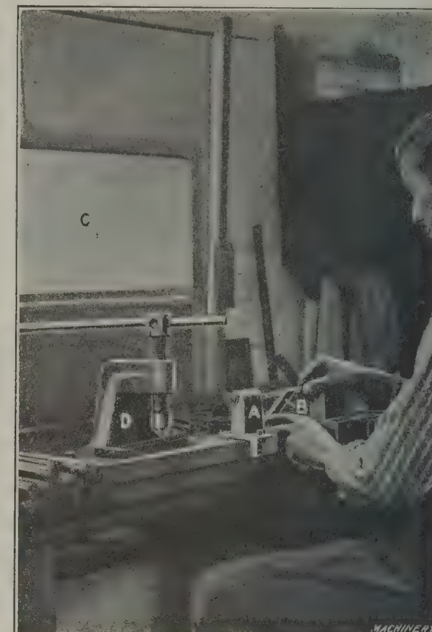


Fig. 6. Straightening the Blanks

Another simple operation, shown in Fig. 10, is that of rounding the shank end of the drill. This is done to remove corners and edges that might otherwise become bruised, thus interfering with the fit of the taper shank. The drill blank *A* is held in the clamp *B* and fed into the box-tool *C* that shapes the end of the shank. Both tool and holder are very strong.

Milling the Grooves

One of the most interesting operations connected with the making of twist drills is the milling of the flutes. Fig. 11 shows a small section of the department where the flutes in the large drills are milled. The drill blanks are fed downward to a pair of cutters that simultaneously mill the two grooves. Of course, it is obvious that the drill must turn while the milling operation is being performed, so as to obtain the spiral flutes. These machines are semi-automatic in their operation, so that one operator can keep several of the machines in operation without difficulty. The result of the milling is shown at *D* in Fig. 1.

The method of grooving the small drills is essentially the same, although the machines are of the horizontal type. Fig. 12 shows a row of the machines that are used in milling the grooves in drills under ¼ inch in diameter. By means of the same automatic feed-releasing mechanism as is used on the turning lathes and tang-milling machines, the feed is thrown out at the end of the milling operation. While being milled, the drill is automatically turned to give the spiral cut to the grooves. As the small drills have straight shanks, they may be held by chucks while being milled. In milling, a cutting compound, of borax, lardoleum and water, is used.

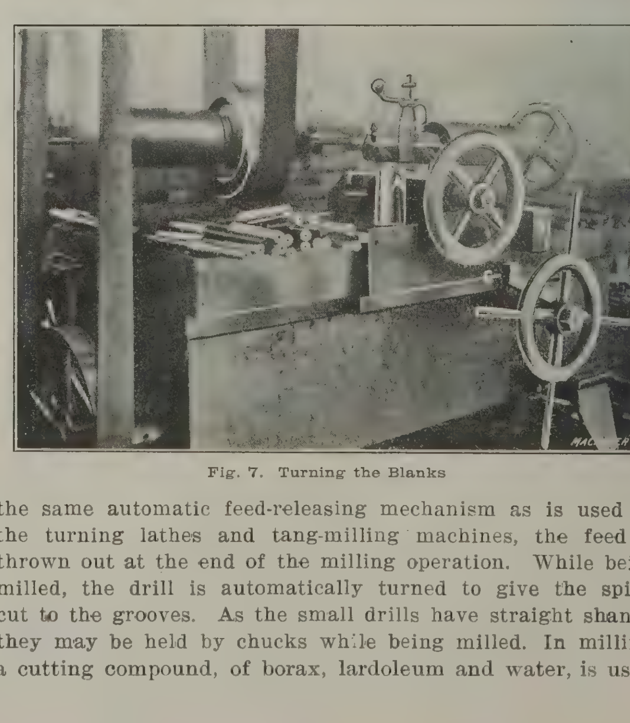


Fig. 7. Turning the Blanks

Increase Twist

To many men, the meaning of "increase twist" as applied to twist drills is not clearly understood. A drill with increase twist is grooved at a constantly increasing angle of spiral, commencing at the point. This variation in the angle of the groove is brought about by the gradual decreasing of the rate at which the drill blank turns while being fed to the grooving cutters, the forward movement of the drill remaining constant. Thus the "twist" steadily increases. The reason for cutting the grooves with increase twist is to increase the area of the groove as it progresses towards the shank, thus allowing the chips more room to work out of the grooves.

Fig. 8. Grinding the Blade Section, preparatory to Milling

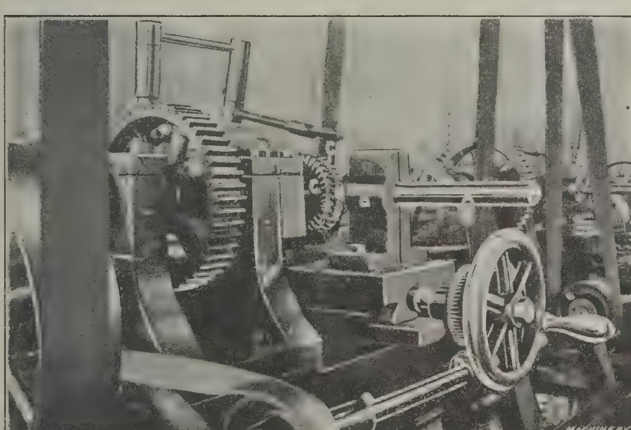


Fig. 9. Milling the Tangs

At first thought it is not quite clear how the increasing of the angle of spiral, or twist, increases the area of the groove. Suppose, to take the extreme view, there were no turning of the drill while being grooved; in such a case it is apparent that the resulting straight groove would be much wider than a spiral groove of any angle. To increase the angle of spiral is to approach the straight line; therefore any increase in the angle of spiral or twist, increases the width of the groove and consequently its area.

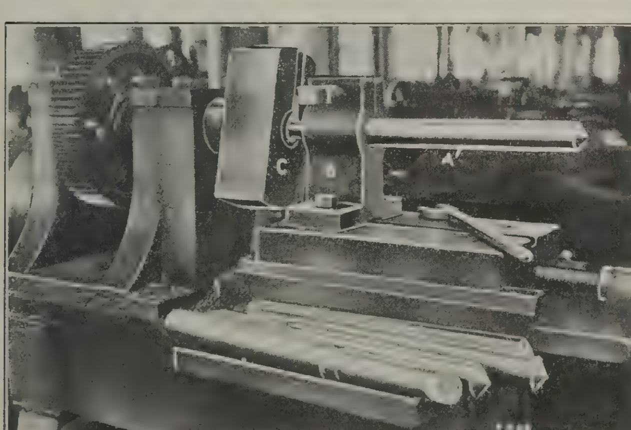


Fig. 10. Rounding the Ends of the Shanks

Milling the Clearance to the Grooves

The edges of the cutting lips of twist drills must be given clearance the same as any other metal-cutting tool. The clearance on Lincoln-Williams drills is milled with cutters; "cutter-cleared" they are termed in the trade. One of the machines for milling clearance may be seen in Fig. 13. The drill is held in the sleeve *A* that runs loosely in tailstock *B*. From the point, it is drawn through bushing *C*, at the same time being slowly turned. Cutter *D* works through an opening in this bushing, removing the clearance. The amount of metal removed for clearance depends, of course, upon the size of the drill, varying from approximately 1/32 inch on the large drills to a few thousandths inch on the smallest drills.

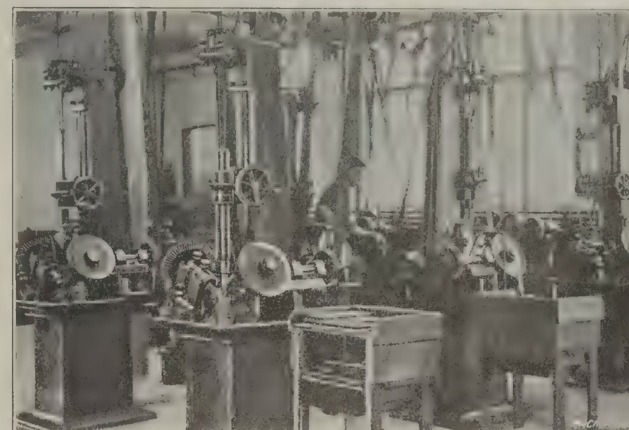


Fig. 11. Milling the Grooves

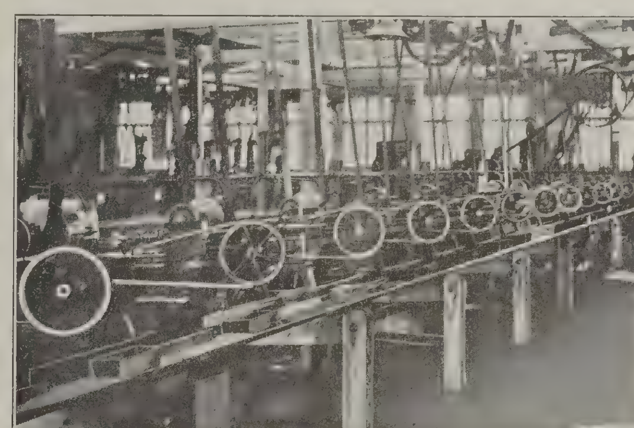


Fig. 12. Milling the Grooves in the Small Drills

The illustration Fig. 14 shows the principle that is followed in "clearing" drills by milling. In a cutter-cleared drill, the stock is milled away in a straight cut, commencing a short distance from the cutting side of the lip and extending parallel to the length of the drill into the groove behind. The result is a clean, even clearance throughout the length of the drill, as may be seen at *E*, Fig. 1.

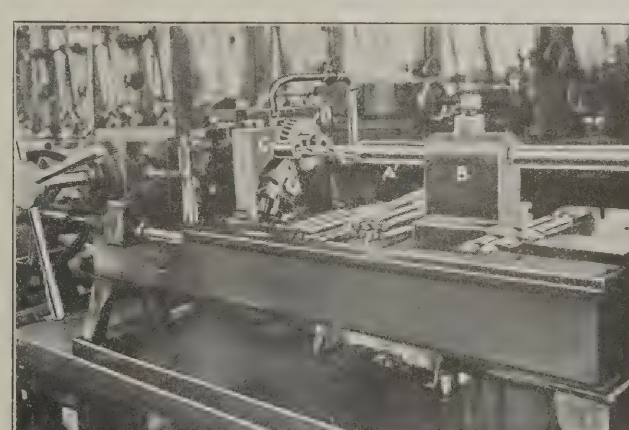


Fig. 13. Clearing the Drills

The ends of the blades of the drills are next relieved, or

sharpened, as we would call it if the drills were ready for use, and then another equally simple operation follows: that of marking the name upon the recess between the shank and blade. The size is also stamped on at this time, and the drills are ready for hardening.

Hardening the Drills

After the clearance has been given to the ends of the lips of the drills they are ready for hardening. Fig. 15 shows a section of the department where the high-speed drills are hardened. The furnaces are all gas furnaces and are of several sizes so as to accommodate the different sizes of drills that must be heated. One of the hardeners is shown heating a drill preparatory to hardening in the oil tank behind him.

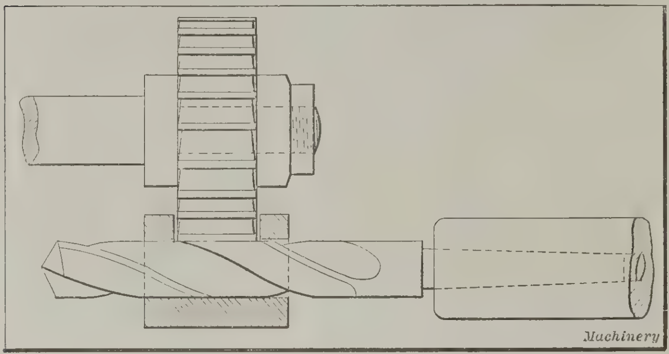


Fig. 14. Details of Clearing Operation

Fig. 15. Hardening High-speed Drills

For hardening these high-speed steel drills the furnaces are regulated to control the heat at approximately 2300 degrees.

In hardening the carbon steel drills, lead pots are used for heating the drills. Fig. 16 shows one of the hardeners at work hardening carbon steel drills. The tank for quenching is an ordinary hogshead filled with brine. The brine is kept cool and at a constant temperature by means of a circulation of cold water that passes through a coil of pipe within the brine barrel. This cold water is pumped from the cistern that may be seen in the right foreground of Fig. 16; thus the continuous stream of cold water circulating through the coil maintains an even temperature in the hardening tank.

Fig. 16. Hardening Carbon Steel Drills

The special tongs used in hardening small drills may be seen in the background of Fig. 17. These tongs will hold twelve drills so they may be hardened at once. One jaw of the tongs is grooved with twelve parallel grooves, while the other jaw holds a flat spring that has twelve "fingers" that bear upon the drills, compensating for any unevenness in the other jaw. The smaller pair of tongs is for holding small drills, as shown. At the right of this illustration may be seen two lots of small drills that are ready for hardening, and in the foreground is a lot of drills that has just been hardened. Fig. 18 is shown to illustrate the way in which the small drills are hardened. The lead pot is heated from beneath by fuel oil. The surface of the molten lead is kept covered with broken charcoal to prevent the formation of dross. It takes but a few seconds to heat up a row of drills and but a few seconds to quench them, so the work proceeds very rapidly. With the above method of even heating, and the constant temperature of the hardening bath, there can be little chance for poorly hardened drills, if the steel is of good quality—and it is.

Fig. 17. Special Tongs used in Hardening Small Drills

Oil-tempering the Drills

Hot oil furnishes the best known method of tempering any kind of a tool that requires an even temper throughout its length, and, of course, it is desirable that drills be evenly tempered throughout their lengths. At *A*, Fig. 19, may be seen the tank in which the drills in this factory are oil-tempered. As will be noticed, the tank is on rollers, running on a track above the gas furnace *B*. The drills are placed in an iron basket *C*, lowered into the hot oil, and left there until they have been brought up to the temperature of the oil, which is approximately 450 degrees F. This gives the drills a degree of toughness that it is impossible to attain in any other way. The box *D* contains sawdust for drying the drills after being taken from the hot oil. At *F*, Fig. 1, may be seen the drill after hardening.

Fig. 18. Method of heating Drills in Lead Pots

Straightening

In spite of all the precautions that are taken to have the drills come from the hardening tank straight, a good many drills will be warped to a more or less degree. To straighten

such drills, they must be heated at the top of the curve and pressure applied. This operation is practically the same as the cold straightening being done in Fig. 6, except that the small drills, under ¼-inch, are straightened on a lead block with a soft metal hammer. Heat is applied with a small gas torch.

Cleaning out and Grinding

After leaving the hardening department, the drills go to the cleaning bench, where they are brushed out with fine emery and oil as shown in Fig. 20. The operator takes three or four drills at once, and holding them at the angle of the flutes, brushes out all of the scale and dirt left by the hardening process.

The final operation in the making of a twist drill is to grind the shank and blade true with the centers, for of course there is bound to be a little distortion, even after straightening Other reasons for grinding after hardening are to size the drill and give it sharpness throughout the length of the blade. This operation is illustrated in Fig. 21, the finished drill being shown at *G*, Fig. 1.

Inspecting and Testing

After hardening, every drill is examined for fire cracks and tested for hardness. After grinding, each drill is tested for size of blade and correctness of taper in the shank, if the drill is of the tapered-shank variety. In addition, drills are selected

Fig. 19. Tempering Drills

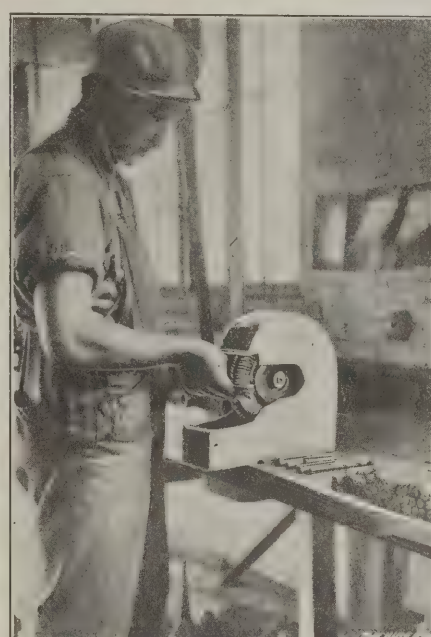


Fig. 20. Cleaning out the Drills

at random from the different lots, and tested in actual use, for the Lincoln-Williams Co. believes that the proof of the drills is in the drilling. For this purpose, semi-annealed steel

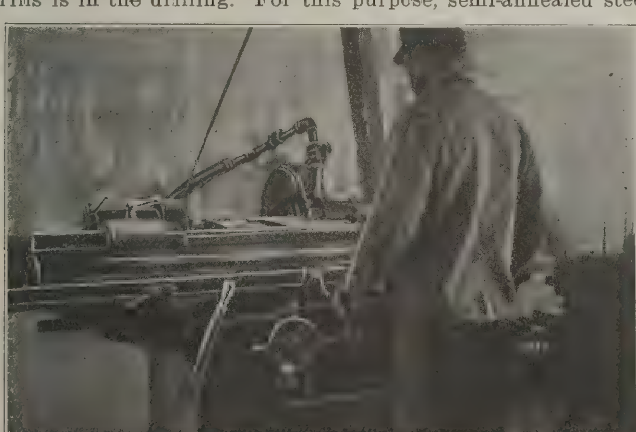


Fig. 21. Grinding the Hardened Drills

is used, and careful records are kept of the performances of the tested drills.

Welding Special Shanks

Fig. 22 illustrates the operation of electric welding special shanks to small drills that are used by woodworkers in bit-braces. The special square shanks are first forged; the drills are made and hardened and the last operation is to weld the two parts together. The drill is held in the spring collet that is closed by handwheel *B*. Several of these collets, which are

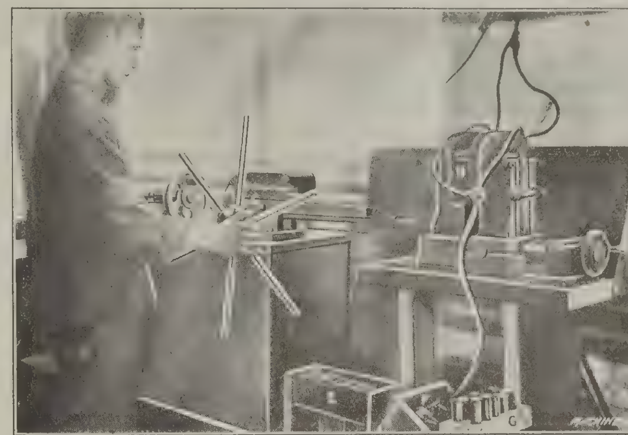


Fig. 22. Welding Special Shanks to the Blades

made of copper, may be seen in the block *G*. At *E* is a rack of drills and at *F* may be seen a box of shanks. The shank is held in the head *A* of the machine. The current quickly brings each part to a welding heat; handwheel *C* runs the head of the machine forward, uniting the two parts while at a white heat. The operation of the head, by means of the handwheel, automatically admits and cuts off the current that comes through the coil at *D*. By means of the handwheel that may be seen at the right of the coil, the amount of current may be regulated to suit any of the sizes of drills that are required to be welded to special shanks. With this machine, approximately 4000 drills may be welded per day of ten hours.

* * *

GASOLINE OR OATS?

Many persons who have studied the case of the auto *vs.* the horse are of the opinion that within ten years the use of horses will be forbidden upon the streets in the congested parts of cities. One of these experts asserts that by 1920 not a horse will be allowed south of Fourteenth St. on Manhattan Island. Another authority says that today the horse is hampering business in all the crowded delivery sections of cities and that horse-drawn vehicles take up so much room that in New York City alone, if the horse were done away with, three hundred miles of streets could be saved.

It is all a question of dollars and cents, this gasoline or oats proposition. Even with an ordinary pleasure automobile it simmers down to that. Tests have shown that the balance is in favor of the motor-car just as it is in the case of the heavier vehicles that do the truck-horse work. A six days' trial, for purposes of comparison, was made not long ago. The automobile ran four hundred and fifty-seven miles in that time at a cost of one and one-half cent per passenger per mile. Depreciation was charged in this cost, too. With a horse and buggy the distance covered in the six days was one hundred and ninety-seven miles and the cost was nearly two cents per passenger per mile.—*Harper's Weekly.*

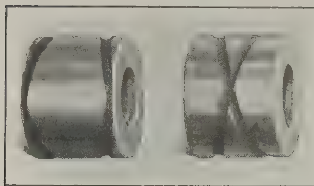
* * *

The National Twist Drill & Tool Co., Detroit, Mich., uses a simple method of etching on cutters and other tools. The steel is brushed with asphaltum varnish which is allowed to stand a few minutes until it thickens and hardens to the right degree. Then the desired inscription is pressed through the asphaltum with a rubber stamp and the etching fluid (aqua regia) is applied with a medicine dropper. Good results are obtained, but some practice and experience are required to judge just when the varnish has dried to the right consistency.

OIL GROOVE CUTTING TOOL*

A SPECIAL TURRET TOOL FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†



Oil-grooved Pin

Cutting a helical oil groove in a cylindrical piece of work in the Brown & Sharpe automatic screw machines is a feat, the successful accomplishment of which demonstrates some of the possibilities of these machines in the hands of a resourceful designer. A turret tool for performing this work was designed by the Brown & Sharpe Mfg. Co., and was used for cutting an oil groove in a needle bar connection pin for the Wilcox & Gibbs sewing machine. This turret tool, which is illustrated in Figs. 1, 2, 3 and 4, is designed on the generating crank principle, so that the cutting tool is moved back and forth in a straight path parallel with the axis of the work while the latter is rotating. The cutting tool while

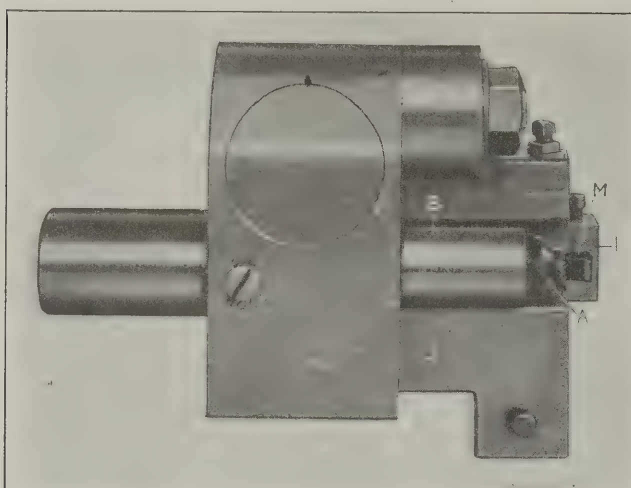


Fig. 1. Oil Groove Cutting Tool showing Driver and Cutter

being longitudinally traversed is at the same time fed into the work to the desired depth by means of a rising block held on the cross-slide.

Operation of the Oil Groove Cutting Tool

The oil groove cutting tool shown in Figs. 1, 2, 3 and 4 is operated in the following manner: After the end of the work

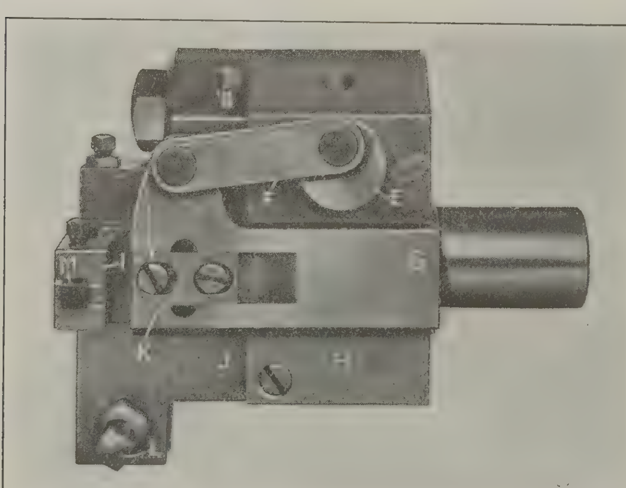


Fig. 2. Rear View of Oil Groove Cutting Tool showing Crank-Tool-slide, etc.

has been knurled, the turret is advanced, bringing the driver *A* into contact with the knurled end of the work. The rotating motion of the work is transmitted by driver *A* to spindle *B*, the latter being connected to the driver by a pin *C* fitting in an elongated hole in the spindle. The spindle *B* is provided with helical teeth that mesh with the helical gear *D*, held on a shaft *E* to which link *F* is eccentrically connected. The other end of link *F* is pivoted to the crank-slide *G*, which fits in a V-groove cut in the main body *H*. The tool-slide *I*, which fits in a V-groove in the swinging member *J* is connected to the crank-slide *G* by a tongued block *K* held by two screws in a slot cut in the crank-slide.

When the driver *A* is in contact with the work, the front cross-slide is advanced and the rising block coming in contact

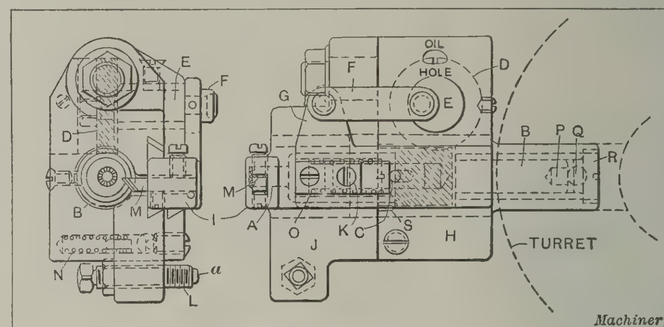


Fig. 3. End and Side Elevations of Oil Groove Cutting Tool

with the end *a* of the set-screw *L* forces in the swinging member *J* carrying the turning tool *M*. While this is taking place, the turning tool is being traversed back and forth by means of the crank mechanism, and thus produces the helical groove in the work. Upon the completion of the oil groove, the cross-slide drops back, and the coil spring *N* returns the swinging member to its former position; and when the turret drops back, the coil spring *O* returns the driver *A* to its "out" position.

Construction of the Oil Groove Cutting Tool

This tool embodies some features in its design which could be incorporated in other turret tools of the generating type,

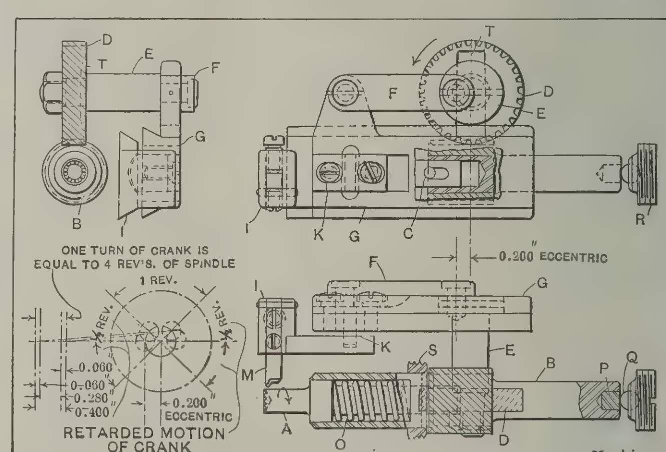


Fig. 4. Diagram showing Operation of the Oil Groove Cutting Tool

so that a description of its construction might be of value. Referring to Figs. 3 and 4, it will be seen that the driver *A* is countersunk and knurled on the end, and is provided with a shoulder against which the spring *O* abuts. The driver is prevented from coming out of the spindle *B* by a pin *C*, driven into the former and fitting in an elongated hole in the spindle. This pin also acts as a stop to prevent further movement of the driver *A*, when it has once come in contact with the work.

The driving spindle *B* is made from machine steel, counterbored to receive the driver *A*, and provided with helically cut teeth. To take the thrust of the driver coming up against the work, the rear end of the spindle is provided with a hardened block *P*; this block bears against a ball *Q* held in the nut *R*, which is screwed into the shank of the holder. The spindle is retained in the main body *H* by a hollow-nut *S*, and runs in a phosphor-bronze bearing. The helical gear *D* is held on the end of the crank stud *E* which runs in a phosphor-bronze bearing, by a nut as shown, and is retained in the

* For a description of other tools on the generating principle, built by the Brown & Sharpe Mfg. Co., see the following articles: "Cutting Helical Gears on the Brown & Sharpe Automatic Screw Machines, April, 1909; and "Attachment for Cutting Helical Steel Gears," August, 1909.

† Associate Editor of MACHINERY.

correct relation to the eccentric by the slot T which fits the flattened sides of the stud.

As the swinging member carrying the tool-slide must have a slight movement across the face of the main holder, it is necessary that the two slides be flexibly connected. This is accomplished by inserting a block K, which is provided with a tongue to fit in the slot cut in the crank-slide G. The tongue extends down through an elongated slot in the slide, and fits in a corresponding slot in the tool-slide I. The slot in slide

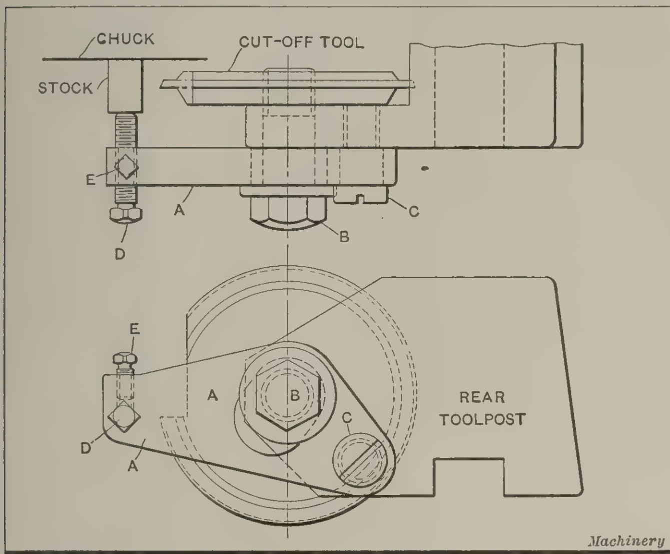


Fig. 5. Stop used on the Rear Cross-slide for Gaging the Stock to Length

G is greater in width than the tongue on the block K so that a slight adjustment for the tool-slide is provided. This adjustment makes it possible to start the cutting tool in the correct relation to the end of the work and the driver.

Obtaining the Throw of the Crank

Referring to the illustration Fig. 7, where a sample of the work is shown at A, it will be seen that the oil groove is to make one complete revolution in 0.282 inch for both forward

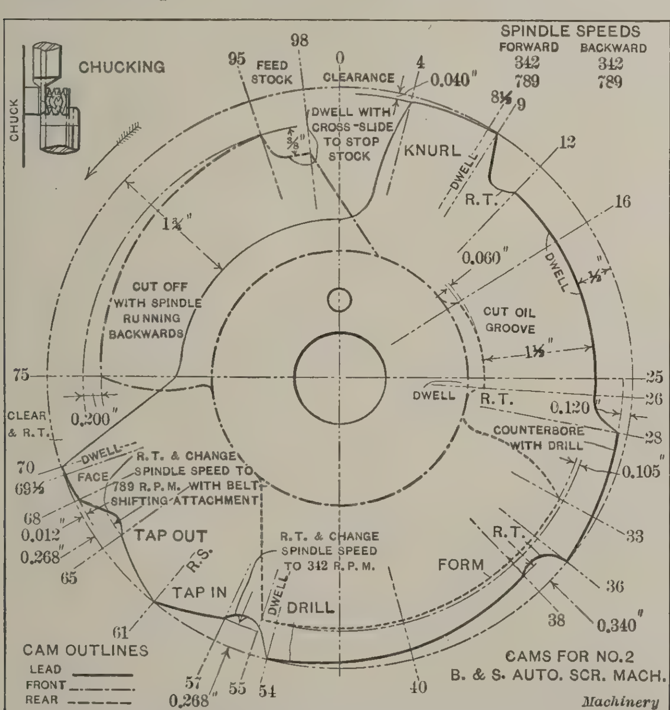


Fig. 6. Cams used in Making and Cutting the Oil Groove in the Needle Bar Connection Pin shown at A in Fig. 7

and return strokes, giving two revolutions in all. The path of the oil groove is more clearly shown in the initial illustration. Now it is evident that the speed at which the tool-slide travels must be less than that at which the work is rotating, or in other words, the work must make four revolutions when the crank is making one complete turn. The helical gears are therefore made in a ratio of 4 to 1.

As this tool is operated by a crank mechanism, it follows that the cutting tool is given a variable movement; that is, it starts up slowly, then increases in speed as it approaches the center, and decreases in speed as it reaches full throw, the same movement being repeated on the return stroke. To obtain the required throw of the eccentric, construct a square having sides equal in length to 0.282 inch, and circumscribe a circle about it. The radius r of this circle, see B, Fig. 7, will then equal the required amount of throw of the crank. The radius r is found by the following formula:

$$r = \frac{\frac{0.282}{2}}{\sin 45 \text{ deg.}} = \frac{0.141}{0.707} = 0.200 \text{ inch approximately.}$$

Referring to the diagram in the left-hand lower corner of Fig. 4, it will be seen that the first one-eighth revolution of

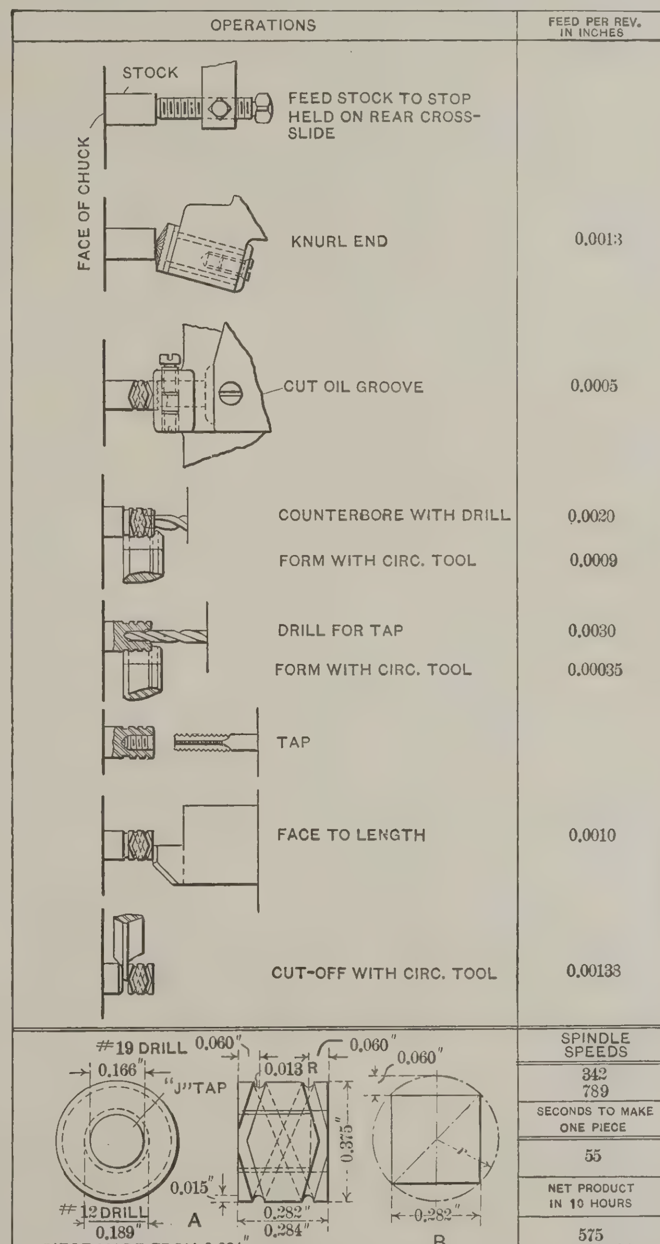


Fig. 7. Order of Operations and Feeds used in Making the Needle Bar Connection Pin

the crank, which equals one-half revolution of the work, gives a longitudinal movement to the tool of about 0.060 inch. The next revolution of the work (or one-quarter revolution of the crank) gives a movement of 0.280 inch, while the remaining forward movement gives a travel of approximately 0.060 inch. The same movement is given to the tool on the return of the crank, the complete travel of which is 0.400 inch. The groove produced by the tool when its motion is retarded is not required. Hence, when the piece is faced and cut off to 0.282 inch, it leaves an oil groove which makes two complete revolutions around the work. The two half revolutions of the groove on each end are removed by the facing tool held in the turret and the circular cut-off tool on the cross-slide.

The chart, Fig. 7, illustrates the tools used and the order in which they are applied. By a close inspection of this chart it will be seen that the turret is full of tools, so that it is necessary to provide some other means for gaging the stock to length. This is accomplished by fastening a block *A* to the rear toolpost as shown in Fig. 5. This block *A* is furnished with an elongated slot so that it can be swung up out of the way to remove the short piece of the bar left in the chuck when it is exhausted. The slot straddles the body diameter of the clamping screw *B*, which is used in holding the circular cut-off tool to the toolpost. The toolpost is drilled and tapped to receive the shoulder screw *C*, which acts as a fulcrum for the block *A*. In the forward end of the block *A* is held a screw *D* which acts as a stop for the stock. This screw is held when adjusted to the correct position by a set-screw *E* bearing upon a brass shoe, which prevents the thread on the screw *D* from being bruised.

Order of Operations

The order of operations followed in completing the needle bar connecting pin is shown in Fig. 7. The first operation is to feed the stock to the stop; then the rear cross-slide drops back and the knurling tool is brought in and knurls the end of the work. The turret is now revolved, bringing the oil groove cutting tool into operation which produces the oil groove. The turret dwells, holding the driver in contact with the work while the swinging memoer is being advanced by the rising block on the front cross-slide, which feeds the tool in to the correct depth. While this is taking place the tool-slide, of course, is driven back and forth across the face of the work by the crank mechanism.

After the oil groove is completed, the turret is again revolved and the drill is brought in to counterbore the front end of the work. The turret is then revolved to bring the tapping size drill in, which drills a hole completely through the work. While the drilling is being accomplished, the front cross-slide is advanced, bringing the circular form tool into operation, which turns down the work to the correct outside diameter. The cross-slide then backs out of the way and the turret is revolved, bringing the tap into operation. After the tapping is completed, the turret is again revolved and the work faced to the correct length by a facing tool held in the turret. After this, the rear cross-slide advances, holding the circular cut-off tool, which severs the completed piece from the bar.

The cams used in making this piece are shown in Fig. 6, where the uses of the various lobes are clearly indicated. It will be noticed that four one-hundredths of the cam surface is allowed between the points where the turret dwells with the oil grooving tool and the cross-slide begins to force the cutting tool into the work. This amount of clearance is necessary because of the relative positions of the lead and the cross-slide levers. The procedure to follow in designing a set of cams for performing operations accomplished by swing tools was illustrated and described in the article entitled "Internal Cutting Tools" which appeared in the November, 1910, number of MACHINERY.

* * *

A petrol-electric omnibus has been introduced in London and extensive tests have been made with it. It is fitted with a four-cylinder engine driving a dynamo which, in turn, supplies the driving current for the motors of the vehicle. The advantages of the design over the regular gasoline engine omnibus are said to be that considerable economy in the use of fuel is possible, that the control of the vehicle is made simpler and more effective, and that the arrangement increases the life of the engine, as the shocks from clutching and de-clutching, which are ordinarily so destructive, are eliminated.

* * *

A maker of twist drills investigated a complaint of a customer who had split several drills in drilling a drop forging. He found that the forging was made with a depression in the center where the hole was drilled, but the depression was of a lesser included angle than the standard drill angle of 118 degrees. The result was that the lips of the drill "hogged in" without having a support for the point. Splitting was inevitable. Changing the angle of the drill to conform to the angle in the forging stopped the trouble.

THE PROBLEM OF FOUR TANGENT CIRCLES*

By WILLIAM W. JOHNSON†

The problem of four tangent circles is as follows: Given three circles and the distances between their centers, to find the radius of a circle which is tangent to the three given circles.

This problem sometimes is met with in practical mechanics. For example, it may be required to find the diameter of a gear which will mesh with three given gears, the diameters

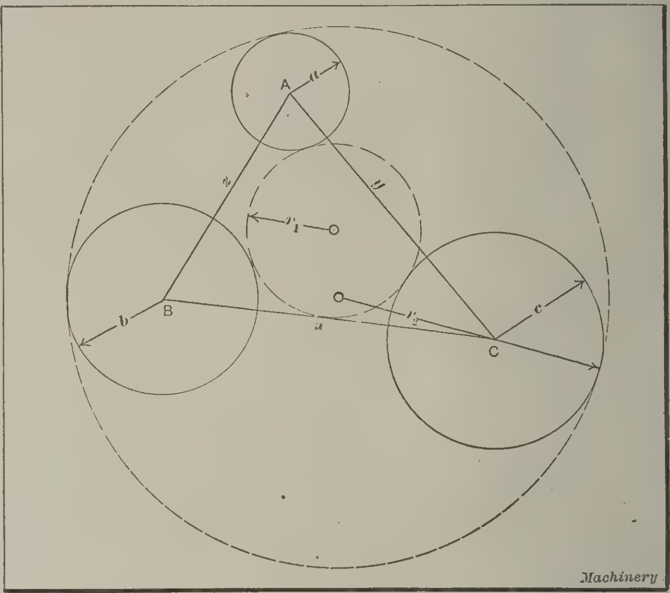


Fig. 1. Circle making Internal Contact with all Three Given Circles, and Circle making External Contact with all Three Circles

and the distances between the centers of which are given. The purpose of this article is to show how general formulas may be derived for calculating the diameter of a circle which is tangent to three given circles. There are not less than eight circles which meet the requirements: One, making internal contact with all three circles (see Fig. 1); one, making external contact with all three circles (see Fig. 1); three, making external contact with two circles and internal contact

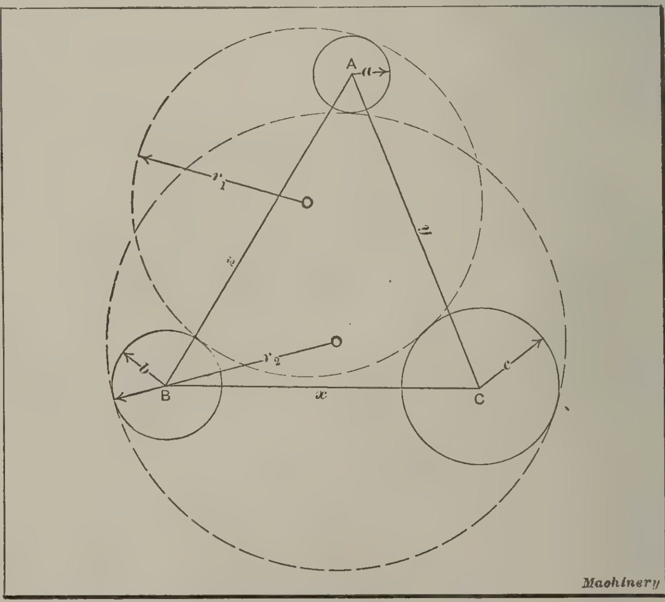


Fig. 2. Circles making Internal Contact with One or Two of the Given Circles

with one circle (see Fig. 2); three, making external contact with one circle and internal contact with two circles (see Fig. 2).

Referring to Fig. 3, let *A*, *B*, and *C* be the centers of the three given circles whose radii are *a*, *b* and *c*, respectively,

* See MACHINERY, March, 1906, How and Why columns, and May, 1906, engineering edition, "The Problem of Touching Circles."
† Address: 1313 East 88th St., Cleveland, Ohio.

and let $BC = x$, $AC = y$ and $AB = z$; find r. We can get an equation of the second degree as follows:

Let $AO = p$, $BO = q$, $CO = s$, and angle $AOB = \theta$, angle $BOC = \phi$, and angle $COA = \psi$. Then, $\theta + \phi + \psi = 360°$; $\theta = 360° - (\phi + \psi)$, and $\cos\theta = \cos(\phi + \psi) = \cos\phi\cos\psi - \sin\phi\sin\psi$, or $\cos\theta - \cos\phi\cos\psi = -\sin\phi\sin\psi$.

Squaring both sides we get:

$$\cos^2\theta - 2\cos\theta\cos\phi\cos\psi + \cos^2\phi\cos^2\psi = \sin^2\phi\sin^2\psi$$
$$= (1 - \cos^2\phi)(1 - \cos^2\psi) = 1 - \cos^2\phi - \cos^2\psi + \cos^2\phi\cos^2\psi.$$

Hence, $\cos^2\theta + \cos^2\phi + \cos^2\psi - 2\cos\theta\cos\phi\cos\psi = 1. \quad (1)$

From the cosine formulas in trigonometry we get:

$$\cos\theta = \frac{p^2 + q^2 - z^2}{2pq} = 1 + \frac{(p-q)^2 - z^2}{2pq}$$

$$\cos\phi = \frac{q^2 + s^2 - x^2}{2qs} = 1 + \frac{(q-s)^2 - x^2}{2qs}$$

$$\cos\psi = \frac{s^2 + p^2 - y^2}{2sp} = 1 + \frac{(s-p)^2 - y^2}{2sp}$$

Put, in the numerators, $p = r + a$, $q = r + b$, and $s = r + c$; then:

$$1 + \frac{(p-q)^2 - z^2}{2pq} = 1 + \frac{(a-b)^2 - z^2}{2pq} = 1 + \frac{A}{2pq}$$

$$1 + \frac{(q-s)^2 - x^2}{2qs} = 1 + \frac{(b-c)^2 - x^2}{2qs} = 1 + \frac{B}{2qs}$$

$$1 + \frac{(s-p)^2 - y^2}{2sp} = 1 + \frac{(c-a)^2 - y^2}{2sp} = 1 + \frac{C}{2sp}$$

Substituting these values in Equation (1), we get

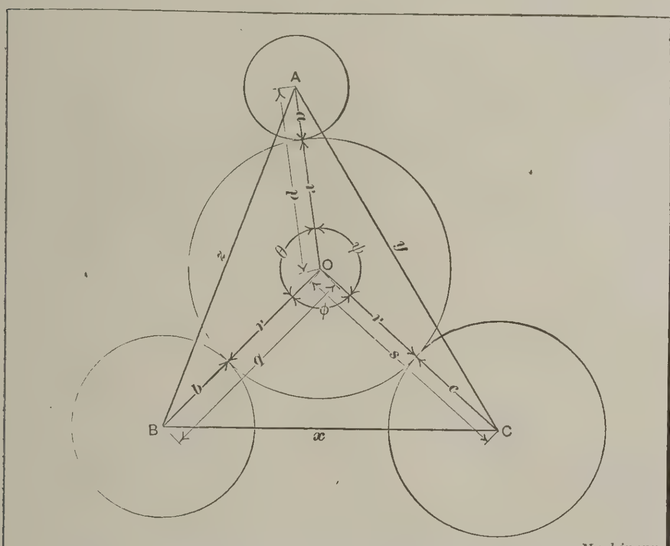


Fig. 3. Diagram for the Analytical Solution of the Problem

$$A^2s^2 + B^2p^2 + C^2q^2 - 2ABsp - 2BCpq - 2CAqs - ABC = 0. \quad (2)$$

Putting $p = r + a$, $q = r + b$, and $s = r + c$, in Equation (2), we get:

$$r^2[A^2 + B^2 + C^2 - 2AB - 2BC - 2CA] + 2r[A^2c + B^2a + C^2b - AB(a + c) - BC(a + b) - CA(b + c)] + [A^2c^2 + B^2a^2 + C^2b^2 - 2ABca - 2BCab - 2CAbc - ABC] = 0. \quad (3)$$

This is the general equation, from which two values for r are always found; one applies to the internal and one to the external circle, Fig. 1.

When $p = r - a$, $q = r + b$, and $s = r + c$ an equation for two other values of r, which apply to Fig. 2, is obtained. When $p = r + a$, $q = r - b$, and $s = r + c$ an equation for two other values is found, and when $p = r + a$, $q = r + b$ and $s = r - c$, an equation for the last two values of r, Fig. 2, is obtained.

By following the same procedure as in the foregoing, and substituting the values for p, q, and s just given, we get as the general equation for the conditions in Fig. 2 ($p = r - a$):

$$r^2[A^2 + B^2 + C^2 - 2AB - 2BC - 2CA] + 2r[A^2c - B^2a + C^2b - AB(c - a) - BC(b - a) - CA(b + c)] + [A^2c^2 + B^2a^2 + C^2b^2 + 2ABca + 2BCab - 2CAbc - ABC] = 0. \quad (4)$$

The other two formulas may be obtained by changing the letters in cyclical order, *i. e.*, changing a to b, b to c, c to a, and x to y, y to z, and z to x. Care must be taken in using the formulas to substitute the values exactly as they appear in the figure. For instance, x is the length of the side opposite the circle of radius a, etc.

Application of the Formulas

In Fig. 1 let $a = 3$; $b = 5$; $c = 6$; $x = 12$; $y = 13$; $z = 10$. Using Formula (3):

$$A = (a - b)^2 - z^2 = -96$$
$$B = (b - c)^2 - x^2 = -143$$
$$C = (c - a)^2 - y^2 = -160$$

Coefficient of $r^2 = A^2 + B^2 + C^2 - 2AB - 2BC - 2CA = -48{,}671$.

Coefficient of $2r = A^2c + B^2a + C^2b - AB(a + c) - BC(a + b) - CA(b + c) = -230{,}909$.

Absolute term $= A^2c^2 + B^2a^2 + C^2b^2 - 2ABca - 2BCab - 2CAbc - ABC = 1{,}250{,}089$.

This gives the quadratic equation

$$48{,}671\ r^2 + 2\ (230{,}909)\ r - 1{,}250{,}089 = 0$$

Solving for r we find:

$$r_1 = 2.1978, \text{ and } r_2 = -11.6864.$$

In Fig. 2 let $a = 1$; $b = 2$; $c = 3$; $x = 7$; $y = 6$; $z = 5$. Using Formula (4):

$$A = (a + b)^2 - z^2 = -16$$
$$B = (b - c)^2 - x^2 = -48$$
$$C = (a + c)^2 - y^2 = -20$$

Coefficient of $r^2 = A^2 + B^2 + C^2 - 2AB - 2BC - 2CA = -1136$.

Coefficient of $2r = A^2c - B^2a + C^2b - AB(c - a) - BC(b - a) - CA(b + c) = -4832$.

Absolute term $= A^2c^2 + B^2a^2 + C^2b^2 + 2ABca + 2BCab - 2CAbc - ABC = 26{,}176$.

This gives the quadratic equation:

$$1136r^2 + 2(4832)r - 26{,}176 = 0.$$

Dividing by 16, reduces to:

$$71r^2 + 2(302)r - 1636 = 0.$$

Solving for r, we find:

$$r_1 = 2.1601 \text{ and } r_2 = -10.6671.$$

* * *

DOUBLE-CUTTING PLANERS

A planer for cutting on both the forward and return stroke has been developed by Joshua Buckton & Co., Leeds, England, and was described in a paper read by Mr. J. Hartley Wicksteed at a recent meeting of the Institution of Mechanical Engineers. Many attempts have been made in the past to adapt the planer to double-stroke cutting, but the objection has always been made that with an equal speed of the planer table on both the forward and return strokes, the absence of a quick return motion on the idle stroke in such cases where the work does not permit of the use of both tools, on account of lack of clearance at the end of the stroke, discounts the advantages gained on work where double-cutting could be employed. This objection is overcome in the double-cutting Buckton planer by adopting for the drive a variable speed motor and using a small auxiliary motor for such operations as feeding and traversing the tools. A special advantage of the Buckton arrangement is, therefore, that it is flexible, so that either the forward and return strokes can be made at a uniform speed, or the return stroke can be made at an increased rate of speed when required. Another design has also been introduced with belt drive to the planer, by means of which the same flexibility as regards the rate of speed of the return stroke can be obtained. The method of holding the double-cutting tools is to fasten them back to back and exactly in line.

* * *

In painting or otherwise coloring the walls of any workroom, this question naturally arises: What color reflects the most and what the least light? Here are the data, based on recent experiments in Germany. Dark blue reflects 6½ per cent of the light falling upon it; dark green about 10 per cent; pale red a little more than 16 per cent; dark yellow, 20 per cent; pale blue, 30 per cent; pale yellow, 40 per cent; pale green, 46½ per cent; pale orange, nearly 55 per cent; *pale white, 70 per cent.* Glossiness and varnish increase the amount of light reflected.—*Detroit-Fenestra.*

THE CINCINNATI METHOD OF INDUSTRIAL EDUCATION—A FRIENDLY CRITICISM*

By JAMES A. PRATT†

The writer recently visited Cincinnati with the purpose of becoming acquainted with the work done there along the lines of industrial education. An opportunity was afforded to visit four very well equipped plants, attention at these visits being given solely to the mechanical engineering and machinist's shop courses there provided in connection with studies at the Cincinnati University or the apprentice continuation school. In each case the writer made his purpose clearly known, and requested the privilege of talking with the students.

The Course for the Students of Mechanical Engineering

In order to obtain an idea of the practical shop knowledge assimilated by the students, a number of questions of the character indicated below were put to them.

What is the advantage of the floating collet as used in small tool design?

In assigning work to the boring mills, what general division would you make between that going to the horizontal mill and that going to the vertical?

What factors would you consider in deciding whether a casting should be made from a full pattern or swept up?

Assuming that you were running a certain mixture, which had previously given satisfaction, in the cupola, and you unexpectedly found your casting coming hard, what would be your line of procedure to determine the cause of the difficulty?

These are questions which with proper shop teaching in engineering, students should be able to answer. Out of five men, however, but one was able to give passable answers to questions of this kind. This man was in the fifth year of the course, and yet, on certain phases of shop work, he could answer no questions, as many subjects had never been taken up at all. According to his own statement, this young man has never been asked, throughout the five years of his course, to make a shop report of any kind to a college authority.

The work done by the engineering students in the shop is in no way different from that given to the ordinary mechanic. It is evident that great breadth of view and ability would result if a man studying to become an engineer could at the same time be trained to be a thorough mechanic in at least one of the trades, while he was given a fair degree of familiarity with all the other trades bearing on his profession. Such a plan, however, could not be carried into effect in much less than seven years entirely devoted to understudy work, not including the three or four years of preparatory work required, and few persons are willing to spend this length of time in training, especially as it is not absolutely necessary for the engineer to be a skilled mechanic.

Since, therefore, some details of the shop work must be dropped from the course of training, which should these be? Logically it would appear that those details which develop dexterity to a greater degree than they impart knowledge of tools and processes, could be eliminated with the least danger. What the student requires most, in order to tell in the future when a man, or a gang of men, is working efficiently, is to understand the purpose and efficient operation of various machines. Outside of this the shop work of the engineering student should have in view the development of his ability to solve engineering shop problems, rather than to train him to be a skilled mechanic. However, the writer was told by a person in authority at one of the shops visited that no attempt was made to give the engineering students any other class of work than was given a boy who was learning a trade.

The manufacturer is surely not to blame for this condition. He is not running an educational institution, and his position was presented clearly by the statement of one manufacturer who said that the manufacturers were glad to have the boys get anything that they could out of the scheme, but no special shop arrangement would be permitted for the benefit of the engineering students. From a business point of view this position is not open to criticism, nor can those in charge of the plants be expected to act otherwise. There is, however, a reason for discussion when the claim is made by educators, that the scheme, as worked out, is a full and satisfactory substitute for proper college shop training. Such a claim is made by those responsible for this method of training in Cincinnati. It is admitted by the writer that there is a great deal of college shop work which does not give the student any better view of actual shop work, nor perhaps as good, as that obtained by the Cincinnati students, but such conditions exist only because of incompetence or indifference on the part of the educators, and this neglect cannot be excused. In any event, the training as obtained by the students in Cincinnati—so far as the work was shown to the writer—does not give a sufficiently broad training, because the student must do the work wanted in the plant regardless of whether it benefits him or not, and, further, some of the plants do not maintain all the departments in which training is usually considered essential to the engineer.

The Coordinator

In visiting the plants it was expected that the coordinator would be met with and an opportunity afforded to talk over this matter with him. The writer had expected that he made frequent calls on the boys while at work. In the first shop visited, however, a man having such duties as ascribed to the coordinator was not known, and the most precise statement obtainable was that a man came around once in awhile, and if a student was kept too long on one job he tried to get him changed. The students interviewed said that there was no connection between the work in the shop and the studies in the college. In theory the coordinator may be clearly defined and his purpose fixed, but as far as ascertainable, the practical results of his work are not effective, since he has no authority over the students or their work in the shop. It is, therefore, open to question whether the cooperative plan is an efficient substitute for proper college shop work, especially since even under the best conditions there is much that is necessary for an efficient training which is not presented.

In three of the four plants visited, it was stated that the students, under the cooperative system, were not to work except in the machine shop, no pattern shop, foundry nor forge shop training having been arranged for. The reason for this was that these plants did not have such departments, work of this character being done for them by outside firms. In another case an engineering student stated that upon authoritative advice he was omitting training in the pattern shop and foundry, because these branches were unnecessary as a part of a mechanical engineer's course.

Apprenticing Engineers

Literally, an attempt is made in Cincinnati to apply the apprenticeship method of teaching engineering. This plan would be satisfactory if the shop work were supervised in such a way that the student covered the proper field in a correct manner, and providing only a small number of students were to be handled. As soon as a large number are placed under such a plan, the training is likely to be insufficient, because there is not enough of the proper kind of work in any one plant to meet the student's needs. The point where there is a surplus of students to permit proper training has evidently been reached in Cincinnati, if it be true, as it is stated, that there are two courses available to students, one under which he can agree to a contract at a certain wage rate, according to which contract the company must place him in all of its departments, and one under a later form of contract where there is no agreement on the part of the employer to afford experience to a student in more than one department of a shop; but in this case a higher wage scale is offered. The writer did not see the latter contract, but was told that such a course was taken by many. This method permits of the entry of a larger number of students to the course, but it does not give them an efficient training.

There are certain excellent features of the engineering shop work as practiced in Cincinnati, one of which is the association with the workmen; but the most important feature of all—that the training of the student should be carried on without curtailment until the requirements of the course are met with in full—is being neglected. There is no department of a technical school which may be used so effectively as the shop in developing executive ability, provided the shop course is properly managed; and the factor of the development

* For previous articles on the Cincinnati plan of industrial education, see "Industrial Education—The Cincinnati Plan," November, 1909, and "Cooperative Industrial Education," October, 1908.

† Director of Williamson Free School P. O., Delaware Co., Pa.

of executive ability should be kept well in mind by all who are training young engineers. Yet this feature is entirely lacking in the method applied in Cincinnati.

Summary

Summing up the points in favor of the Cincinnati plan and the points that are against it, we find the following favorable conditions embodied in the method.

1. The student has an opportunity to see a shop arranged for commercial production. During noon hours and, perhaps, at other times when not engaged, he may go about, ask questions, and observe for himself, thus gathering much valuable information.
2. The student has an opportunity to see modern tools installed and running in an efficient manner, and observe the operation of all classes of shop devices.
3. He gets used to factory routine.
4. He learns his place as a factor in the productive plan, and finishes his college course with a balanced estimate of his knowledge and usefulness.
5. He develops dexterity.

The unfavorable points, as the writer sees them, are as follows:

1. The student does not obtain a full understanding of the possibilities and the wide application of any one tool.
2. The ability to discriminate between methods of production, and their bearing upon economy, is not developed.
3. The underlying reasons for using jigs and fixtures and similar labor-saving devices are not made thoroughly clear.
4. There is a lack of general familiarity with elementary shop processes with which the engineer must necessarily come in contact.
5. The student cannot be placed to advantage in the various shops by the college authorities who are responsible for his training.
6. His executive capacities are not developed.
7. Necessary branches of the work are dropped from the course at will.
8. The trend is toward training a mechanic for the shop rather than an engineer.
9. There is insufficient supervision of the shop work by the college authorities, or else the supervision is ineffective.
10. A large number of students do not get the proper training and the opportunities which may be available are for a few.
11. The feature of alternating between shop and school (the Cincinnati system being based upon the plan of the student working one week in the shop and then the next week in the college, and so on) is detrimental to the student's work in both branches, because of the frequent extended interruptions, first in one department and then in the other.

The Trade Course

The previous discussion has dealt with the engineering work only, no thought having been given to the training of mechanics, as the method of teaching for the two classes should be entirely different. Boys learning a trade have four hours a week off to go to school, and are paid apprentice wages for this time. In the apprentice school the problems given are related to the shop. The writer did not have an opportunity to see a class in session, but talked with some of the boys, and apparently this work consists of a series of shop talks with related problems. The subject matter of these shop talks appears to be good, though limited in its scope. They are delivered by persons who know their business, which by the way, is a very important feature. The apprentice classes meet in a separate school building devoted to this work alone. This school feature, however, is the only feature which is in any way different from the apprentice course available almost anywhere in the country to a boy who enters a machine shop.

One must not regard shop talks and the solution of problems as the whole of trade teaching. They are important and necessary adjuncts, but the real teaching of the trade is done on the shop floor by a man who makes it his business to see that the apprentice understands what he is doing; at the same time he is given such a range of experience that he may enter any shop as an all-around man. This involves the ability to operate all the principal machine tools, as well as familiarity with floor work; as principal machine tools are classed the lathe, planer, shaper, slotter, milling machine, boring mill, and grinding machine.

Now it depends on the position which one takes relative to trade teaching, whether the manufacturer is morally responsible for teaching a trade such as outlined above or not. If no claim is made to public attention or funds, any manufacturer may give any kind of training that a boy is willing to accept, or may be compelled by force of circumstances to accept, and there is no fault to find. The manufacturer has a right to make the apprenticeship he offers meet his own requirements for the benefit of his plant, and take care that the working personnel may not become depleted. This is what the men in charge of the shops in Cincinnati claimed to be doing and nothing more. No person in authority with whom the writer talked claimed to be training all-around men. "Three branches is all we give, at most," someone said, "and all the boys do not get these." One man in charge at one of the shops stated very clearly that there was no claim towards doing anything in this matter of trade training that is not done in almost every community, except that in the continuation school an effort was made to give the boy a proper view of his trade.

While thus the writer was not given any erroneous impression of the nature of the training afforded boys under the Cincinnati arrangement by those in charge of the shops, yet is it claimed by the educational authorities in presenting the cooperative plan of work in Cincinnati that the boy has an excellent chance to learn a trade, and this is the one point where the system is open to criticism—when it is claimed before the public that a course based on the needs of the apprentice is offered, and that his needs are the prime consideration. Persons connected with the school work in Cincinnati, however, have no control over the shop work and no assurance that the boy shall apply any of the matter taught at school in practice. In fact, the school work seems to be merely a scheme to keep the boy interested in what he is doing in the shop, in a vague way, rather than having direct application to his work. No one on the shop floor gives the apprentice any special attention. The instruction he gets is mere chance, and is not a certainty for every boy.

Therefore, in view of the fact that, at best, but a limited course is offered, and that even such a course is frequently curtailed, it hardly appears that the cooperative plan is a good way to teach a trade, nor even a desirable way in view of the fact that there are better ways open at a low cost to any community. This way is the trade school pure and simple. Worcester, Bridgeport, and New Britain, as well as some other communities have tried this method and seem to be satisfied with it. To say that such a school is too expensive is to admit that one does not understand the operation of a plant on a business basis, because all the trades taught at a school can be made to contribute to its support in the making of its own equipment.

This article should not appear without an acknowledgment of the courtesies extended the writer at the various plants, and an appreciation of the frank and open way in which each of those in authority at these plants answered all questions and assisted in the obtaining of the required information.

* * *

When steel balls are used for burnishing small metal articles by tumbling, it is important that a liberal amount of steel balls be used. There is a strong tendency, particularly among the smaller manufacturers, to attempt to economize on the balls and use too few. The result is, according to the *Brass World*, that not only is it difficult to obtain a good burnished surface on the goods in a reasonable time, but sometimes the appearance of the articles is such that the manufacturer will condemn the ball burnishing process. If too small a quantity of balls is used, they do not come in contact with the surface of the work being burnished as often as is necessary, and hence the process is slower than it would otherwise be. Also, if a small quantity of balls is used, the surfaces of the articles being burnished come in contact with one another instead of with the balls, and abrasion takes place instead of burnishing. In establishments doing some excellent work by the use of steel balls it is customary to use about twice the quantity of steel balls as compared with the quantity of the work in the barrel.

* * *

When the New York, New Haven & Hartford railroad shall have completed the electrification of its lines all the way to New Haven, as recently decided upon, it will have a mileage of about 150 miles under electric operation, or a trackage of about 600 miles. It is expected that these lines will be electrified before the end of 1913. This electrification marks the greatest undertaking along these lines as yet definitely proposed.

IMPROVED DESIGN OF HYDRAULIC ACCUMULATOR

By ALEX. W. BEGGS*

In the December number of MACHINERY an illustrated description on designing a hydraulic accumulator appeared. The writer has no fault to find with this article, or the calculations as given for the design presented, but he takes exception to the design or type itself. The design shown is con-

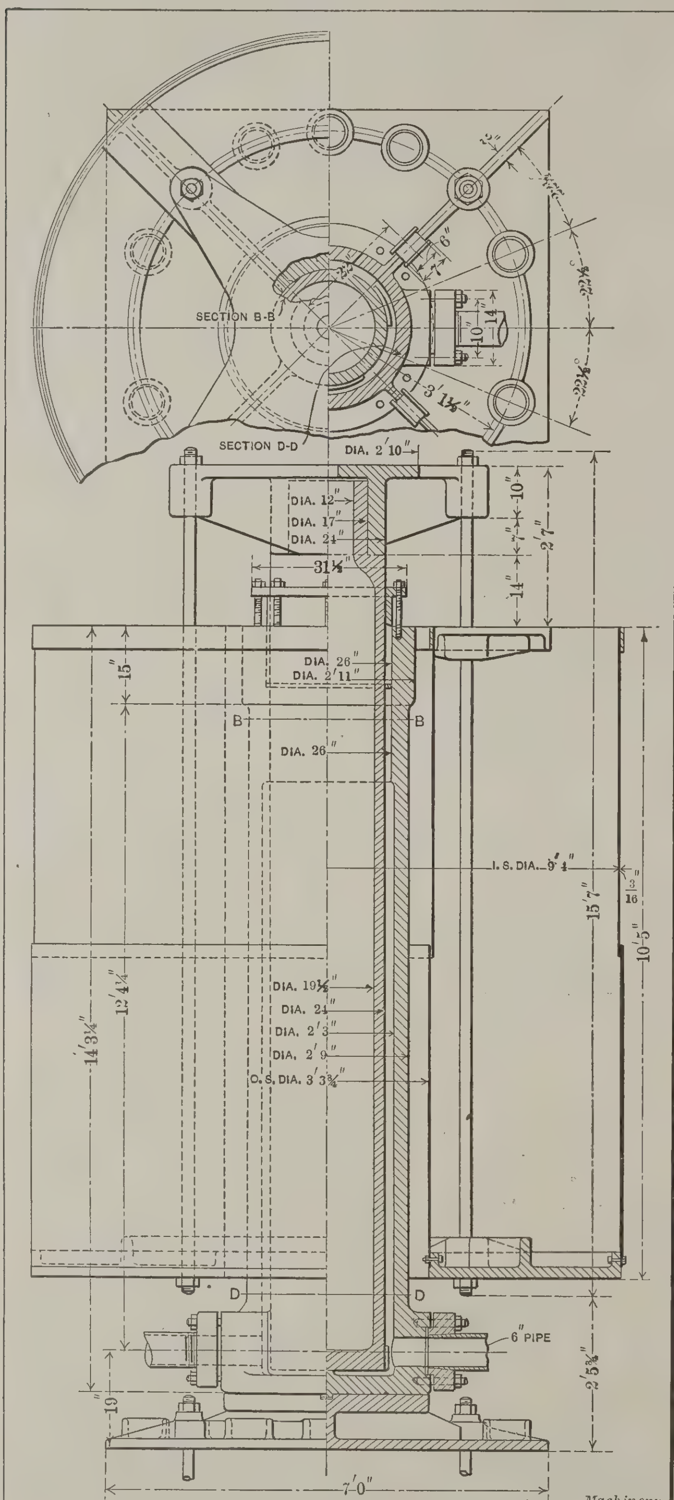


Fig. 1. Improved Design of Hydraulic Accumulator

sidered out of date, being what one might call "upside down." Furthermore, the author of the article states that it is better to make the plunger small in diameter and the stroke long, thus saving in the number and size of cast-iron weights required. The latter statement is, of course, correct, but it makes a more costly machine to build. Castings 23 feet long are difficult to make in the foundry, and to handle in the machine shop, and few shops have lathes that will take castings of that length. In addition, there is the guide frame to build and to fasten to the building, and the overhead room required. It is also troublesome for the man who has to crawl in under the accumulator to pack the gland on the plunger.

If it is necessary to save on the cast-iron weights, a tank can be used which can be filled with any kind of cheap scrap. The accompanying illustration shows a 24-inch accumulator for 600 pounds pressure, of which several have been built. It is self-contained, and as the packing of the gland is at the top, it can be easily reached. It is the practice in some plants employing hydraulic power, to use about 600 pounds pressure for general work. If a higher pressure is required an intensifier is used.

All the principal points of the design are indicated in the illustration, and it is not necessary to elaborate on them. One point in the design may, however, be worth while calling attention to. As will be seen in the engraving Fig. 2, the plunger is provided with four lugs, 9 inches wide, on the lower end. Four similar lugs are also provided on the inside of the upper end of the cylinder. If the plunger is placed in the cylinder and then given one-eighth of a turn, this will bring the lugs exactly in line with each other, and when the plunger is extended to its full stroke, the lugs will come in contact with each other and prevent further movement of the plunger. The plunger is prevented from turning back by a 1½-inch bolt

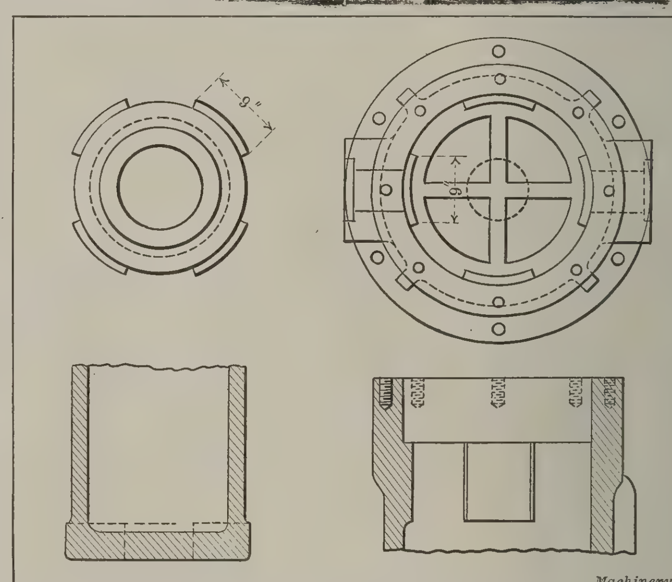


Fig. 2. End Views of Cylinder and Plunger, and Sections of Upper End of Cylinder and Lower End of Plunger, showing Safety Lugs

at the upper end, which passes through both the yoke and plunger. The yoke is prevented from turning by the flanged guide wheels on the bottom of the tank.

* * *

BRITISH STANDARD DEFINITIONS OF YIELD POINT AND ELASTIC LIMIT

The Engineering Standards main committee has agreed upon the following definitions for yield point and elastic limit. The elastic limit is the point at which the extensions cease to be proportional to the loads. In a stress-strain diagram plotted to a large scale it is the point where the diagram ceases to be a straight line and becomes curved. The elastic limit can only be determined by the skillful use of very delicate instruments and by the measurement of the extensions for small successive increments of load. It is impossible to determine it in ordinary commercial testing.

The yield point is the point where the extension of the bar increases without increase of load. Practically, the yield point is the load per square inch at which a distinctly visible increase occurs in the distance between gage points on the test piece, observed by using dividers; or at which, when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gage finger. A steel test piece at the yield point shows rapidly a large increase of extension, amounting to more than one two-hundredth of the gage length. The point is strongly marked in a stress-strain diagram.

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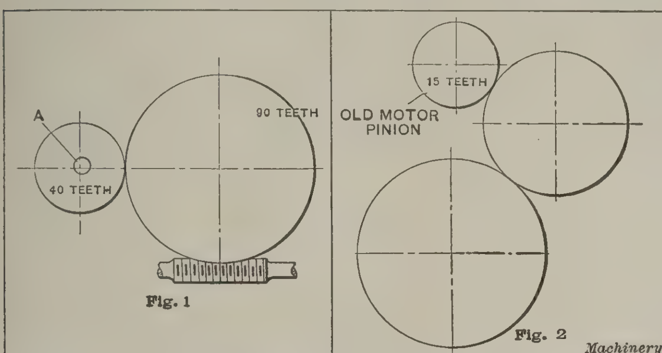
SHOP PROBLEMS INVOLVING GEAR AND PULLEY SPEEDS*

By J. H. CARVER†

In the following article are given a number of problems involving gear and pulley speeds. The problems are of a type likely to occur in ordinary shop practice, and their solutions are submitted with the hope that they will be of interest and value to those who may meet with similar instances, where the methods here given might be employed.

In the first place, assume that we have two gears with fixed center distance and a given ratio, which are to be replaced by two gears of a different ratio. Let R be this new ratio;



Figs. 1 and 2. Problems in Gear Ratios

and let the sum of the number of teeth in both the new and the old gears be $N + n = S$, where

N = the number of teeth in the large new gear,

n = the number of teeth in the small new gear.

R and S are known, and N and n are to be found. But, as $R = n \div N$, we have $NR = n$, or $NR - n = 0$. We have also $N + n = S$. Adding these two equations we have:

$$NR + N = S, \text{ or } N = \frac{S}{R+1} \qquad (1)$$

$$\text{From } R = n \div N, \text{ we have } n = NR. \qquad (2)$$

These formulas determine the number of teeth in the two new gears, which are of a different ratio but have the same center distance as the old gears.

As an example, assume that we have two gears on fixed studs, each having 60 teeth, and that these gears are to be replaced by two having a ratio of 4:11. Then, from the equations just given we have:

$$N = \frac{S}{R+1} = \frac{120}{(4 \div 11) + 1} = \frac{120 \times 11}{15} = 88 \text{ teeth.}$$

$$n = NR = 88 \times \frac{4}{11} = 32 \text{ teeth.}$$

In the arrangement of gearing shown in Fig. 1, shaft A is

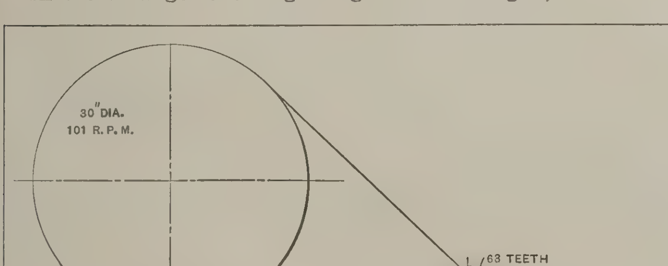


Fig. 3. Speed Reduction obtained by Gearing and Belting in Combination

turned by a worm- and spur-gear train. It is required to revolve shaft A thirty per cent faster by replacing the 40- and 90-tooth gears by other gears of proper ratio and suitable for the fixed center distance.

$$\text{Old gear ratio} = \frac{40}{90}. \quad \text{New gear ratio} = \frac{40}{90} + \left(\frac{30}{100} \times \frac{40}{90}\right) = \frac{52}{90}$$

$$\text{Hence, } N = \frac{S}{R+1} = \frac{130}{(52 \div 90) + 1} = 82.3,$$

or say 82 teeth, which is the nearest whole number. Further

$$n = NR = 82 \times \frac{52}{90} = 48, \text{ approximately.}$$

Hence, two gears of 82 and 48 teeth, respectively, making $S = 130$ teeth, as it should be, will give an increase of speed to shaft A of practically 30 per cent.

It is sometimes desired to change the size of the motor because of the increased duty of a motor-driven machine. For example, a 30-inch engine lathe is provided with a 2½ horsepower variable speed motor running at 700–1400 R.P.M., and it is desired to replace it with a 5 horsepower motor running at 500–1500 R.P.M. The speeds of the lathe spindle must cover at least the same range as before. The arrangement of the gears near the motor is shown in Fig. 2. The only change necessary would be in the motor pinion. The number of teeth N in this pinion is found from the proportion:

$$\frac{N}{15} = \frac{650}{500}, \text{ or } N = \frac{15 \times 650}{500} = 20 \text{ teeth, approximately.}$$

The value 650 is used in place of 700 because both slower and faster new speeds can thereby be provided for.

It often happens when belting from the motor to the pulley on a motor-driven machine, that the desired slow speed cannot be obtained by belting directly to the regular motor

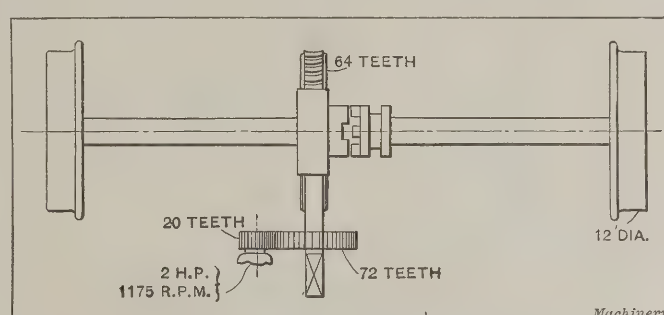


Fig. 4. A Simple Problem in Gear Ratios

pulley. In this case the motor may be geared as illustrated in Fig. 3. A bracket carrying a shaft is mounted on the motor frame. This shaft has a gear on one end meshing with a pinion on the motor shaft, and a driving pulley on the opposite end to which the pulley on the machine to be driven is belted.

A punch-press, for example, has a balance wheel 30 inches in diameter, as indicated in Fig. 3, and is driven by a two-horsepower constant-speed motor running at 1175 R.P.M. The required speed of the balance wheel is 100 revolutions. It will be found that by the arrangement shown a speed of

$$\frac{1175 \times 27 \times 6}{63 \times 30} = 100.7 \text{ R.P.M.}$$

will be obtained, which is near enough for practical requirements.

An inclined hydraulic press, whose back yoke is mounted on wheels and designed to be moved by an individual motor at a speed of 16 feet per minute, is arranged in the manner indicated in Fig. 4. A two-horsepower constant-speed motor is used, running at a speed of 1175 R.P.M. The wheels on which the yoke is mounted are 12 inches in diameter, or 3.14 feet in circumference. Hence, the number of revolutions necessary for a speed of 16 feet per minute equals $\frac{16}{3.14} = 5.1$ revolutions. Further, the speed of the worm $= 64 \times 5.1 =$ 326.4 R.P.M. Assume that we choose a 20-tooth gear on the motor shaft. How many teeth should the gear on the worm-shaft, meshing with this 20-tooth gear, have? Denoting the

* For a treatise dealing more completely with the principles involved in the problems presented in the present article, see MACHINERY'S Reference Books No. 18, "Shop Arithmetic for the Machinist," and No. 52, "Advanced Shop Arithmetic for the Machinist."

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number of teeth to be found by T, we find this number as follows:

$$T = \frac{20 \times 1175}{326.4} = 72 \text{ teeth.}$$

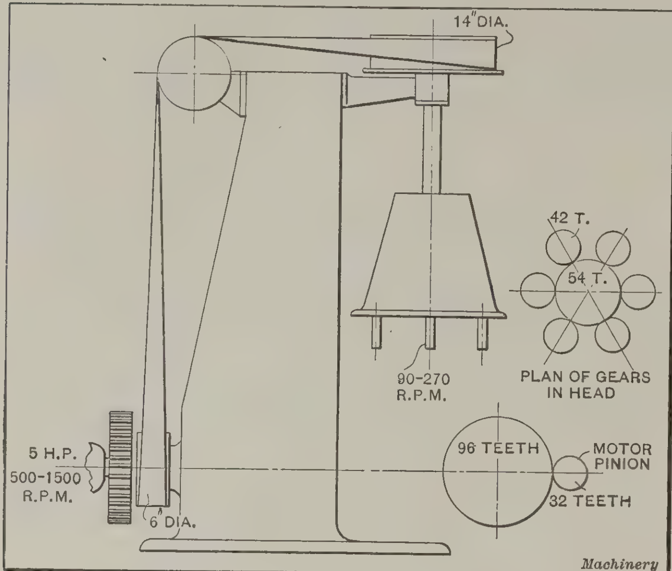
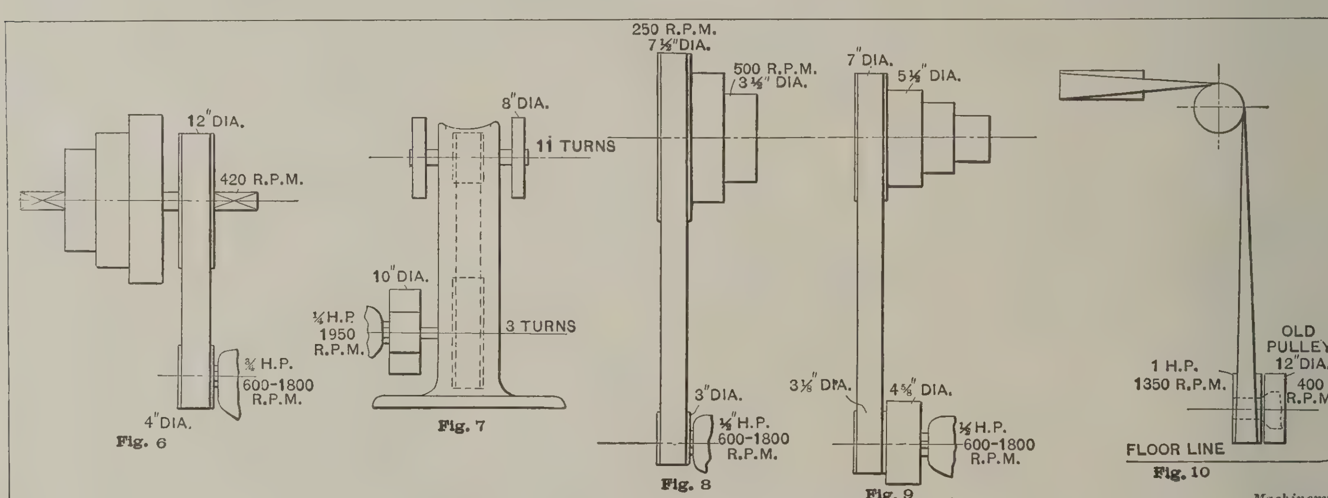


Fig. 5. Drive of a Six-spindle Drill Press

In Fig. 5 is shown a diagram of gears and pulleys used on a six-spindle multiple drill. A 32-tooth pinion on the motor meshes with a 96-tooth gear, as shown. A five-horsepower motor, 500–1500 R.P.M., was used. The drill speeds neces-



Figs. 6 to 10. Miscellaneous Examples of Belt Drives

sary were 90–270 R.P.M. The number of teeth in the motor pinion was found as follows:

$$\frac{96 \times 14 \times 42 \times 90}{6 \times 54 \times 500} = 32 \text{ teeth, approximately.}$$

A three-spindle sensitive drill was to be equipped with a ¾-horsepower variable speed motor, running at 600–1800 R.P.M. It has been found that ¼ horsepower per spindle is ample for driving sensitive drills. In the old belt-drive arrangement, the drive was to a 12-inch pulley, driving the cone-shaft at 420 R.P.M., as indicated in Fig. 6. The motor is belted to the same pulley, as shown. The diameter of the pulley on the motor is found as follows:

$$\frac{12 \times 200}{600} = 4 \text{ inches diameter.}$$

The value 200 is used instead of 420 in order to give a slower speed for the lowest motor speed than that obtainable by the belting arrangement. The average motor speed will then give the required speed to the cone shaft.

A grinder using an 8-inch emery wheel is to be driven as shown in Fig. 7, by a ¼-horsepower motor running at 1950 R.P.M. The emery wheel is run at 2100 R.P.M. The pulleys shown dotted are enclosed, and it is difficult to measure their diameters so as to determine the proper size for the motor pulley. By turning the emery wheel spindle, however, it can be found that eleven turns of the emery wheel correspond to three turns of the 10-inch pulley belted to the motor pulley. Hence, the speed of the 10-inch pulley equals $\frac{3 \times 2100}{11} = 573$ R.P.M., and the size of the required motor pulley will be $\frac{10 \times 573}{1950} = 3$ inches, approximately.

When changing the style of drive on a machine tool from belt to motor drive, it often happens that a cone pulley must be belted to the motor pulley. In the case of many lathes, profiling machines, drill presses, shapers, slotters, milling machines and special tools, the ratio of the speeds obtainable through the cone pulley may run from 3 to 1, according to whether the belt is on the smallest or largest step of the pulley. In such a case a 3 to 1 variable speed motor with the proper diameter of pulley to give the desired slow speed when belted to the large step of the cone will also give the corresponding high speed. As an example, assume that a turret lathe runs at 250 R.P.M. with the belt on the largest step, and at 500 R.P.M. with the belt on the smallest step, as indicated in Fig. 8. This lathe is to be belted directly from the motor pulley to the largest cone step. A 3-inch motor pulley gives a greater speed range than the old speeds, when using a ½-horsepower motor running at 600–1800 R.P.M.

In the case of higher ratios of machine cone pulleys, where the motors obtainable do not cover the desired speeds, a two-step motor pulley will meet the requirements. For example, a speed lathe, the cone of which together with the two-step cone of the motor is shown in Fig. 9, is driven by a ½-horsepower motor running at 600–1800 R.P.M. The lathe originally ran at 200–1500 R.P.M. With the motor pulley shown the speeds are 270–810 R.P.M. with the belt on the large step of the lathe pulley, and 500–1500 R.P.M. with the belt on the next smaller step.

A drill press was belted in the manner shown in Fig. 10. The 12-inch tight and loose pulleys shown were to be removed and replaced by a motor with pulley. The pulleys ran at 400 R.P.M. The motor was 1 horsepower, running at 1350 R.P.M. The peripheral speeds of the 12-inch pulley and the required motor pulley must be the same, if the drill press speed is to remain unchanged. Therefore, when the speed is increased, the diameter will be proportionately decreased, and

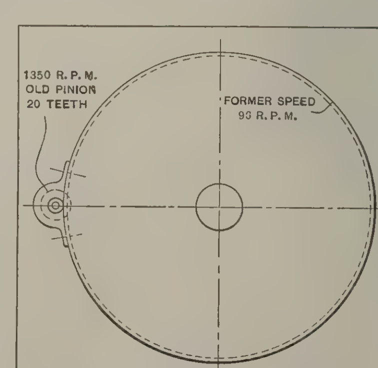


Fig. 11. A Problem in Gear Ratios

hence, the diameter D of the required motor pulley will be found as follows:

$$\frac{D}{12} = \frac{400}{1350}, \text{ or } D = \frac{12 \times 400}{1350} = 3.55,$$

or, say, 3½ inches, which is near enough for all practical purposes.

Fig. 11 shows a diagrammatical view of a punch press arrangement, the balance wheel being driven by a ½-horsepower motor running at 1350 R.P.M. The motor pinion has 20 teeth meshing with teeth in the balance wheel. The wheel runs at 96 R.P.M. It is desired to change to a 2-horsepower motor running at 1175 R.P.M., and at the same time increase the speed of the balance wheel to 110 R.P.M. The balance wheel is enclosed, making it difficult to measure or count the number of its teeth. By the calculations in the following, the necessary number of teeth in the new motor pinion is determined without reference to the balance wheel. If N is the number of teeth required, then

$$\frac{N}{20} = \frac{1350}{1175}, \text{ or } N = 23 \text{ teeth, approximately}$$

if 96 turns per minute, only, were required; but when 110 R.P.M. are required, we would have:

$$\frac{N}{23} = \frac{110}{96}, \text{ or } N = 26 \text{ teeth.}$$

* * *

An electrically operated blueprinting machine, used for making the blueprints for the municipal departments of St. Louis, Mo., produced 15,900 blueprints last year. According to the *Engineering Record*, the cost per square foot, including labor, material, and depreciation of the machine, was 1.5 cent for blueprints, 3.4 cents for brown-prints, 5.4 cents for black-prints, and 6.4 cents for blue-cloth-prints.

AUTOMATIC DIE-CASTING MACHINES*

By E. F. LAKE†

Nearly all die-casting machines in use at the present time are operated by hand, that is, a number of levers are pulled back and forth to perform the different operations of closing the mold, moving the plunger to force the metal into the mold, cutting off the sprue, opening the mold, and ejecting the castings. Nearly all of these machines require two men to operate them, and in some cases it requires five men to operate two machines. With these hand-operated machines a large quantity of castings can be manufactured in a day, and many have not considered it necessary to design and build more expensive machines. Some manufacturers, however, have built completely automatic machines for their own use, in order to save the labor cost of the hand-operated machines.

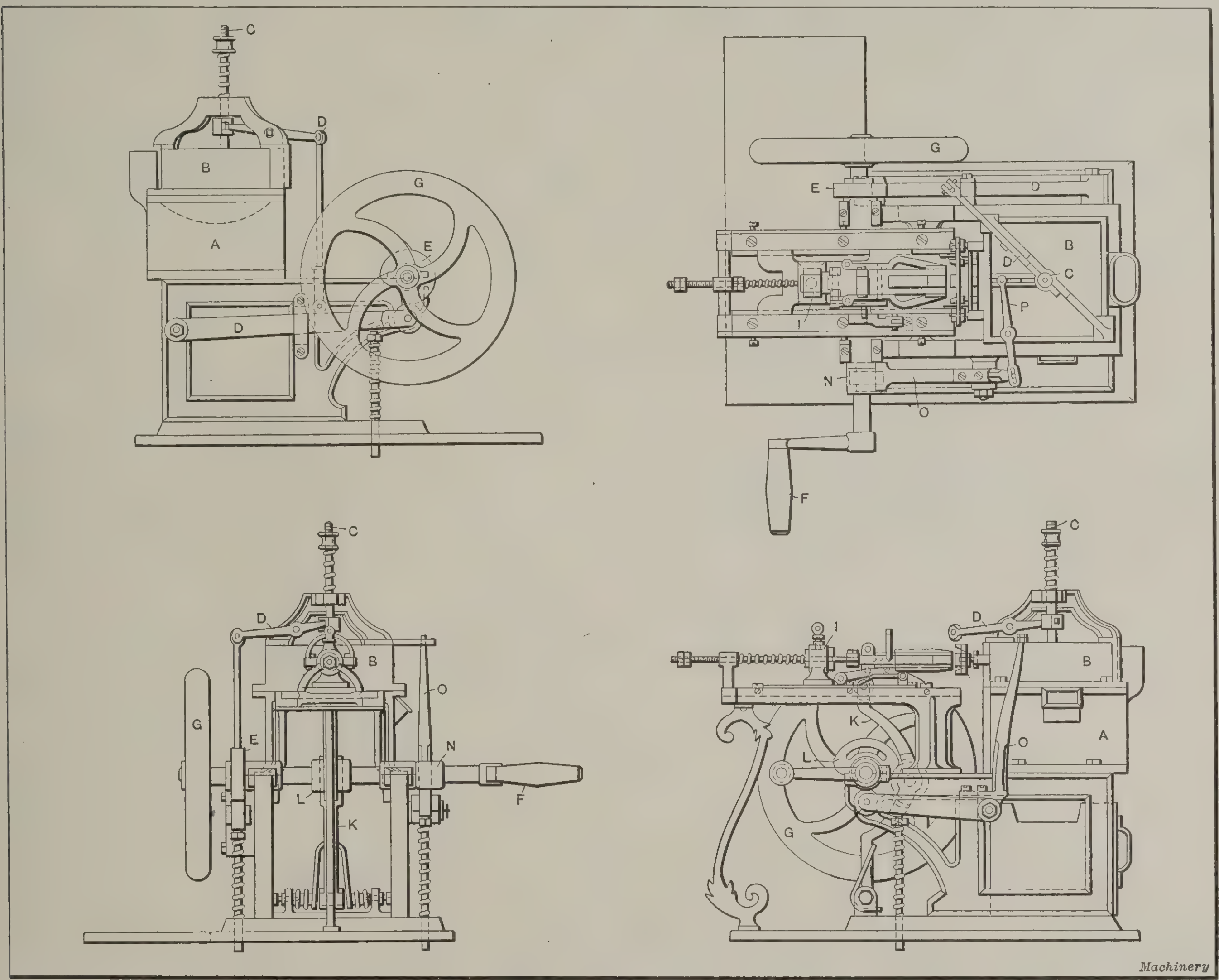


Fig. 1. First Automatic Die-casting Machine

These automatic machines are very successful, and are producing die-castings at a very low cost.

Automatic machines for casting type have been in use for more than sixty years, and these are, in reality, die-casting machines, although only used for the particular purpose of manufacturing type. Like all other die-casting machines, the automatics were devised from ideas and principles adopted in the type-casting machines, and are, in fact, largely improvements of these. The first attempt at applying such machines to the manufacture of castings, other than type, is shown in Fig. 1. This machine was patented by M. Dimock in 1875 for the manufacture of sewing machine bobbins. By turning crank F, all movements were produced that were necessary for the casting of a bobbin and throwing it out of the machine. By putting a pulley in place of the crank, it could be belt-driven and thus made completely automatic. In this machine,

* See MACHINERY, July, 1911, engineering edition, "The Design of Die-casting Machines—Alloys for Pressure Castings," and also the previous articles there referred to.

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A is the furnace and *B* the melting pot located over the furnace, in which the metal is melted and held, ready for casting; *C* is the upper end of the pump or plunger that forces the metal into the mold. This plunger is raised and lowered by levers *D*, which in turn are moved by cam *E* located on the driving shaft, which passes through the machine from crank *F* to the flywheel *G*. The mold and the apparatus for opening and closing it and ejecting the casting are located on a

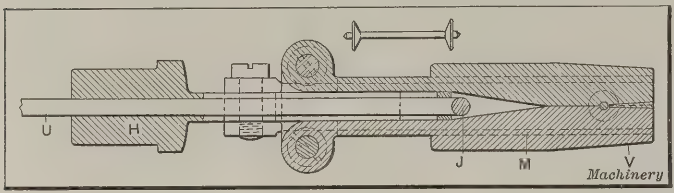


Fig. 2. Die-mold and the Bobbin cast

framework just above this shaft. The die-mold receives its metal from a nozzle in the side of the melting pot.

The cross-section of the die-mold, with shank *H* on which it is pivoted, is shown enlarged in Fig. 2; the bobbin which is cast in it is shown above the mold. Shank *H* fits into cross-head *I*, and is, by means of this cross-head, pulled back from the spout so that it can be opened. The two halves of mold *M* are opened like an alligator's jaw by turning bar *J*, which is long enough for this purpose and is located on the end of shaft *U* that passes through shank *H* and carriage *I*. The cast bobbin is then thrown out and the mold closed, ready for another casting. The cross-head and mold are moved back and forth by lever *K*, one end of which is pivoted to the frame at the bottom of the machine, while the other end works in a slot in the cross-head. Lever *K* is operated by cam *L* which is located on the center of the main shaft. When mold *M* is moved up to the nozzle of the machine, the tapered end at *V* enters a socket, thus holding the mold firmly closed. As soon as the mold assumes this position, a cam located on the main shaft at *N* operates hinged lever *O*, and this, in turn, moves lever *P*, which opens a valve that allows the molten metal to be injected into the die-mold. This valve operates in practically the same manner as valve *T* in Fig. 3 and valve *L* in Fig. 5, to be described later. In the meantime, plunger *C* has been raised to the top and as soon as the metal cut-off valve opens, the plunger is forced down and fills the mold with metal.

While this machine was simple in design, it worked fairly well, and many castings were made with it. The springs which gave the levers their return motion, however, were not positive enough, and on later machines cams were added for this work. A sprue cutter, such as is now used, was not provided, and hence the sprue had to be broken off from each casting. These were about the only faults that could be found, and the principles here adopted were developed to a point that enabled automatic die-casting machines to cast pieces very intricate in shape. Movements were devised for pulling out pins, located in the die-molds, as well as other loose pieces that might form any size or shape of hole in the casting.

In 1902, Mr. C. H. Veeder patented the machine shown in Fig. 3. On this he was granted patents on nineteen combinations claims, but it will be seen that, although the machine is greatly improved in its design, the basic principles on which it operates are practically the same as those of the machine patented in 1875. The furnace is located at *A*, the melting pot at *B*, and the upper end of the plunger at *C*, as in the former machine. Lever *D* is operated by cam *E* and moves rod *Q* and lever *R*, which latter causes plunger *S* to travel up and down and squirt the molten metal into the die-mold. Another cam moves pivoted lever *O*, which is connected with the valve rod, and opens and closes valve *T* in identically the same manner as did the earlier machine; in fact, the shape of lever *O* is almost the same. This, however, is a design that has been successfully used for years on type-casting machines and is difficult to improve upon.

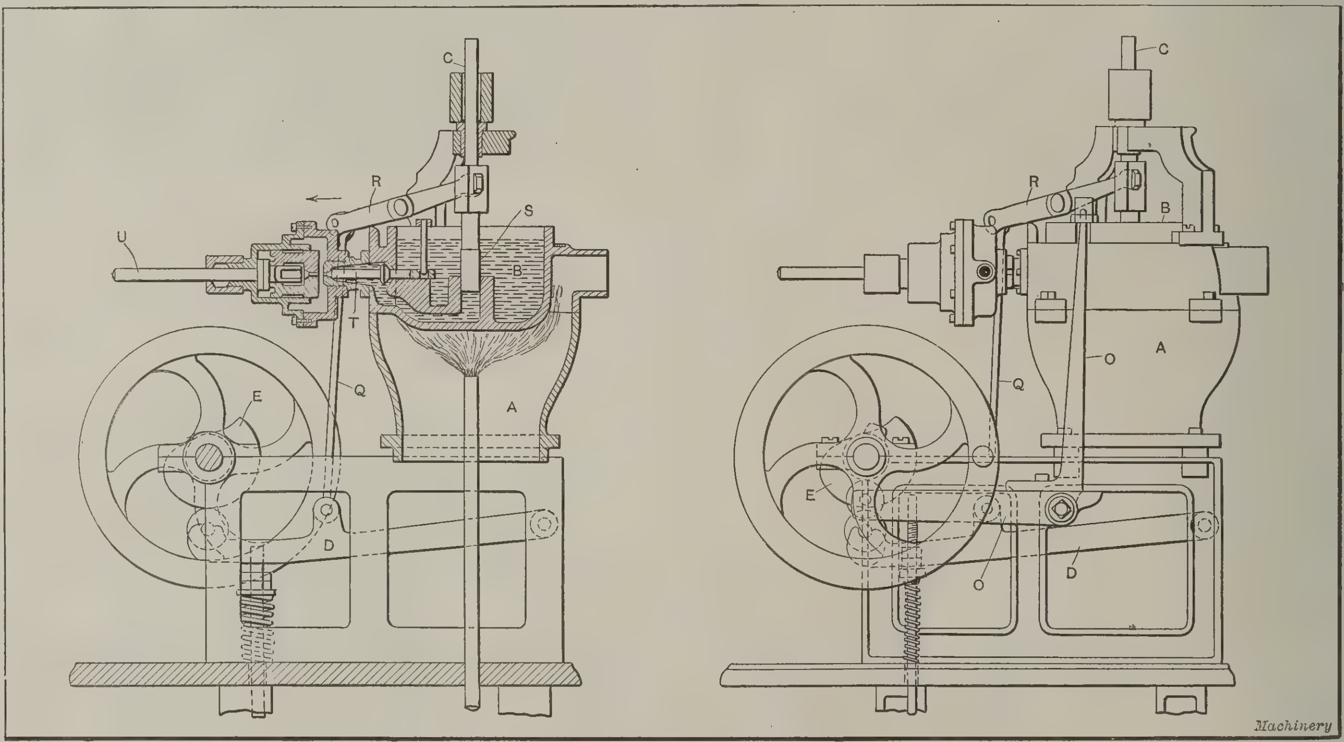


Fig. 3. Modern Die-casting Machine

The manner of parting the mold to remove the casting is altogether different. Instead of opening it like an alligator's jaw, as in the earlier type of machine, a part of the mold is moved back, away from the machine, and the casting is thus allowed to fall out. The mechanism that opens and closes the mold is not shown in Fig. 3, but it is done with a very similar supporting frame and cross-head to that which draws the mold away from the nozzle in the Dimock machine in Fig. 1; but, instead of using rod *U* to turn bar *J* and thus open the mold, as in the Dimock machine, rod *U* is used to form a core in the casting and after the casting has been made, rod *U* is pulled back to free the casting from the mold. This machine has been used for several years, but has also been improved upon. It has been made entirely automatic by putting a pulley in place of the crank wheel.

While in most automatic machines cams have been used to control nearly all of the movements, in others springs and gears have been used in combination with cams. Such a machine is shown in Fig. 4. In this a cam *E* is used to control the motion of the pump plunger and a large spring is used to hold the lever against this cam. The mold is moved

up to the spout and away from it by a crank on the end of the shaft that holds the cam. This shaft is driven by a gear N that meshes with a pinion L driven by a worm-wheel K and worm J; the worm, in turn, is driven by a pulley F and belt. A stationary cam is used to control the motion of a knife which cuts off the sprues and a brush that brushes off the knife. With the exception of the spring for holding the lever that operates the plunger against the cam, this machine works successfully. A spring in this location is liable to fail, owing to the plunger's sticking in the cylinder, due to dross in the molten metal; no metal would then be forced into the mold.

This machine was especially designed for casting electric storage battery grids, but can well be used for making many shapes of castings for machine parts. These grids are thin strips of metal, crossing each other at right angles, the strips being joined together at each intersection; they thus contain a number of square openings, and resemble wire netting, except that the strips are not round. As in the other die-casting machines, A is the furnace, B the melting pot over the furnace, C the plunger rod, and D the lever that operates the plunger. A roller attached to lever D rides on cam E, to guide the up and down motion of plunger G; spring I holds lever D against cam E. It would doubtless be better to use another cam to perform the work of this spring and thus make the upward motion of the plunger as positive as is the downward motion. Cam E is so shaped and timed in its motion as to cause the plunger G to move down only when the mold is closed tightly against the nozzle and ready to receive the metal. To reduce the air pressure in the mold against the plunger's action and insure that all parts are filled with the incoming metal, an air pipe Y, with pump, is often connected to the mold. This automatically pumps out the air and creates a vacuum in the cavity of the mold that shapes the casting, just before the molten metal is injected into it by the plunger.

The mold is operated by a mechanism that is as simple, positive and handy as that of any die-casting machine made. Mold M is located on rocker arm H, which is connected by rod P and spring Q to crank R. Thus, while cam E is controlling the operation of plunger G, crank R is controlling the movements of the mold. Mold M is thus brought up to the nozzle and held there while plunger G descends and squirts the metal into it. Plunger G is then raised for another stroke, while mold M is rocking back away from the nozzle. For the grid casting made in this machine many gates are used, and while the rocker is carrying the mold back to the end of its stroke, knife S travels across the face of the mold and cuts off the sprues. A brush then travels across the face of knife S and brushes off any chips that may have accumulated. These motions are controlled by cam U, which is bolted to the side of the frame.

On many kinds of castings for machines or instruments, the shape is such that this knife and brush could not be used for the sprue cutter, but it is easy to take off this mechanism and attach others that would perform the necessary operations, and which might be even simpler in design. The distance through which rocker arm H travels can be adjusted by shortening or lengthening rod P by the nuts provided. The mold can thus always be kept tightly against the nozzle, and also go back far enough to eject any casting. When rocker arm H reaches the end of its backward stroke, arm V strikes block W and this operates the mechanism that ejects the casting from the mold. To insure no jar, flat spring X is provided for rocker arm H to strike against.

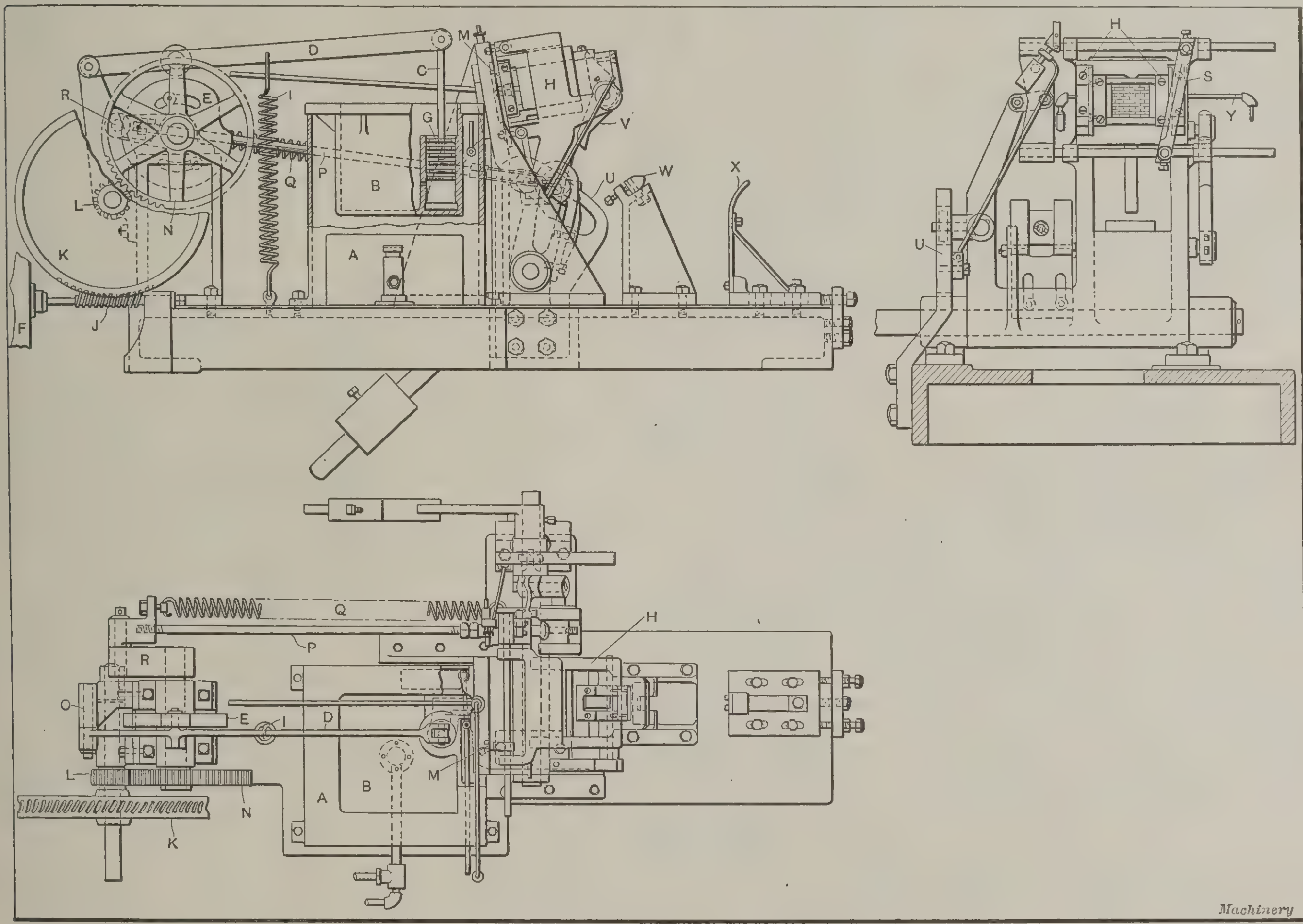


Fig. 4. Another Modern Type of Automatic Die-casting Machine

One of the most complete automatic die-casting machines built is shown in Fig. 5. This machine was patented by Mr. C. H. Veeder and is a vast improvement over the machine shown in Fig. 3. It is supplied with two melting pots and is completely automatic. All that the attendant has to do is to keep the secondary melting pot filled with metal and carry away the finished castings. With each casting that is made, the metal lowers in the melting pot and the secondary melting pot is used for the purpose of keeping the primary melting pot filled. In this machine the air is exhausted from the mold with an air pump before forcing the metal into it, thus insuring the filling of every crevice. The machine differs from nearly all other types in that it has provision for a

powerful, positive pressure for forcing the metal into the mold, in addition to the vacuum. Thus, the formation of gas bubbles or air pockets in the cavity that forms the castings is overcome and deformed castings are not produced. The percentage of bad castings has, therefore, been reduced to a minimum.

In this machine also, A is the furnace; B the melting pots; C the plunger; D the lever that moves the plunger up and down; E the cam that causes the movements of this lever; F the pulley that drives the machine; H the carriage that holds and operates the mold; and M the mold.

A single shaft J, driven by pulley F, controls all the movements. Cams are located on the central portion of this shaft and cranks on the two ends to give the machine all of its movements. No gears are used. A double-action valve is used to control the injection of the metal into the mold, and to cut off the sprue. This valve is shown at L. Before plunger C starts moving downward, arm N is moved away from valve L and the flow of metal due to the downward

This is a weak point of the machine, as the pressure that forces the molten metal into the mold is exerted against this spring, unless a locking device is attached to the mold, and this requires additional mechanism. Another cam could more easily be used to close the mold and hold it against the pressure of plunger C. While the mold is opening, bar S is moving to the left through carriage H to eject the casting from the mold. The movement of bar S is controlled by a series of levers moved by cam T. While the mold is closed, vacuum tanks U are automatically connected with it and draw out all of the air. A vacuum is constantly maintained in these tanks by an air pump.

With all of these movements properly timed, die castings are made as fast as the metal will solidify, and can be ejected from the mold without deforming the castings. Most die-casting machines do not apply as much pressure to the plunger, but depend on the suction created by the vacuum to draw the metal into the mold. This does not produce castings

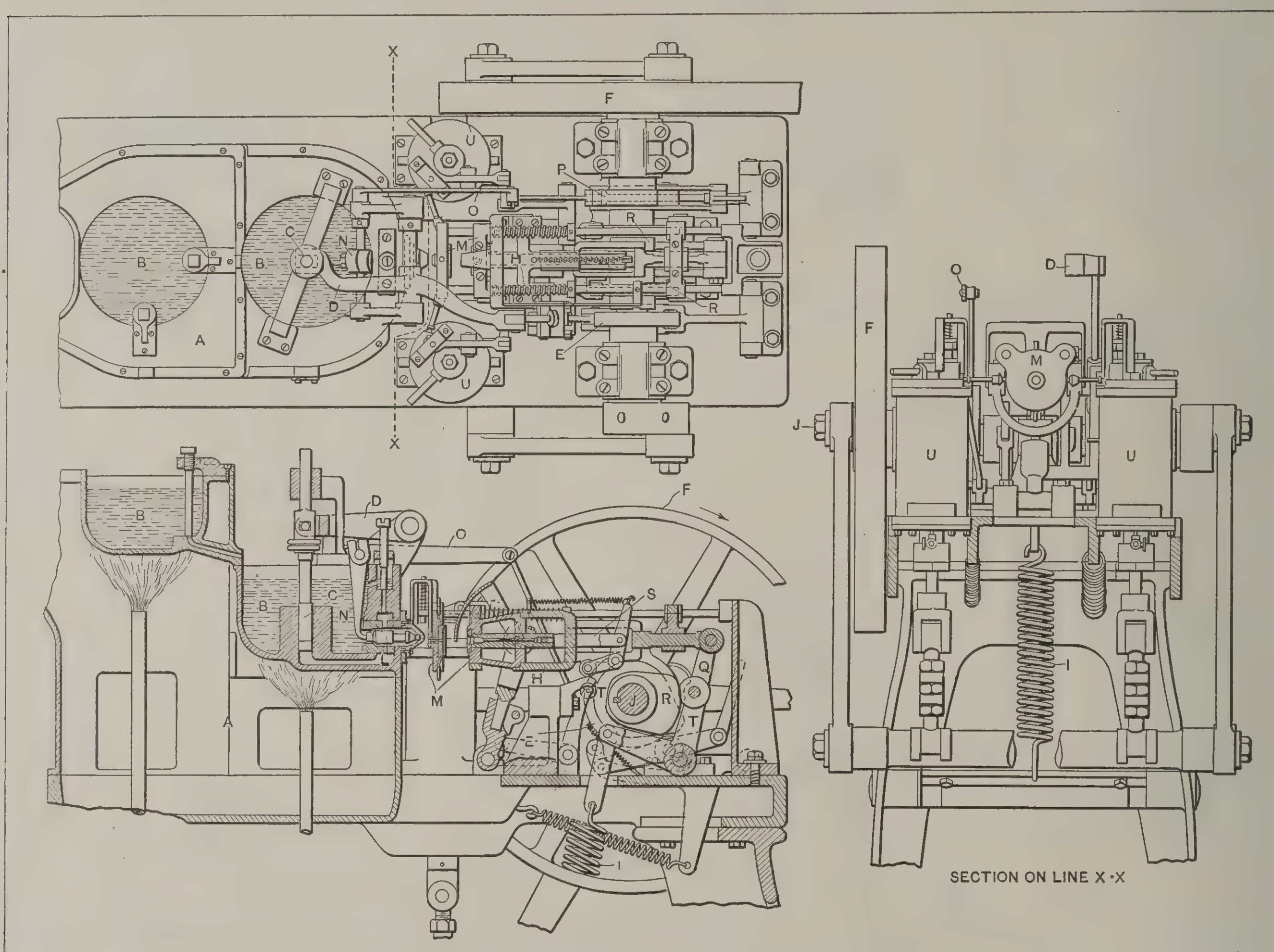


Fig. 5. The Latest Type of Automatic Die-casting Machine

motion of plunger C causes valve L to move to the left and close the opening between the passage in which this valve is located and the melting pot. Thus, all of the pressure exerted by the plunger is used to force the molten metal from this valve chamber into the mold. When the die-mold has been filled, arm N pushes against valve L and causes it to close up the nozzle opening through which the metal flows into the die-mold, and, at the same time, valve L cuts off the sprue of the casting. Arm N is moved by lever O, which, in turn, derives its motion from cam P.

Carriage H, which holds the mold and controls its movements, is operated by a series of levers that are moved by two cams. Lever Q, with its connecting levers is moved by cam R, and this pulls carriage H to the right to open the die-mold as shown in the lower left-hand view of Fig. 5. By the action of cam R, lever Q afterwards moves carriage H to the left, thus closing the mold and holding it tightly against the nozzle while it is being filled with the casting metal. Spring I holds the roller of lever Q against cam R.

with as fine and dense a grain as when a high pressure is applied, and they are more liable to have porous and spongy places. The high pressure, combined with the vacuum in the mold, also makes the casting correspond exactly to the contour of the cavity cut in the mold. One die-mold can be taken out and another, for a different casting, inserted in its place with very little labor. Thus the machine can be made to operate on several kinds of castings in a day's run.

These and other reasons make it one of the most economical machines built, as the cost of the castings has been reduced to little more than the cost of the metals for making the alloys, the gas that keeps the metal molten, interest on original investment, and the expense necessary to keep the machine in repair. Automatic type-casting machines cast one type at a time, at the rate of 240 per minute. This speed is largely due to the fact that cold water is forced through a water-jacket that surrounds the type cavity in the mold; as many as 240 per hour would be a high figure for die-castings for machine or instrument parts, as these are nearly always

more intricate in design and have a larger volume of metal to be cooled. Many times, however, more than one casting can be made in a mold. When the mold is water-jacketed, and the machine completely automatic, the output of perfect castings will be many times that of hand-operated machines, and at a very low labor cost.

The formation of coarse crystals is an inherent trait of all metals when they are slowly cooled from the liquid state. This coarse crystallization is more pronounced in some metals than in others, and the alloys from which die-castings are made are composed of the metals that form the coarsest crystals, when so cooled. The most notable example of this crystalline formation is antimony, while zinc is another metal that has a very flaky crystalline structure. This formation of coarse crystals can be overcome to a large extent if the metals are chilled and suddenly solidified from the molten state, when casting them into shape. This is done in the machine shown in Fig. 5 by circulating a stream of cold water through a water jacket formed around the cavity in the mold that forms the casting. While the vacuum created in the cavity of the mold and the pressure used to force the metal in have a tendency to reduce the coarse grain and crystallization, the rapid cooling and solidification that is caused by the current of cold water still further aids in refining the grain.

The action is similar to that which takes place when hardening steel. In this case, the grain is refined by heating cold metal to the desired temperature, and the fine grain is retained by instantly quenching in a liquid, and thus suddenly cooling the metal. If it were allowed to cool slowly, the grain crystals would return to the coarse size of the unheated steel; or if heated to too high a temperature, a coarse grain would be formed that could only be refined by the pressure or hammering applied during forging operations. In the die-casting alloys, this fine grain is produced by melting, and the quicker it can be cooled down from the molten state, the finer will be the grain of the metal in the castings. It is not a difficult matter to surround the casting cavity in all die-molds with a water-jacket. This, of course, will not only give the metal a more dense, homogeneous grain, but will also solidify the castings much more quickly and enable many more castings to be made per hour than can be made in a machine where the mold is not water-jacketed.

* * *

The manufacture of tungsten lamps has been a difficult and expensive matter because of the characteristics of tungsten. Up to a few months ago it was impossible to draw tungsten into wire as the common ductile metals are drawn, but it had to be squirted while in the so-called "colloidal" state to form the required filaments. The other elements mixed with the powdered tungsten had to be driven off by heat, thus leaving a very brittle wire, exceedingly difficult to mount in the lamp and easily broken by shock. Now, thanks to improved methods of treatment, it is possible to draw the pure metal into wire of great tenuity, diameters of 0.003 inch or less being readily produced. The metal is drawn through diamond dies into lengths of 600 or 700 feet and can be wound on spools without danger of breakage. The success of the research has made the tungsten lamp as practicable as the old carbon filament lamp which it is rapidly displacing because of its much greater efficiency.

* * *

A reader suggests that the boss who refuses to help a man acquire knowledge of those things in which he is weak for fear that he might get the boss's job some day, is not up-to-date. The modern foreman strives to surround himself with intelligent men, realizing that the higher the grade of average intelligence of men, the better will *he* stand with his employers. The intelligent foreman should cooperate in the training of an understudy who will be able at a moment's notice to take charge of his department. The late R. T. Crane of Crane & Co., absolutely required that every man occupying a responsible position have an alternate who knew all his duties and how to execute them. Did this mean that the foremen were likely to lose their jobs at any moment's notice? No, on the other hand the tenure of position was much more secure there than in the common run of factories.

THE EVOLUTION AND PRESENT DEVELOPMENT OF THE TURBINE-PUMP*†

At the present time the use of the turbine-pump has become so extended that it is difficult to find services to which it cannot be advantageously applied. It will no doubt, therefore, be a matter of interest to trace the evolution and development of machines of this design, and this, perhaps, cannot be better done than by considering in particular one type only. As a description of the commercial application of the steam-turbine is a history of the Parsons machine, so that of the turbine-pump can be adequately portrayed by an account of the evolution of the Osborne Reynolds pump.

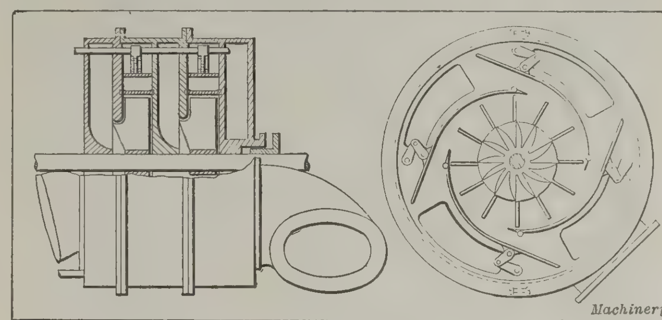


Fig. 1. Reynolds Turbine-pump, 1875

Centrifugal pumps were in the past accepted by engineers as suitable appliances for easily and cheaply (as to first cost) raising water to low heads. It was not realized that they were capable of dealing with any but low heads; in fact, this view became a canon of ordinary engineering practice, creating a tradition which took many years to remove. It is singular that, though the water-turbine with its guide-vanes was a matter of common knowledge at the time, no attempt appears to have been made to reverse its action with the prospect of obtaining a similar high efficiency and increase of head, for the purpose of raising water. There was, however, one exception in the invention of Prof. Osborne Reynolds'. It is the object of the present article to trace and discuss the development of this invention.

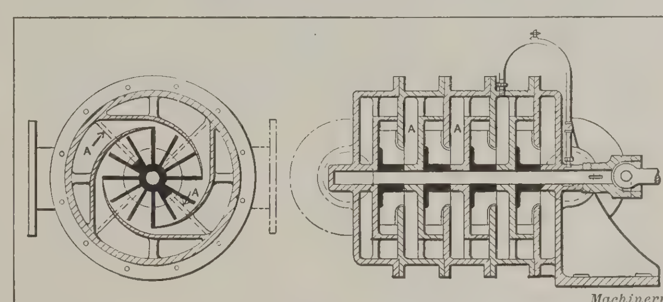


Fig. 2. Reynolds Pump, 1887

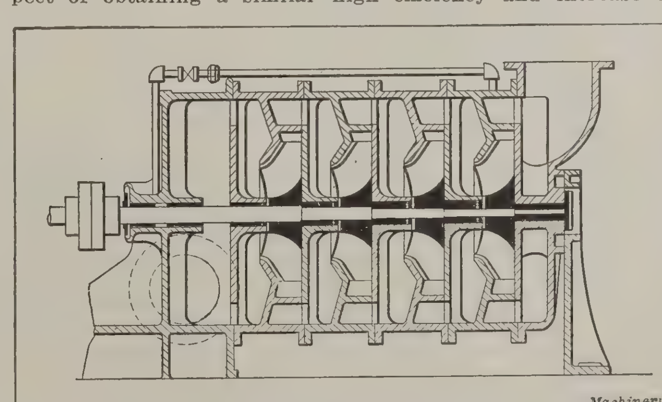


Fig. 3. Mather-Reynolds Pump, 1895

* Abstract of paper by Dr. Edward Hopkinson and Mr. Alan E. L. Chorlton, of Manchester, England, read before the Institution of Mechanical Engineers, January 19, 1912.

† For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Self-contained Turbine Pumping Engine," April, 1910; "Turbine Pump Motor Drive," and "Electric Drive of Turbine Pumps," December, 1909, engineering edition; "Centrifugal Pumps," June, 1909, engineering edition; "Centrifugal Pumps," February, 1909, engineering edition. See also the note published in connection with the last mentioned of these articles.

In 1875 Prof. Osborne Reynolds invented a turbine-pump of the series type, fitted with guide-vanes, as shown in Fig. 1. Comparison of this figure with illustrations following show how the essential features of his original proposition have been adopted in subsequent practice. In this pump the impeller delivered its water to tangent guide-vanes, as shown, and the similarity to an inward-flow turbine of the Thomson type is noticeable, for, as in that machine, the mouths of the guide-channels could be regulated to raise the efficiency of the pump for smaller outputs, a device however seldom adopted in later practice.

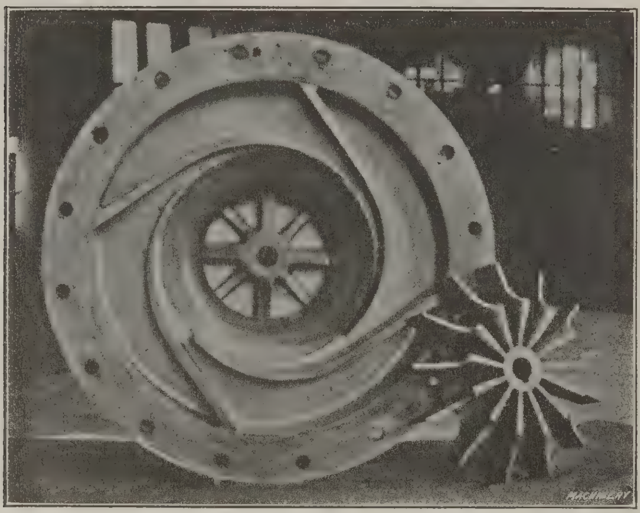


Fig. 4. Impeller and Guide-passages of Mather-Reynolds Pump

Nothing of any commercial value appears to have been done with the invention for many years; in fact, the first pump of which records and tests are available was constructed in 1887 by the firm of Mather & Platt for the engineering laboratory of the Owens College, Manchester. This pump, shown in cross and longitudinal section in Fig. 2, had four impellers in series and gave at 1500 revolutions per minute a total head of 148 feet or 37 feet per chamber. The average efficiency recorded in the tests made by Prof. Reynolds was 58.5 per cent, a high result, in proportion to its small size, for a pump made twenty-five years ago. The readings were taken from a dynamometer fixed between the pump and the belt-pulley, and, as no method of damping the indicating finger seems to have been employed, they may be liable to some error. Thus the maximum efficiency obtained, *viz.*, 70 per cent, appears open to some doubt. The guide-vanes, after leaving the wheel in a curve, reached the inner periphery of the outer shell of the chamber at an angle. The water having had its velocity of whirl converted into pressure-head in these passages, had then to pass sideways at right angles into radial-return passages formed in the back portion of the chamber and marked *A* in Fig. 2. In these passages the water was guided and prevented from rotating by radial vanes. The water on reaching the center passed into the eye of the second impeller, and so on until it was finally delivered at the pump outlet at the head pressure required. It will be observed that the impeller was of the open type with radial vanes.

The tests of Prof. Reynolds proved the capability of the pump to perform many duties, previously thought impossible by centrifugal pumps, and in 1893 the firm of Mather & Platt took up its commercial manufacture. The mechanical construction of a standard Mather-Reynolds pump as built in 1895 is illustrated in longitudinal section in Fig. 3. The impeller and guide-passages are also shown in Fig. 4. The pump consists of four chambers working in series. At one end, these are secured by bolts against the circular flange of a frame carrying the driving pulley or shaft coupling, this having the suction branch and entrance to the first chamber cast with it. At the other end the delivery chamber forms the final cover, and has the delivery pipe cast on the upper part connecting to the annular space into which the last set of guide-passages deliver, and at this end a suitable stay is attached to support the pump from the floor. The chambers are secured to each other by bolts through external flanges, each chamber being recessed and spigoted so as to preserve the correct alignment of the whole. This forms an inexpensive design, and permits of accurate manufacture. It allows of

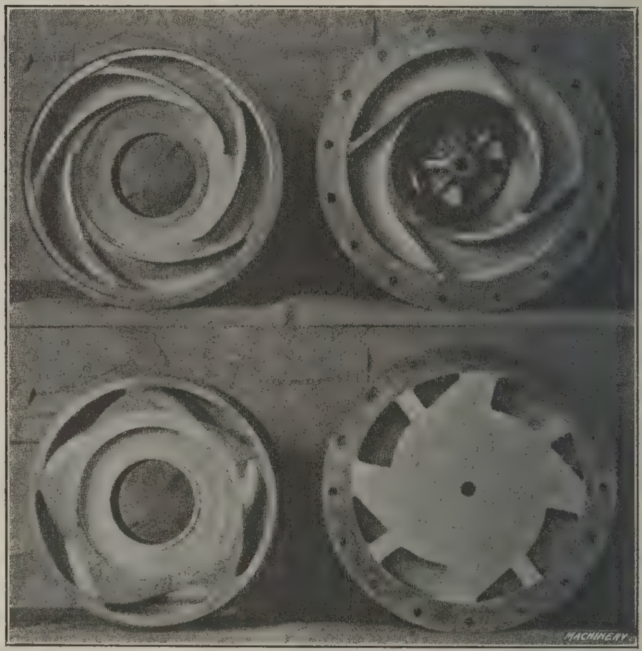


Fig. 5. Comparison between Guide-vanes in Pump of 1895 and Modern Pump

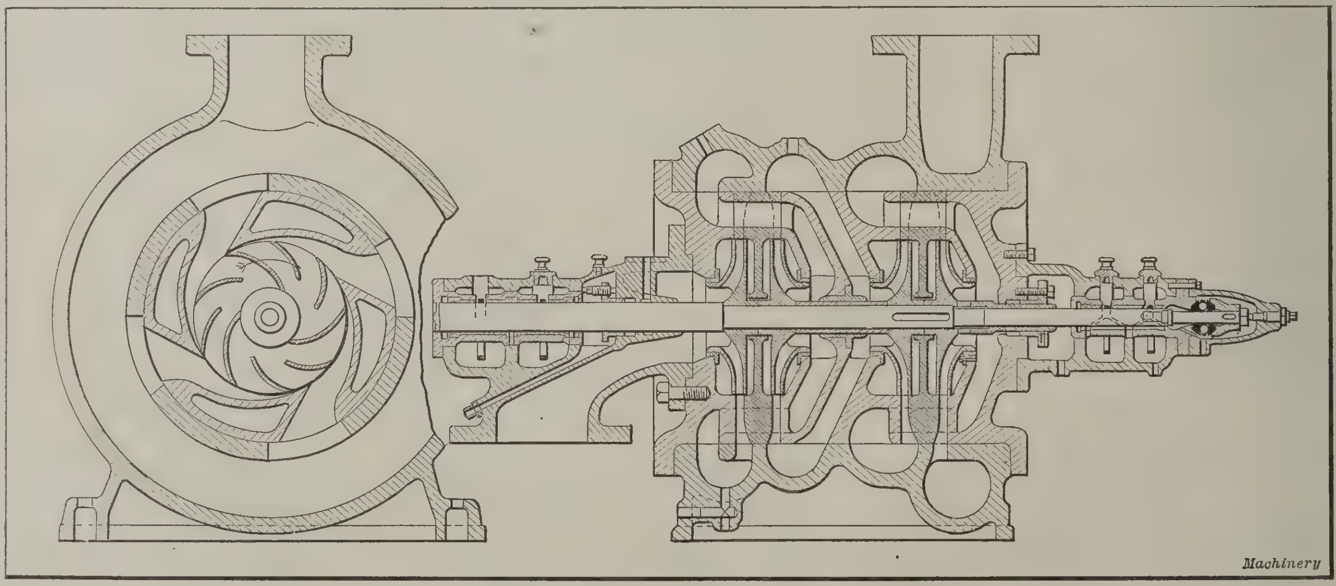


Fig. 6. Four-chamber High-lift Centrifugal Pump of Sulzer's Design

chambers being added or subtracted for higher or lower heads. Each chamber is distinct in itself, and has on one side the guide-vanes, receiving the discharge from the impeller, and on the other the return passage to the eye of the next impeller. This return passage is walled by a diaphragm integral with the casting. The water leaving the impeller, guided by the

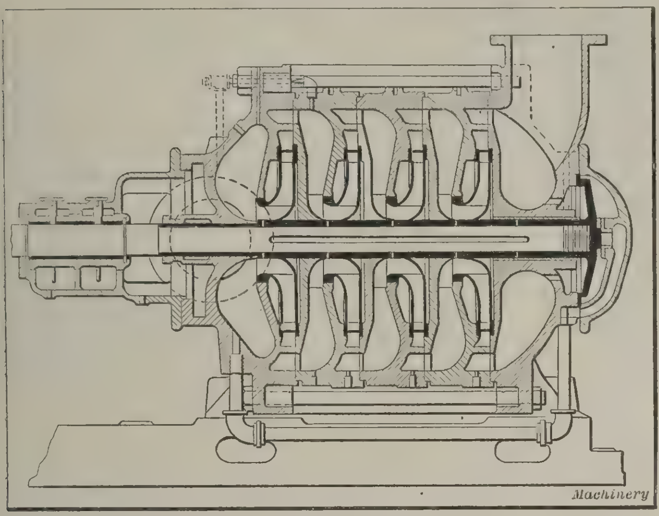


Fig. 7. Modern Four-chamber Pump

delivery vanes, passes to the next chamber and is there guided to the eye of the following impeller.

In comparing such a pump with a modern one (see Fig. 5) it will be found that it is in the form of its impeller and its delivery-casing that the original Mather-Reynolds pump differed most from the present design. The impeller, as shown in Fig. 4, is of the open type (not shrouded), with radial vanes, the roots of which are carried across the openings of the eye into the boss, necessitating the use of a modified form of Francis entrance. This form was probably adopted in order to secure sufficient strength to drive the vanes, necessitating their being carried through full width to the boss on the pump-shaft, and not starting level with the outer diameter of the eye as now. The impeller was turned all over, and revolved a close fit in its casing, which was turned to a corresponding form. This prevented leakage and loss of efficiency by the return of the water from the tip to the suction along the impeller sides.

In the 1895 pumps the speeds of the water through the impeller and passages were comparatively low, and large areas were therefore necessary. Each wheel being of the open type was nearly balanced as to end-thrust in itself, and so with the moderate heads pumped against, troubles with lateral end-thrust were not experienced. There is no doubt, however, that end-thrust did occur, and this caused the impellers to rub on the sides of their casings with consequent friction, the wear causing leakage and loss of efficiency, the varying conditions of which make the true comparison of various tests difficult. This, however, did not cause any serious trouble in practice on account of the large areas on which the end-thrust was taken, and the low head per chamber.

Considering the guide-vanes, it will be seen that in the 1895 pump these are shorter, or rather open out more quickly than in a modern pump. (See Fig. 5.) They are obviously less efficient if judged from the analogy of a Venturi tube, which must have a certain length if serious loss is not to be occasioned by converting velocity into pressure.

A considerable number of pumps of the 1895 form were constructed for installations in this country and abroad. Meanwhile Messrs. Sulzer Bros., of Winterthur, had commenced the manufacture of multiple turbine-pumps about 1896, and had evolved various modifications in the Osborne Reynolds design, whereby both the efficiency and the lifting capacity were considerably improved. They had established in 1898

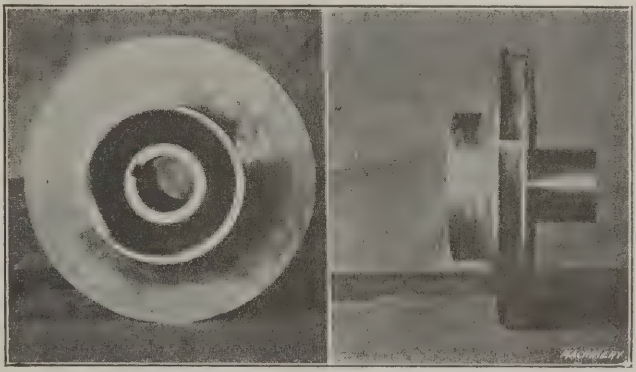


Fig. 8. Impeller of Pump in Fig. 7

an interesting and novel installation of these improved pumps at the Spanish mines of Horcajo, which attracted considerable attention. Two years later an agreement was concluded between Messrs. Sulzer Bros. and Messrs. Mather & Platt, providing for an interchange of future improvements.

A four-chamber pump of the Sulzer design is shown in longitudinal and cross sections in Fig. 6. Comparing this with the 1895 design, three important differences are noticeable. Firstly, the body casting of the pump is constructed in one piece, with the intermediate pieces, guide-vanes, and impellers put in from one end. Secondly, the impellers are shrouded and have backward-curved vanes. Thirdly, the impellers are arranged back to back to compensate for the increased lateral end-pressure set up by the higher heads worked against. This arrangement of the impellers involved the use of somewhat tortuous pas-

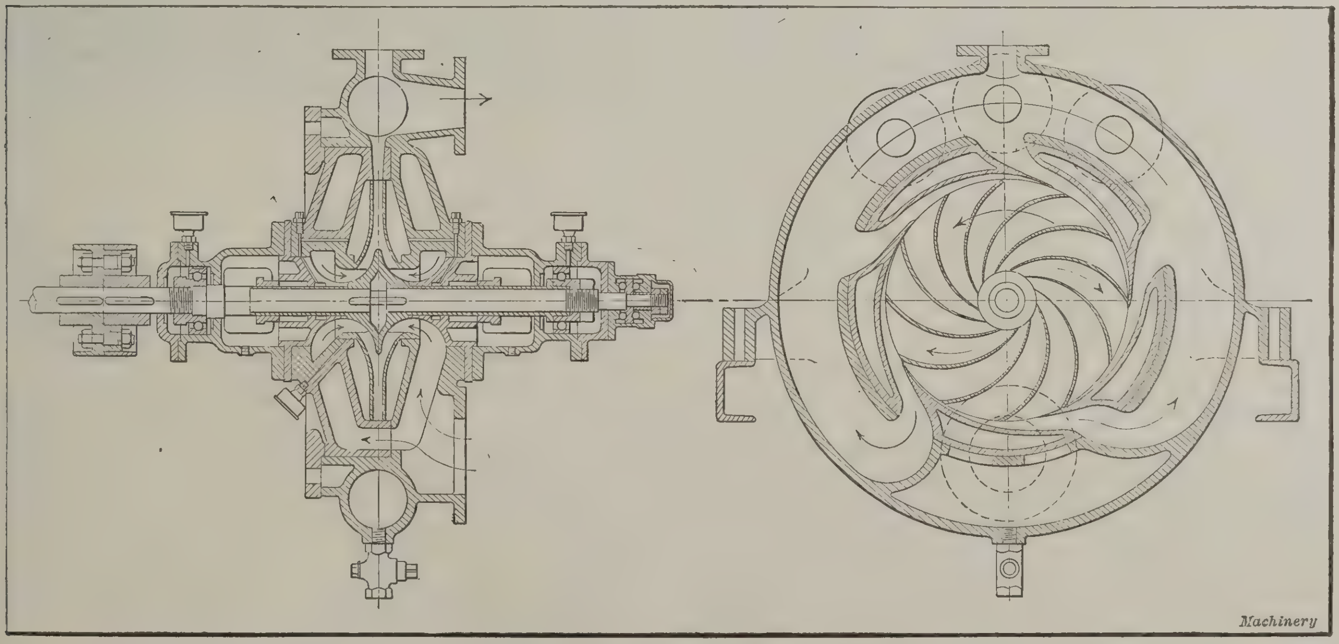


Fig. 9. Single-chamber High-lift Turbine-pump

sages in the pump to bring the discharge of the first impeller to the eye of the second, and so on. Moreover, these passages passing several joints increased the probability of internal leakage from one stage to another. The agreement between Sulzer Bros. and Mather & Platt came to an end by mutual consent in 1904, and after that date each firm further developed their pumps on their own lines.

Proceeding now to the discussion of later designs, a four-chamber pump is shown in longitudinal section in Fig. 7, its guide-vanes being shown in Fig. 5, to the left in the lower view, and its impeller in Fig. 8. It will be seen that constructionally this pump differs principally in that the extended suction-end is shortened, and is similar to the delivery-end. This enables various classes of drives—motor, belt, or steam-turbine—to be better negotiated with a standard pattern. Successive chambers, instead of being secured to their neighbors by bolts and flanges, are held together by long bolts extending the entire length of the pump body and held only at the two ends (suction and delivery).

The impeller is of the shrouded type, having vanes bent well backwards and the guide-passages are longer and more correctly divergent, while the return-way to the eye of the next impeller is of a curved form and more in line and continuous with the receptive ports, thus preventing the abrupt right-angle turn through the casing obtaining in the Reynolds pump. The losses in the Reynolds impeller through side friction in its casing are obviated, and any leakage from the periphery back to the suction is prevented or greatly minimized by the outer circumference of the impeller eye running in neck bushes with a very small radial clearance, amounting to less than 0.005 inch. The importance of preventing this leakage is very great if high efficiency is to be secured. The impeller is turned all over on the outside, to reduce loss by skin friction, and with the same object it is usual to use as many wheels as the circumstances will otherwise allow.

An interesting application of the turbine-pump for fire-prevention purposes, as fitted to petrol automobile fire engines, is shown in Fig. 9. The capacity varies usually from 350 to 1000 gallons per minute, against a head of 250 to 300 feet. The pump has a single chamber and is designed to fit on the back part of the chassis of an automobile, and to be driven by an extended shaft from the engine. The regularity of the flow of water delivered renders the holding of the hose-jets much easier and the action of the turbine-pump allows the shutting off of any particular jet, or of all the jets, without any tendency to burst the hose-pipes, as may be the case with a reciprocating pump. Further, the pump is much lighter than a corresponding pump of reciprocating type, and takes up considerably less space. The difficulties incident to starting with a heavy suction can be met by the provision of a small auxiliary pump which exhausts the suction pipe, thus causing the water to fill the turbine-pump. As soon as the turbine-pump has developed its head pressure, the auxiliary pump can be put out of action, and the turbine-pump will continue to work with suction lifts up to at least 80 per cent of the height of the barometric water column.

* * *

"PRESSURE OF COAL ON STORAGE BIN WALLS"—CORRECTION

The formulas for the pressure of anthracite and bituminous coal given in the February number on page 432, engineering edition, second column, should read as follows:

$$P = \frac{w \times 1.454\, h^2}{2} \tan^2 31°\ 30' \text{ for anthracite coal, and}$$

$$P = \frac{w \times 1.574\, h^2}{2} \tan^2 27°\ 30' \text{ for bituminous coal in which}$$

form they agree with the formula

$$P = \frac{wh^2}{2} \tan^2 \alpha$$

* * *

The third and concluding installment of "The Forms of Lathe Beds," by Mr. Joseph G. Horner, will appear in the April number.

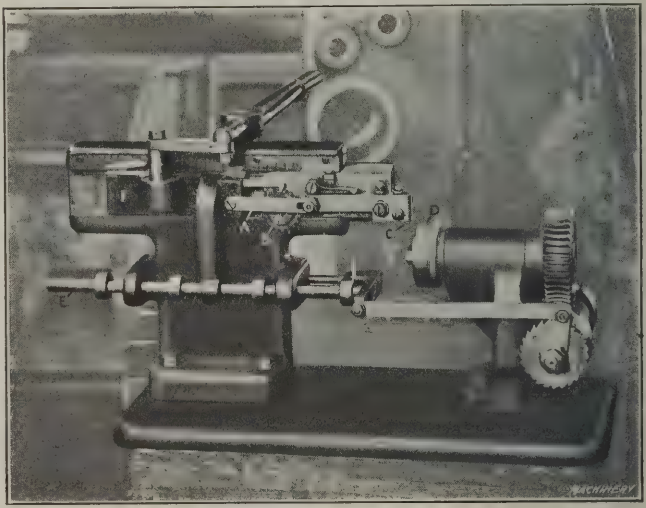
CLEVELAND GRADUATING MACHINE

The halftone shows a simple and effective graduating machine made by the Cleveland Machine Tool Works, Cleveland, Ohio, and used in the manufacture of the Cleveland horizontal boring machines, to graduate the collars of feed and adjusting screws.

The machine comprises a work spindle (at the right in the illustration) driven by a worm and worm-wheel, the collar to be graduated showing at *D;* and a slide at the left which is in two parts, consisting of the part *F* and the tool-slide proper on which the marking tool is mounted. Both slides work in the same guides. The slide *F* is worked by the hand lever at the top, and *F* has an arm projecting downward loosely fitting the horizontal rod *E* on which are four collars. The outer collars limit the travel of the slide, and the position of the middle pair of collars determines the swing of the ratchet indexing lever on the end of the worm.

The form of graduation most used is markings in groups of five, every fifth graduation being denoted by a longer line than those indicating the intermediate graduations. The means by which the variation in length of lines is effected constitute the chief novelty of the machine.

The tool that cuts the lines is fixed just at the left of *C* in the tool-holder. In advance of the cutting tool at *C* is an adjustable hardened stop which limits the depth of the line. This stop is pressed against the collar to be graduated, by the flat spring seen above, so that any irregularities in the work



Cleveland Graduating Machine

do not affect the depth of the line. As stated before, the tool-holder is mounted on a slide moving between the same guides as the slide *F*. It is connected to *F* by the link *A* which is slotted at the right end. Behind the link is a ratchet wheel *B* having every fifth tooth longer than the intermediate teeth. This wheel is mounted on the slide carrying the tool-holder, and is turned one tooth at each stroke of the operating handle by the pawl shown above it. The tool-slide is pushed to the right by a pin in *F*, concealed by *A*, which strikes the end of the ratchet teeth in *B;* and it is pulled to the left by the link *A*. The lost motion or dwell of the slide, due to the slotted link connection, operates the ratchet. The action is as follows:

Suppose that the first four graduations are the short lines. Then the tool is pushed to the right for the minimum length of line. On the fifth stroke, however, the ratchet has turned so that the driving pin strikes on top of the long tooth, and thus the tool slide is pushed to the right an amount greater than the previous four strokes by the difference in height of the long and short ratchet teeth.

Of course the machine is not limited to a fixed order of graduations. Other graduations can be made by using ratchets to suit the required combination of long and short lines.

* * *

The output of steel from electric furnaces during 1910 amounted to almost 112,000 tons in Germany, the United States and Austria-Hungary. There are at the present time in use, or being built, not less than 118 electric furnaces of all types.

THE NEW PLANT OF THE CINCINNATI MILLING MACHINE CO.*

Some years ago, when the Cincinnati Milling Machine Co.'s business had grown beyond the capacity of the old plant, Mr. Fred A. Geier, president of the company, conceived the idea of organizing a factory colony grouped about a central power plant. Three other companies that were in need of better facilities joined at once in this project, and the outcome of the idea is the factory colony at Oakley, situated forty minutes by trolley from the business center of Cincinnati. Seven plants are now located there. In the present article the new plant of the Cincinnati Milling Machine Co., as built in this location during the last three years, will be described. In many respects this plant is one of the most remarkable factory buildings in the country. It is apparent to the observer that a great deal of thought has been expended to secure, as nearly as possible, ideal shop conditions with regard to mechanical arrangement, light, heat, ventilation and sanitation. It is no exaggeration to call these works a model plant, constructed and equipped for the highest efficiency.

General Arrangement and Character of Plant

A bird's-eye view of the entire plant is shown in Fig. 1, while Fig. 2 shows an outline plan of the buildings, indicating their relation to each other and to the railway tracks, etc. The total floor space of the whole plant is 275,000 square feet; the machine shop proper is 585 feet long, and the three-story building facing south has a length of 380 feet. A general idea of the size and arrangement of the machine shop may be obtained from the interior view Fig. 3.

Fig. 1. The New Plant of the Cincinnati Milling Machine Co., at Oakley, Cincinnati

The first section of the machine shop was erected in 1909 and 1910, and was operated in connection with the old plant until the three-story section was completed in the fall of 1911. The machine shop proper is a single-story brick and steel building, 16 feet high under the trusses, and 26 feet under the peak. A 60-foot section along the eastern side of the building is 21 feet under the trusses, and is traversed by 5-ton traveling cranes. The roof is of concrete and steel, covered with Carey roofing. It is supported by hollow cast-iron columns of small diameter, thus avoiding that sense of obstruction which is sometimes present in shops using built-up steel columns. The hollow columns also serve as downspouts. The roof trusses are provided with gusset plates to facilitate the placing of countershafts and crane-ways in either direction.

The floor is of reinforced concrete, 8 inches thick, so that individual foundations for the machines, except in the case of the largest planers, are unnecessary. The heavy concrete floor also provides for that stability in the assembling and testing departments which is essential for satisfactory working conditions. That part of the shop which is occupied by the planers has a floor 16 inches thick, to carry the weight of the smaller planers and the masses of heavy material in process of manufacture which are grouped about them. In preparing the ground for the concrete floors the sod was thoroughly removed and the surface was rolled with a 10-ton roller, after which it was leveled and rolled a second time. A covering of tar felt was then placed over the entire surface, and the concrete was placed directly on this covering. The reinforcement consists of 1/4-inch twisted bars laid at right angles with each other and spaced 12 inches apart, the bars being wired together at all intersections. This kind of floor proved so satisfactory during more than a year's use in the first part of the building that it was adopted without hesitation for the addition recently completed.

The three-story south front of the building is of reinforced concrete construction faced with brick. The first floor is a continuation of the one-story shop. The upper floors, each covering an area of 380 by 60 feet, provide quarters for the various offices and space for those departments which should preferably be separated from the main machine shop. Thus the third floor contains the general offices, and the engineering and clerical departments. This floor was selected for the offices because of the desirability of having them on the floor highest above the ground level on account of being more quiet, cleaner and better ventilated. Access to the office is by means of an elevator. The western end of the third floor contains an auditorium, having a seating capacity of 600 people, and is also provided with a kitchen and dining rooms. The floors of all the offices, as well as the floor in the main entrance to the building, are laid with ceramic tiling with a 6-inch sanitary base of green tile.

Immediately adjoining the engineering department on the east is the toolmaking department, this arrangement bringing the latter into close touch with the tool-designing department. In general, as indicated in Fig. 2, the principle of placing all related departments adjacent to each other has been adhered to, and this principle has been carried out in the offices to the same extent as in the manufacturing departments.

The second floor is devoted to stock-rooms for the finished parts, and also to the assembling of cutter grinders, and milling machine attachments. This is the only manufacturing done outside of the main machine shop floor. One portion of the second floor was also especially set aside to provide a place where the dividing heads could be assembled, as experience had shown that this precision work could be done more satisfactorily in an isolated department.

The Shop Departments

When the factory colony at Oakley was decided upon, the Cincinnati Milling Machine Co. retained seventeen acres for

* For descriptions of other of the new plants located in the Oakley factory colony, see MACHINERY, July, 1911, engineering edition, "Cincinnati-Bickford Tool Co.'s Plant at Oakley, Cincinnati"; March, 1911, engineering edition, "Interesting Tools and Methods of Cincinnati Shops—The Cincinnati Planer Co."; June, 1910, "The New Cincinnati Planer Plant," and "Opening of New Plant of Triumph Electric Co. and Triumph Ice Machine Co."

foundry and machine shop purposes. The first building erected was the foundry, which is run as a separate organization known as the Modern Foundry Co., but owned by the stockholders of the Cincinnati Milling Machine Co. This foundry has a daily melting capacity of 30 tons of iron for machine-steel castings, all of which, including the largest milling machine column castings, are made on molding machines. As shown, the foundry is located to the north of the machine shop, with which it is connected by an industrial track. A depressed railway siding connects with this industrial track over which all the raw materials enter the north end of the machine shop.

As indicated in Fig. 2, the various departments are located with relation to each other in accordance with the sequence of operations. Hence the automatic screw machines and turret lathes are placed at the extreme north end, these machines performing the first operations on bar stock and on small castings, drop forgings, etc. On one side of these departments are racks upon which are stored all the bar steel adjacent to the machines. The machine equipment, in general, is highly specialized, and many machines are especially fitted up for certain work which is never done on any machine except the one so equipped. There are also many special machines which have been designed and installed mainly to improve the quality of the work. Some extremely large bar work is done on automatic machines, the largest automatics taking bars up to 6¾ inches in diameter. Individual motor drives are largely used, the motors being mounted directly on the machines. In some cases, however, this arrangement has not been found desirable, and the motors are then mounted in the ceiling directly over the machines.

Adjoining the automatic machines are the engine lathes, arranged in four rows, the two center rows being placed close together, back to back, with an ample aisle space between each of these and the outer rows. Next to the lathe department is the grinding department, and adjacent to this are the thread milling and screw chasing machines. Here all short screw threads are milled, while long lead-screws are made on automatic thread chasing machines. Next to the thread millers are the gear cutters, the equipment including a Gleason bevel gear generator, and two special tooth-rounding machines. The latter have been designed and built by the

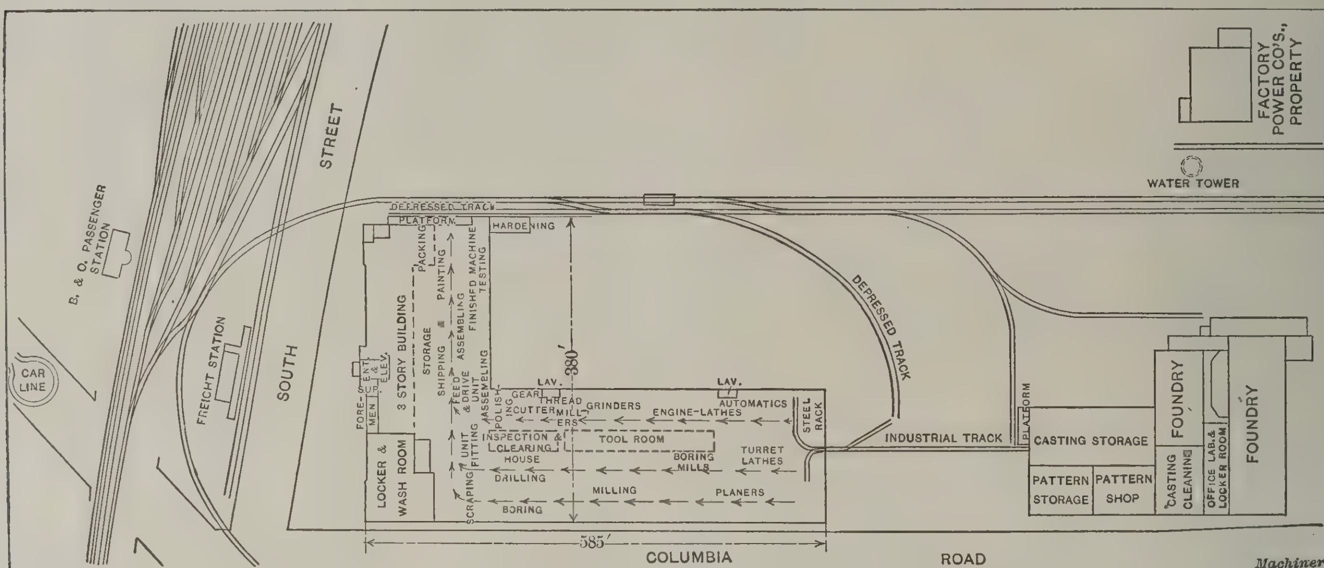


Fig. 2. General Plan of New Plant

Fig. 3. General Interior View of Machine Shop

company to meet its own special requirements. Special testing devices are provided, on which all gears are tested on fixed centers placed at the correct theoretical distance apart. The gears must show a proper bearing and must revolve freely without pinching or backlash when testing. The 20-degree pressure-angle form of tooth has been adopted because of its greater strength, and the cutters for each gear are especially developed for the correct number of teeth for that gear. The cutters are made in pairs for the two gears that work together. Proper running clearances between the gears are provided in the completed machine by arranging their final center distances a few thousandths inch farther apart than the theoretical distance.


Fig. 4. A View in the Tool-room

Tool-room—Inspection and Routing Department

The tool-room, as indicated in Fig. 2, is located as nearly as possible in the central section of the main manufacturing department, and comprises a floor space of 28 by 200 feet. A general view of this department is shown in Fig. 4. All jigs, tools, and fixtures, except some very large ones, are kept in this department, and may be withdrawn only on the presentation of workmen's checks and a shop order, the latter showing the part number and the operation for which the jig is wanted. A carefully planned system is used for taking care of the tools, and an arrangement is introduced which economizes space and gives easy access to all the shelves on which the tools are stored. This tool-room is distinctly a storage and distributing room, no toolmaking or repairing being done here, except that all cutting tools are sharpened here immediately upon their return from the manufacturing departments, and before being again placed on the shelves. Every tool, jig and fixture is inspected after having been used, and, if in need of repairs, is sent immediately to the toolmaking department. Because of the large size of this tool-room, there are three windows, one of which serves the drilling, fitting, and gear-cutting departments, one, the screw-cutting, grinding and engine lathe departments, and the third, the turret lathe, milling and planing departments.

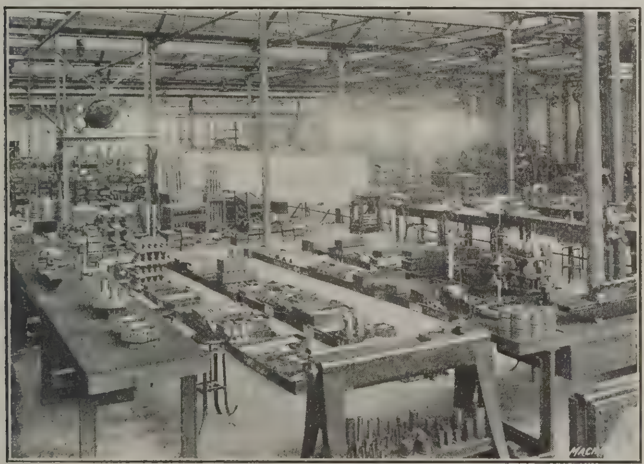


Fig. 5. Inspection and Routing Department

Immediately adjacent to the tool-room is the inspection department shown in Fig. 5. Here all the parts are inspected after each machining operation, the necessary gages, indicators, etc., being conveniently provided. All hardened gears, clutches and similar parts are tested with the scleroscope, definite standards of hardness having been determined upon for each part. The routing department is also located here. The large charts shown in the center of Fig. 5 contain a record of every piece passing through the shop, indicating which department it is in and, therefore, which operation is being performed on it, and also the date when each succeeding operation must be finished. In this way absolute control is kept over the movements of every individual piece and operation.

After having passed the final inspection, the finished parts are delivered to the stock-room shown in Fig. 6, where they are placed on shelves and await withdrawal for assembling.


Fig. 6. Stock-room for Finished Parts

An accurate record of receipts, withdrawals, and balance on hand of each individual part is carefully kept on the bin-slips attached to each shelf, a number of which are shown in the illustration. As already mentioned, this stock-room occupies part of the second floor of the three-story building. It is located close to the elevator, which is immediately adjacent to the assembling department on the machine shop floor. The remainder of the second floor, as also mentioned, is devoted to the assembling of cutter-grinders and milling machine attachments. This department is illustrated in Fig. 7. In this view are also shown some of the details of construction of the concrete building. The cast-iron-lined bolt-slots in the bottoms of the girders for suspending the countershafts, and those at the tops of the columns for attaching crane runways, are of special interest.


Fig. 7. Department for Assembling Cutter Grinders and Milling Machine Attachments

Planing, Milling and Boring Departments

All the large castings when entering the north end of the building are carried by the industrial track to the planing department, Fig. 8. The planers are all driven by individual motors. A number of them have 40-foot beds, the largest of them being the 72-inch by 72-inch by 40-foot planer, shown in

the background at the extreme right. The planers are all provided with a variable cutting stroke and a constant return stroke of 100 feet per minute. After leaving the planer department, the castings pass on to the drilling, milling and boring departments, as required.

A section of the milling department is shown in Fig. 9. The machines are grouped according to size and with regard to the nature of the work done on them. All of the larger machines are provided with individual motor drives and are located under the traveling cranes. A row of vertical milling machines along the wall is served by jib cranes, and similarly a row of large horizontal machines placed on the other side of the main aisle are also served by jib cranes. The space between these machines is entirely clear and available for handling the work. The machines face the jib cranes to facilitate swinging the large castings onto and off the machines. The smaller machines are belt-driven and are arranged in two parallel rows, but in this case they are placed back to back instead of facing each other. The radial drills, which are chiefly employed on large castings handled by jib cranes, are shown in the center of Fig. 3, under the traveling cranes.

Fig. 8. The Planing Department

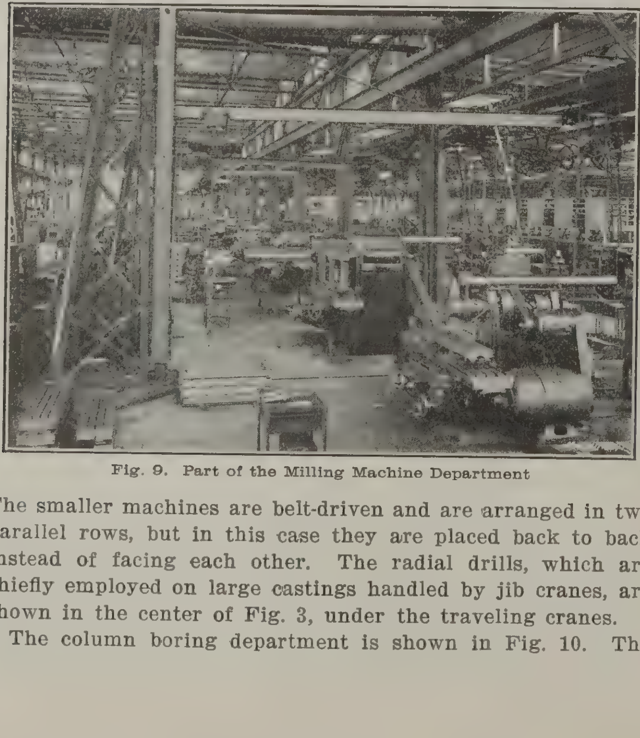


Fig. 9. Part of the Milling Machine Department

The column boring department is shown in Fig. 10. The faces of the columns are first rough scraped, and then the columns are placed in a specially designed machine which bores the spindle hole and the supporting or over-arm hole simultaneously. This machine is shown in the center of the illustration. The boring bars are in a vertical position. They may be operated simultaneously or independently, and either for boring or facing. The correct distance between the holes and their parallelism is taken care of entirely by the guides of the boring bars. The guides for the outer bar are removable and are provided in proper sizes for each size of column. The holding device on the bed of the machine locates the column central with the boring bars, which are connected with the driving spindles by a bayonet lock, facilitating quick and easy release, and providing sufficient play to allow the bars to revolve freely, regardless of the lack of alignment with the driving spindles.

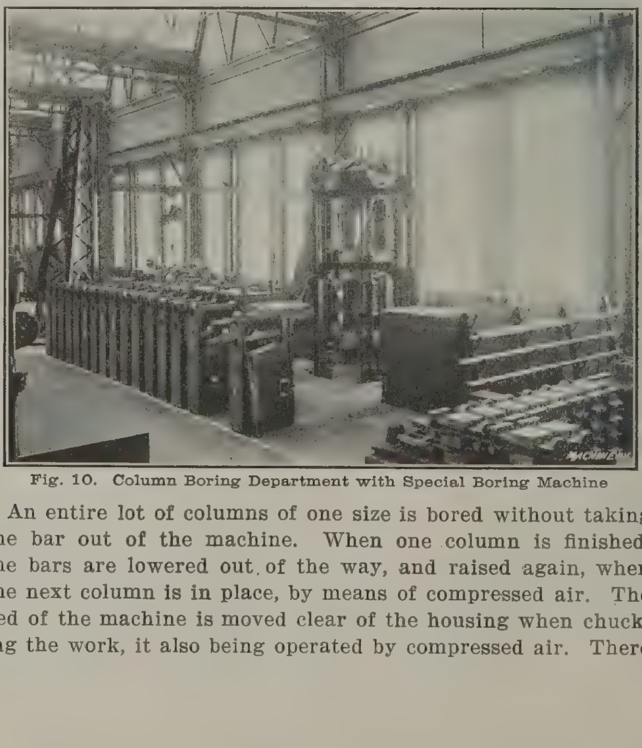


Fig. 10. Column Boring Department with Special Boring Machine

An entire lot of columns of one size is bored without taking the bar out of the machine. When one column is finished, the bars are lowered out of the way, and raised again, when the next column is in place, by means of compressed air. The bed of the machine is moved clear of the housing when chucking the work, it also being operated by compressed air. There

are two sets of operating levers, and the operator is provided with an elevator, the framework of which is shown in the front of the machine, for changing his position readily.

The chief consideration which led to the building of this machine was to obtain the highest possible accuracy rather than quantity of output. After the columns have been bored they are tested for accuracy by an inspector located in this department. The column in the foreground shows a testing instrument in place for examining the accuracy of the spindle holes with regard to their being at right angles with the

Fig. 11. Department for Assembling and Testing Feed and Drive Boxes

column face in both the vertical and horizontal direction. Further tests are made for parallelism, diameter, distance between over-arm and spindle holes, etc. A record of these tests accompanies each column to the fitting department. This inspection does not take the place of the final accuracy test to which the finished machine is afterwards subjected.

Scraping and Assembling

The large machine parts, such as columns, saddles, etc., next arrive at the scraping department shown in the foreground of Fig. 3. All the scraping is done to surface plates and master

Fig. 12. A Corner of the Department for Assembling Dividing Heads

gages. In this department there are a number of interesting devices, as, for example, a swiveling arrangement for holding the tables for the scraping operation, enabling the workman to always bring the surface worked upon into a horizontal position. Another interesting device is the so-called "scraping machine" at the left of Fig. 3, between the first two jib cranes. This is a hydraulic cylinder fitted with reversing valves which give the piston a continuous reciprocating movement. This device is used for sliding large parts on each other, to determine the accuracy of their bearings. The device is arranged to swivel, and it may be elevated by hydraulic means to suit the height of the different parts. The column scraping is done under the framework at the right of the picture, the framework forming a number of parallel runways for hoists.

Fig. 3 also shows the extent to which crane service and hoists are provided. The main traversing cranes are of five-ton capacity with 60-foot span. These cranes serve all the planers at the far end of the building and transport material from one department to the other. The individual machines, other than the planers, are served by self-contained jib cranes. The steel work of the jib crane is fastened to and supported by a large cast-iron base. The mast rests on a ball thrust bearing, consisting of a single ball of large diameter. These cranes are not a permanent part of the building, but are bolted to the floor and can be placed in some other part of the shop at any time that it may be desirable to do so.

The assembling department for feed and drive boxes is shown in Fig. 11. In the foreground is shown the testing stands on which each feed box and each drive box is given a running and endurance test under conditions which duplicate those under which it will operate when placed on the machine. In the immediate foreground is shown the driving clutch pulley testing stand on which the units entering into the single-pulley high-power machines are given a running and load test. This stand is provided with a prony brake and an ammeter which indicates the load applied under each test.

Fig. 13. The Hardening Room

Fig. 12 shows a corner of the dividing-head department. As already mentioned this department is purposely isolated, because of the precision work required. On completion, each dividing head is subjected to the most rigid accuracy tests, and a copy of each test is filed. The dividing-head worm-wheels are hobbed on a machine especially designed for this one operation. The worm-wheels hobbed in this machine will index work 8 inches in diameter with an average accuracy of 0.00025 inch of accumulative error in any one quarter of the circumference.

Fig. 14. The Toolmaking Department

The carbonizing and hardening department is shown in Fig. 13. In addition to the clutches and other small parts, a large number of the gears entering into the milling machines manufactured are hardened. The hardening department is equipped with gas furnaces and lead baths. Temperatures are determined by a pyrometer mounted on a track over the furnaces. The pressure blower is motor-driven, and a gas engine is also installed for emergency service, so as to provide for the necessary continuous carbonizing. Two oil tanks immersed in running water are placed in the floor. They are provided with steel covers for closing them when not in use.

Since the toolmaking department does not make any part

used in the products of the shop, there would be no advantage in having it located with the manufacturing departments. On the other hand, there is an advantage in having it located by itself, and, therefore, it has been placed on the third floor so as to be close to the tool-designing and engineering departments. This department, a view of which is shown in Fig. 14, is equipped with all the machine tools necessary for toolmaking, including a cylindrical grinder, an internal grinder, and a surface grinder, so that there will be no need to call on any of the manufacturing departments for assistance, except in the case of an unusually large planer job for a heavy fixture. No shapers are employed, all the work of a character for which shapers could be used being done on milling machines.

Fig. 15. Department for Testing the Completed Machines

As the new model milling machines built by the company are constructed entirely according to the unit system, the final assembling consists merely in assembling such units as feed boxes, drive boxes, driving clutch pulleys, etc., into one complete machine. After the machines have been assembled by successive groups of men, each attaching one class of units, they arrive at the final testing department shown in Fig. 15. Here each machine is given a thorough test for accuracy of alignment, and a running test under belt for a specified length of time. Each machine must also do a specified amount of milling. A permanent record is kept of all these tests.

Adjacent to the testing department are the shipping and

Fig. 16. The Packing Department

packing departments, the latter of which is shown in Fig. 16. There are two shipping doors leading to the shipping platform. The one in the center of the illustration is provided with a vestibule for the protection of this part of the shop during severe weather. They are closed by steel drop doors and are entirely surrounded by circulation pipes of the hot water heating system. The railway cars come up to the shipping platform on a depressed track so that the floors of the cars are level with the platform. Three cars may be loaded at one time.

Washrooms, Sanitation, etc.

The employes' entrance on the Columbia road side (see Fig. 2) leads directly into the service room where ventilated steel individual lockers are provided for all the men. The wash basins are of the individual type with hot and cold water, and there is one basin for every three men. Hot water for this room and for the shower baths is obtained from instantaneous heaters, one of which is shown in Fig. 17.

The sanitary arrangements are of the very best. The toilet rooms are marble lined, and all metal work is nickel-plated, these materials having been selected in order to keep everything in a sanitary condition. The shower baths for the use of the employes are also built of marble, each compartment being divided into two sections, with a bath in the rear and a dressing room in the front. Sanitary drinking fountains are provided at intervals throughout the shop.

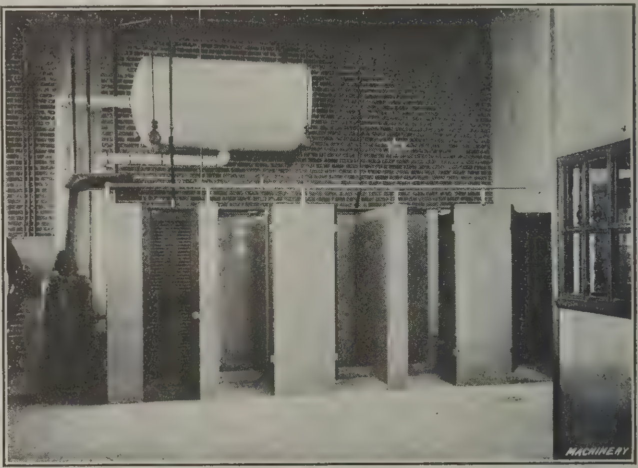


Fig. 17. The Shower Baths

The manufacturing departments are lighted by Cooper-Hewitt lamps which furnish sufficient illumination for all purposes without the use of individual lights, with the exception of a few special cases. The offices and engineering departments are lighted by the indirect system using tungsten lamps in clusters. This soft, diffused and evenly distributed light has proved as satisfactory as good daylight. The buildings are heated by the Evans-Almirall system of forced circulation hot water. In the single-story part of the building, the circulation pipes are placed on the lower chord of the trusses, immediately below the window space, as indicated in Fig. 16. This arrangement prevents drafts caused by descending cur-

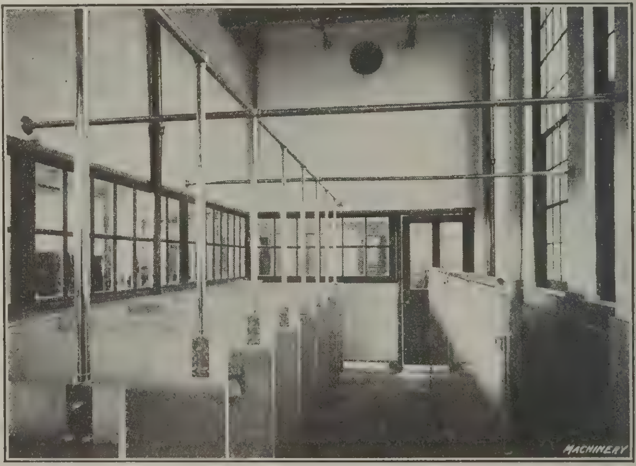


Fig. 18. One of the Marble-lined Toilet Rooms

rents of cold air from the roof windows, and has proved satisfactory during the extreme cold of the present winter. The provisions for ventilation have also proved sufficient during the extremely hot weather of the past summer. The arrangement of the roof windows permits the opening of the entire upper one-third of the sash, providing for 60 square feet of opening for each 500 square feet of floor space, the liberality of which is evident when compared with the usual arrangement of one 48-inch ventilator for every 100-foot length of roof, providing only 12 square feet of opening for each 2500 feet of floor space. The sash opening devices are operated from the floor, and in some cases as much as 100-foot lengths of sash are controlled from a single point.

APPLICATIONS FOR PNEUMATIC TOOLS

By A. M. M.

There are many classes of work now done by hand to which pneumatic tools can be applied with advantage. Many plants have developed special uses for these tools, a few of which are here presented.

A contractor engaged in erecting large electric generators had several thousand tubular rivets, 1½ inch in diameter, which were to be headed cold. This was a very slow and laborious job. The rivets were used to hold together the laminations of the stator, and were drilled at the ends to make them tubular and to facilitate heading. By means of a beading tool and a hand-hammer, they could be riveted up in the same manner that boiler tubes are beaded, but it was found that not more than two per hour could be headed by hand. After considerable experimenting a 9-inch pneumatic riveter was fitted with a special die for the work, and the time was reduced to five minutes per head, with less fatigue to the operator.

Fig. 1, showing the die and rivet end, illustrates the idea. A common riveting die was turned to fit the finished head, leaving a centering pin in the middle of the die. Two opposite sides of the die were then slabbed off on a milling machine, leaving the working edge about ⅜ inch thick. This edge was filed round, and the die hardened. A hole drilled through the die provided means for attaching a piece of ⅜-inch round steel wire as shown. This served as a handle to rotate the die. The operator could form a perfect head on the bolt by slowly rotating the die, and working down the edges as desired.

Hardening Riveting Dies

Many concerns have trouble with the breaking of riveting dies. One large company using about thirty riveters broke on an average ten dies per day. As these dies cost about $1.75 each, it will be seen that the total expense was considerable. The blacksmith hardened the dies only at the cup and shank, leaving the shoulder soft. He decided that as all the dies were breaking at the shoulder, he would leave that part as soft as possible. Many blacksmiths make the same mistake. The trouble, however, is that the tension set

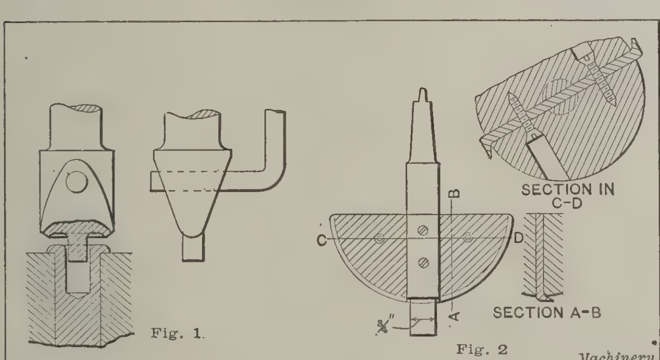


Fig. 1. A Pneumatic Beading Tool. Fig. 2. A Pneumatic Wood-cutting Tool

up by the uneven hardening causes the breakage. The following method of hardening was adopted, and the breakage fell to one die per week or less, instead of ten per day.

A die was first heated slowly and evenly to a temperature considerably higher than that required for the hardening. It was then allowed to cool for several minutes to insure that the interior of the die was as hot as the outside. It was then (at a dull red heat) quenched in oil. The blacksmith had previously prepared a ring or tube rolled up from a piece of ¾-inch plate. This tube was about 6 inches in inside diameter and 10 inches long. It was heated to a bright red heat, and the die held in the center of it to draw its temper evenly. When the right color was reached, the die was quenched in water. Dies hardened in this manner gave excellent results. A steel costing 12 cents per pound was used.

Driving Drift-bolts in Crib Work

A contractor was building crib work of hard fine timbers, 10 inches square. He had several thousand drift-bolts to drive. The bolts were 8 feet long, and 1 inch in diameter. He had several gangs of three men each working from a staging, driving with heavy sledges. The three men would drive one bolt, striking alternately. The work was progressing so slowly that he determined to try a pneumatic riveting hammer. He found that a heavy riveter, operated by one man, would do the work of two gangs (six men), and dispense with the heavy staging.

Use of Pneumatic Hammer in Broaching Operation

A machine shop had a large number of hexagon bushings whose inside surface had to be finished smooth and of accurate dimensions to make a close fit on a ¾-inch hexagon rod. A hexagon broach of the same dimensions as the rod was machined and the end squared off to a cutting edge. It was found very difficult to drive this tool through the bushing with a hand hammer, but it was easily and quickly accomplished by the rapid blows of a pneumatic hammer.

A Pneumatic Wood-cutting Tool

It often happens that wooden hatches or decks are fitted with I-bolts or handles which must lie flat with the surface.

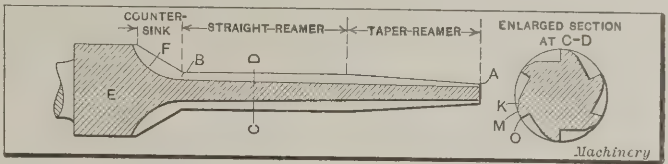


Fig. 3. Combined Reamer and Countersink

To make room for the fingers or a rope under the ring, the wood must be cut out in the form of a cup or depression. Often, on a large job, there will be several hundreds of these cups to hollow out of the flat surface. A carpenter with his gouge and mallet will take a couple of hours to finish one, but the cutter here described, fitted to a pneumatic machine, will do this work in a few minutes. The cutter blade is formed of ¼-inch tool steel plate, set into a slotted bar and brazed. After this operation is completed, a block of wood, turned in a wood lathe to the shape of the cup, is fitted to it as shown in Fig. 2. This block allows the cutter to project beyond its surface, and prevents it from taking too large a chip. The tool works best in one of the smaller machines of high speed. A ¾-inch guide hole is first bored to the required depth.

Special Reamers for Pneumatic Tools

In a plant handling structural or steel ship work, the reaming and countersinking of the thousands of rivet holes is a large item, and may represent a considerable percentage of the cost of construction. It is important that the reamer with which this work is done shall have certain properties. It must cut rapidly, without heating. It must clear itself when forced, without breaking. It must stand the abuse of unskilled labor. Two men with an ample supply of sharp correctly made reamers will ream several thousand holes per day, where they will only ream several hundred if obliged to work with reamers which do not cut properly. The following description and illustration, Fig. 3, shows how one of the large shipyards increased the efficiency of this operation several hundred per cent by giving careful attention to these points.

This yard had a million, more or less, ¾-inch rivet holes to be reamed and countersunk. The work was started with the ordinary pneumatic reamers and countersinks, making two separate operations. The tool-room, having only a small supply of these tools and having other troubles, was very "economical" in handing out reamers, and kept the men working with the tools long after they were too dull to cut properly. The consequence was that the men would keep a reamer turning in one hole for several minutes, and not only did it not work, but the reamers were burned. The men made no attempt to rush the work as this only resulted in burned reamers and a "call-down" from the tool-room.

The following system was adopted with an increase of about 500 per cent in the amount of work turned out. A special combination reamer and countersink was designed as shown in Fig. 3. Enough of these tools were provided to allow about four reamers per gang. The gangs were put on piecework

and one skilled operator in the tool-room was made responsible for keeping the reamers sharp. Each gang was given a can of tallow in which to lubricate the reamer as often as required. The gangs working on the flat decks were cut down to one

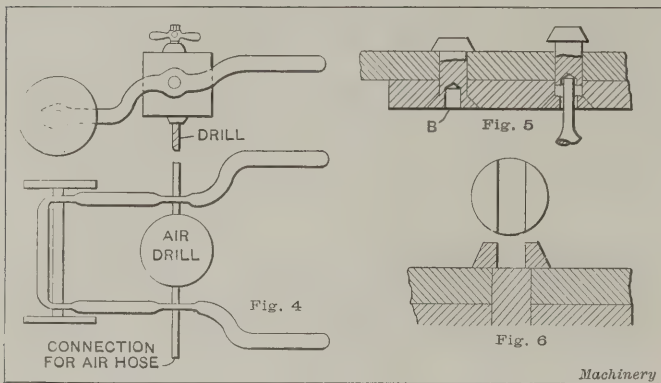


Fig. 4. A Substitute for the "Helper." Fig. 5. Method of Removing Rivets. Fig. 6. Method of Cutting-off Rivet Heads

man, and this man was provided with one of the "wheelbarrow" devices shown in Fig. 4, in place of his "helper." All extension shanks were inspected and those having damaged sockets were thrown out and replaced with new ones of tool steel with close-fitting sockets. Many of these shanks were found to be made of soft steel, and the socket which received the Morse taper shank was so cut out as to allow the reamer to jump out and turn in the socket. Many reamers were ruined by having the small ends of the shanks twisted off. All of these shanks should be carefully made of tool steel. The countersink-reamers insure that the countersink will be concentric with the reamed hole, and the whole job is done at one operation.

These reamers are turned out of solid stock ("22-cent" tool steel, box annealed) of the diameter of the countersink-portion E. In milling, a single straight cut is made from A to B, and the milling cutter is of a diameter to form the curve at F. This is not an ideal method, but it saves several resetting operations and is satisfactory in practice. Care is taken to grind off the back of the tooth to the proper angle at K. A cutting edge must be made with the clearance from M to O less than at K, and is the only portion ground in resharpening.

Easy Way of Cutting out Rivets

An easy way of cutting out rivets is as follows: First drill a hole as shown in Fig. 5 at B. Then use a backing-out punch made to fit a pneumatic riveting hammer. If a good backing is available, a pneumatic "jam hammer" can be used to advantage. For cutting off rivet heads proceed as in Fig. 6, using a pneumatic chipping hammer and "cape" chisel. First cut a slot through the head, making it like a slotted screw-head. The two sides can now be cut off without trouble.

* * *

Just so much of forms, rules and regulations as will insure that the right thing will be done in the right manner at the right time, is system. Whatever is more than that is red tape.

MAGAZINE ATTACHMENTS—2

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

Small pieces which have been partly completed in the punch press can be handled satisfactorily in a Brown & Sharpe automatic screw machine by the application of a magazine attachment. The type of attachment to use depends entirely on the shape and character of the work. In the February number, a few of the more simple attachments were illustrated and described. In this article is given a description of three attachments and their auxiliary mechanisms for handling parts blanked out in the punch press. Reference is made to Figs. 5 and 9, which appeared in the February number.

A Snake-shaped Attachment

Fig. 11 illustrates a snake-shaped slide which is used for handling the watch crowns shown at N and O in Fig. 9. The sectional views of this slide show the shape of the different crowns for which this attachment is used. Of course special slides were made for each different size. The slide shown in Fig. 11 is held in a bracket similar in construction to that shown at A in Fig. 12. The watch crowns are made from sheet metal, which is drawn up and formed around a solid

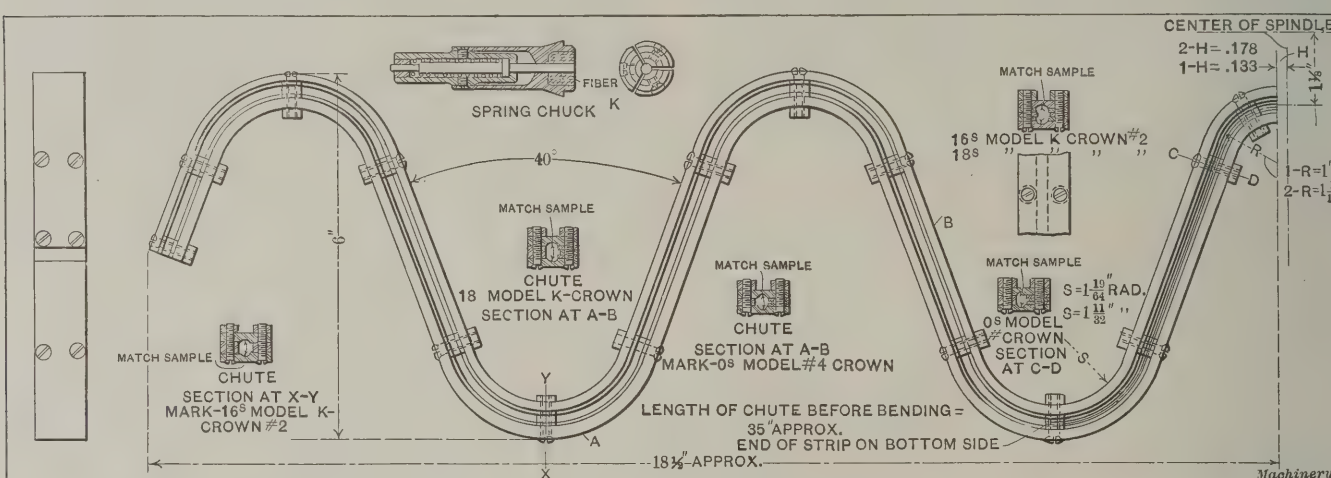


Fig. 11. Magazine Attachment for Handling Watch Crowns

center in the punch press. The knurling on the crown is also produced when it is being formed. The reason for making a crown in this manner is that it can be made from "rolled plate," the name given to a class of material used in

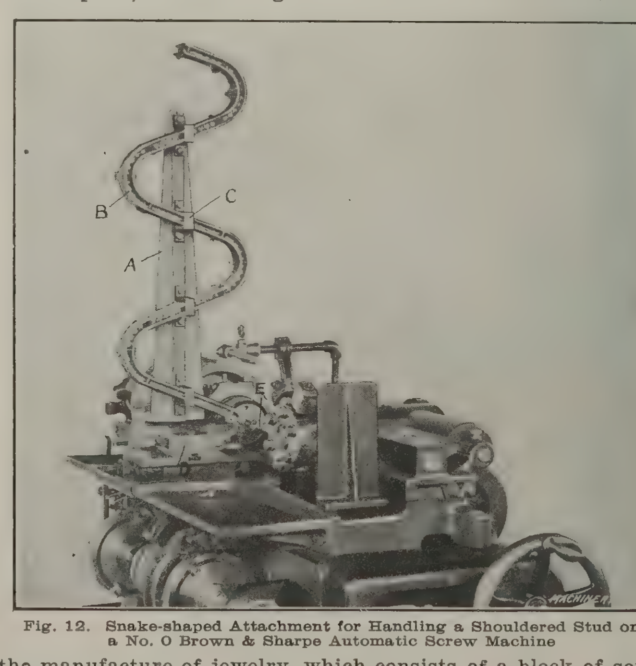


Fig. 12. Snake-shaped Attachment for Handling a Shouldered Stud on a No. 0 Brown & Sharpe Automatic Screw Machine

the manufacture of jewelry, which consists of a block of some composition, such as brass, to one side of which is soldered a thin sheet of gold; this block is then rolled out into sheets

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of the desired thickness and cut up and formed in a punch press. This facilitates the production of an article which is much harder than gold, will not corrode, and wears well.

Referring to Fig. 11, this slide consists of two strips *A* and *B* held together by screws and separated by blocks. The strips are milled out to suit the work which is to be placed between them. There are two reasons for having the slide of this attachment made in this manner: First, being bent into the shape shown, it will hold a greater number of pieces in

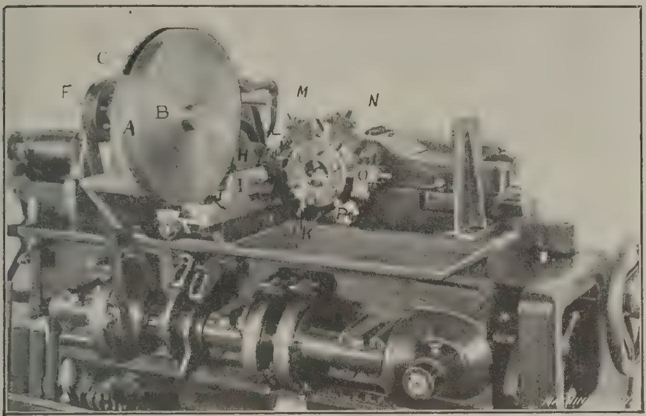


Fig. 13. Semi-automatic Magazine Attachment for Handling Blanks for Watch-spring Barrels on a No. 0 Brown & Sharpe Automatic Screw Machine

the same height, thus making it more accessible to the operator; second, it gives a practically vertical slide at the curved point, which assists in feeding the work to the machine. The work is carried from the slide to the machine by a carrier, a description of which will be given later. The chuck for holding these crowns is shown at *K* in Fig. 11; it consists of an ordinary spring collet, bored out in the front end to receive a fiber "bushing" which is cupped out to suit the crown. This fiber bushing allows the knurling on the crown to sink into it, thus holding it securely while being counterbored, drilled and tapped. Except for the addition of the fiber bushing this spring collet is similar to those previously described, being provided with a spring ejector.

In Fig. 12 is shown another snake-shaped attachment, which is used for handling a collar stud. The slide *B* is fastened to the bracket *A* by U-shaped braces *C*. The work is carried from the slide to the chuck by means of a carrier *D*, similar in construction to that shown in Fig. 5. The spring collet used for holding this piece is similar in construction to those previously shown, and the work is inserted by a spring plunger *E* held in the turret. Attachments of this type are bent to an included angle of 40 degrees, which has been found to give the best results for feeding the parts to the chuck.

Semi-automatic Magazine Attachment

The magazine attachment shown in Fig. 13 is used for feeding the blanks from which the barrels for watch springs are made, to the chuck. A watch spring barrel which has been completely machined is shown at *P* in Fig. 9, and also at *A* in Fig. 18. The teeth are cut on this barrel in an automatic gear cutter. This magazine attachment, which is fastened to the bracket on the No. 0 Brown & Sharpe automatic screw machine, consists of a rotating wheel held on a spindle and enclosed in the casing *A*.

The construction of this attachment is more clearly shown in Fig. 14, to which reference should now be made. The wheel *B* is recessed to form a pocket or magazine for the blanks, and is provided with slots in which the blanks fit. The blanks are inserted in the attachment through the slot *C*, which passes down into the pocket *D* of the rotating wheel. The wheel is driven from a pulley *E*, located on the front cam-shaft (see Fig. 13) by a belt running on the pulley *F* keyed to the wheel spindle. An idler pulley *G* is furnished to change the tension of the belt. As the pulleys *E* and *F* are of the same diameter, the wheel *B* rotates at the same speed as the front cam-shaft. The blanks, when carried around by the wheel *B*, drop into the slide *H* and from there into a pocket in the bushing held in the carrier *I*.

On account of the type of tools shown in Fig. 13, which are used in machining the spring barrel, and the shape of the carrier, it is necessary to increase the actual throw of the ordinary cross-slide, so that the carrier, when it drops back, will allow the tools in the turret to get at the work. The ordinary cross-slide is removed, and a slide *J*, which is shown more clearly in Fig. 15, is substituted. Referring to Fig. 15, it will be seen that slide *A* is provided with a dovetailed slot in its top face, in which the auxiliary slide *B* works. Attached to the machine by a shoulder screw *C*, fitting in an elongated hole in the bracket *F*, is a rack *D*, that meshes with a pinion *E* held to the lower slide *A* by a screw as shown. Pinion *E* meshes with teeth cut in the auxiliary or top slide *B*.

In operation, as the cam on the front cam-shaft advances the lower slide *A*, the pinion *E* is rotated, this action carrying forward the auxiliary slide *B*, and increasing the throw of the cross-slide. The rack *D* is formed into an L-shape in the rear end, and a set-screw, fitted into it and butting against

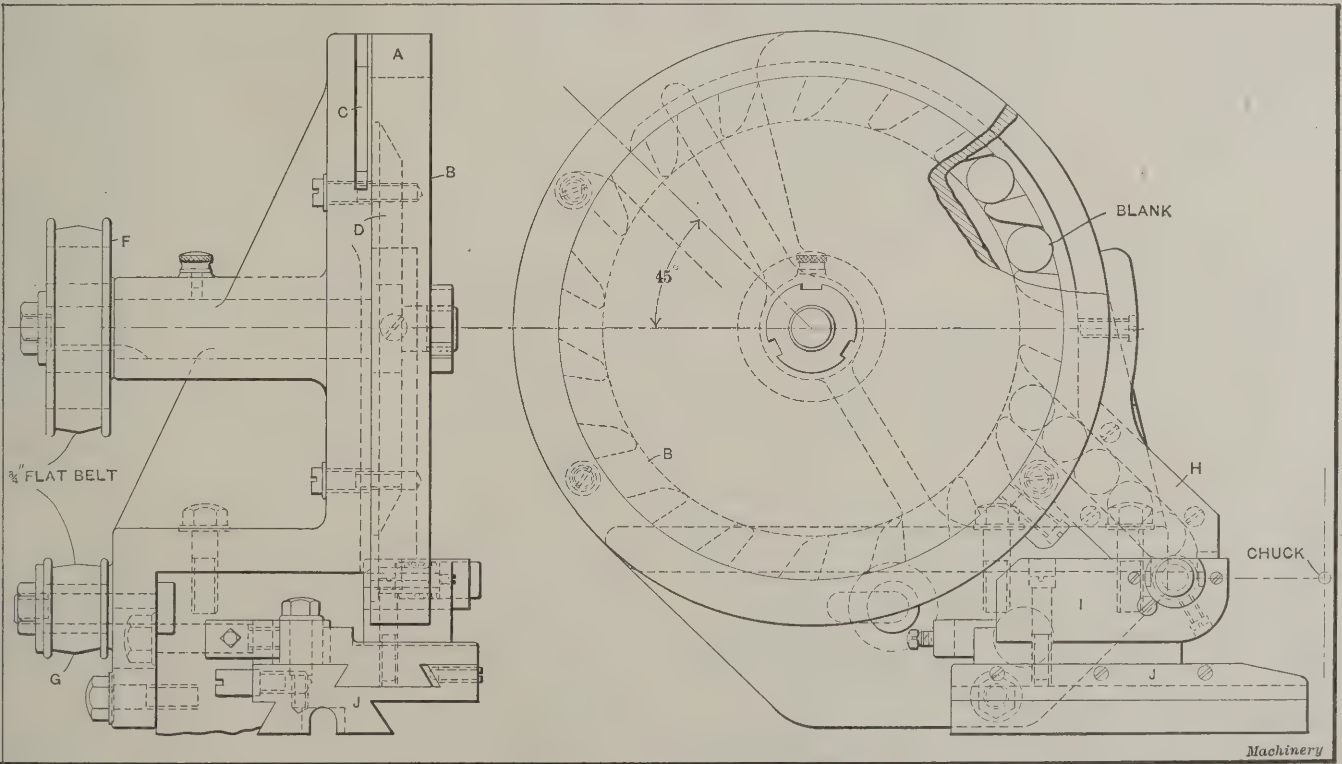


Fig. 14. Assembly Views of Magazine Attachment shown in Fig. 13

the bracket, is used for changing the position of the rack relative to the cross-slide.

The work carrier *I*, Fig. 13, which is shown more clearly in Fig. 16, consists of a block *A* counterbored to receive a bushing *B*; the bushing is also counterbored to receive a spring plunger *C* and cut out to fit the spring fingers *E*. The fingers are made from spring-tempered sheet steel, and fastened by flat-head screws to plugs *F*, which are held in drilled holes

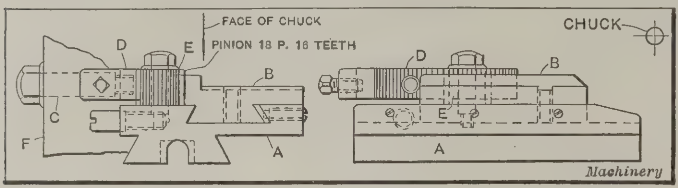


Fig. 15. Double-throw Front Cross-slide for the Magazine Attachment shown in Figs. 13 and 14

in the carrier block *A*, and retained by means of headless screws, as shown. The spring plunger *C* is retained in the bushing *B* by means of a pin driven into the bushing and fitting a terminated slot in the plunger. The bushing *B* is free to slide in the carrier block, and is held back by means of a coil spring *G* bearing against a pin driven into the bushing. The bushing is located in its "back" position by a headless screw acting as a stop for the pin which is driven into the bushing. It is also prevented from rotating by means of a screw *H* turned down on the end to fit a slot in the bushing.

In operation, as the blank comes down the slide, it is deposited in the bushing *B*. The cross-slide then advances and brings the blank in line with the hole in the chuck. When in this position the turret is advanced, and the stop *K* (see Fig. 13) pushes the spring plunger *C* forward, forcing the blank out from the fingers and depositing it in the chuck. It will

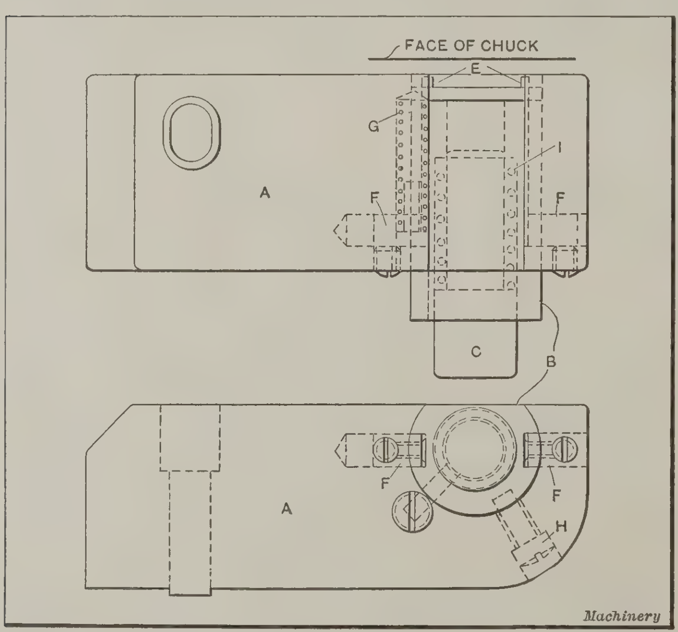


Fig. 16. Work-inserter used in Connection with the Magazine Attachment shown in Figs. 13 and 14

be noticed that the spring *I*, operating the spring plunger *C*, is made much heavier than the spring used for holding back the bushing *B*. The object of this is to insure that the bushing will be brought up close to the face of the chuck before the plunger forces the blank out of the spring fingers.

These spring barrels are difficult to hold, as can be seen by referring to Fig. 18. The part not cut down with the circular form tool is only 0.034 inch wide, which means that only about 0.025 inch can be used for gripping purposes, as it will require from 0.005 to 0.010 inch for clearance. It would be difficult to hold this blank rigidly and true in an ordinary counterbored spring chuck, owing to the fact that a recess would have to be made at the shoulder in the chuck which would reduce the gripping portion.

The manner in which these blanks are held is interesting and is clearly shown in Fig. 17. A special threaded cap *A* is made to fit over the nose of the spindle, and is provided with grooves in which a spider *B* is held to it by screws. This spider is made from tool steel, hardened and ground on both faces. The cap is also hardened and ground on the face bearing against the nose of the spindle and in the slots. The spring collet *C* projects past the face of the spider about 0.028 inch, and is cut out to fit the arms of the spider. The hole in the chuck is serrated to hold the blank more securely.

The tools used for performing the operations on this spring barrel are shown in Fig. 13, where *K* is the pusher which forces the piece out of the carrier into the chuck; *L*, a combination drill and countersink; *M*, a roughing recessing tool; *N*, a second roughing recessing tool; *O*, a finishing recessing tool; and *P*, a reamer holder. The cams used in making this blank are shown in Fig. 18 where the uses of the various lobes are clearly indicated. It might here be mentioned that the making of this spring barrel presents an unusual difficulty in

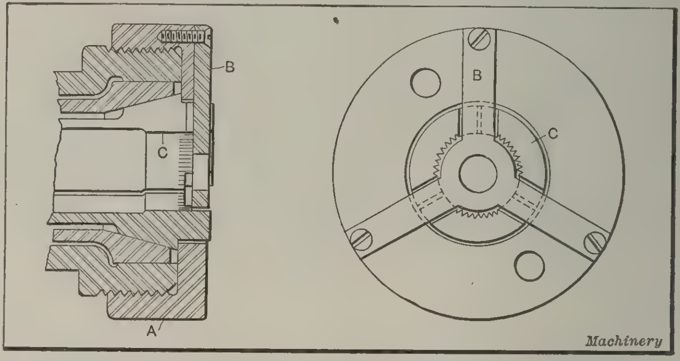


Fig. 17. Special Spring Collet used in Holding the Blank for the Watch-spring Barrel

producing a wall which will be of an even thickness and not cupped. This is accomplished by using a recessing tool for facing, instead of counterboring with a counterbore held in the turret. The application of recessing tools to work of this class was described in an article which appeared in the November, 1910, number of MACHINERY, entitled "Internal Cutting Tools." Here the proportion of the thickness of the wall to

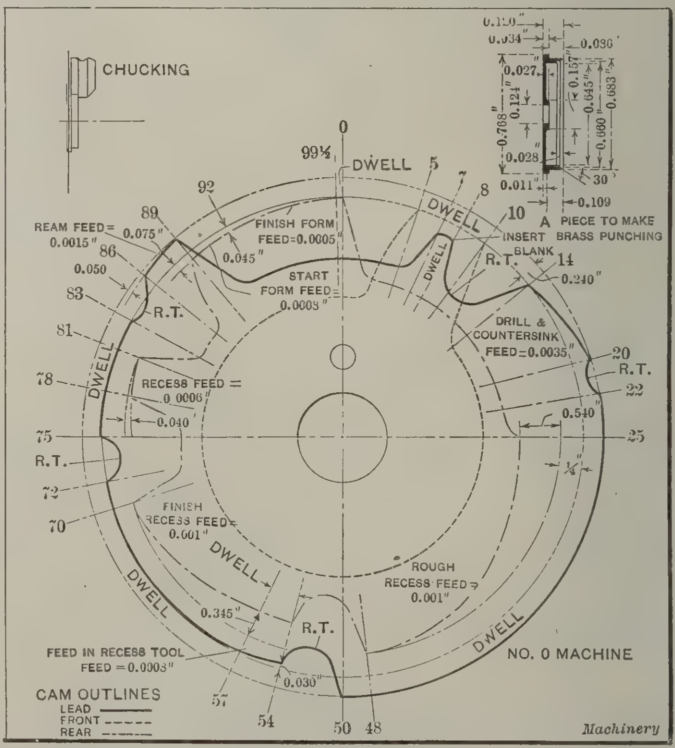


Fig. 18. Cross-slide and Turret Cams used in Producing the Watch-spring Barrel

the diameter, for facing operations, and the feeds to be used, were given.

The order of operations for piece *A*, Fig. 18, is as follows:

Order of Operations	Revolutions	Hundredths
Open chuck	24	2
Eject piece with feeding finger	30	2½
Clearance	6	½
Bring up carrier on front cross-slide	(48)	(4)
Hold carrier in line with chuck	60	5
Insert piece with inserting tool	(30)	(2½)
Dwell with inserting tool	(12)	(1)

Close chuck	(24)	(2)
Clearance	6	½
Revolve turret	42	3½
Drill and countersink, 0.240 inch rise at 0.0035 inch feed	72	6
Revolve turret	24	2
Clearance to place recessing tool in position	12	1
Advance rear cross-slide	24	2
Rough recess, 0.540 inch rise at 0.001 inch feed with L. H. swing tool	276	23
Clearance to drop back pusher on cross-slide	24	2
Revolve turret and clear	48	4
Advance recessing tool and feed in for cut 0.030 inch rise at 0.0008 inch feed	36	3
Dwell with rising block on cross-slide	(36)	(3)
Advance pusher on cross-slide, 0.345 inch rise at 0.001 inch feed	156	13
Clearance to drop back pusher on cross-slide	24	2
Revolve turret	36	3
Bring recessing tool into position	36	3
Advance pusher on cross-slide, 0.040 inch rise at 0.0006 inch feed	36	3
Clearance to drop back pusher on cross-slide	24	2
Revolve turret	36	3
Ream, 0.050 inch rise at 0.0015 inch feed	36	3
Start forming with circular tool, 0.030 inch rise at 0.0008 inch feed	36	3
Finish form, 0.045 inch rise at 0.0005 inch feed dwell 0.050	96	8
Total	1200	100

This article completes the extensive series, which have appeared in MACHINERY from June, 1909, up to the present time on the Brown & Sharpe automatic screw machines. Back numbers of MACHINERY containing all of these articles* cannot be supplied, but the complete series will be incorporated in MACHINERY's Reference Books, in the near future.

In bringing this series of articles to a close, the writer wishes to express his gratitude to the Brown & Sharpe Mfg. Co., who has very carefully gone over all manuscripts which were submitted. This company has also been very liberal in supplying us with drawings and photographs, for illustrating the machines, tools, and other equipments.

* * *

HOLDING WORK FOR GRINDING

The accompanying illustrations show three methods of holding work that are employed in the Stevens-Duryea factory in Chicopee Falls, Mass. Fig. 1 illustrates a chucking fixture for use in the bench grinding machine for holding small disks

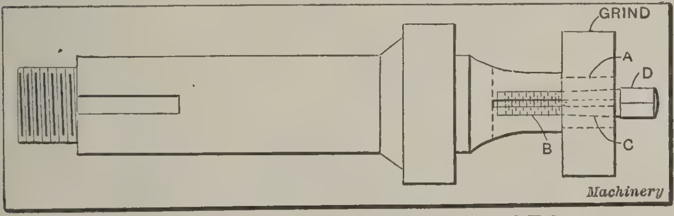


Fig. 1. Fixture for Holding Work by a Central Hole

that must be ground with their peripheries concentric with the central hole. This fixture consists of a shank that fits the spindle of the bench grinding machine. The outer end of the fixture has been turned at *A* to fit the bore of the hole of the piece to be ground. In the center of this turned portion a hole *B* is drilled and tapped. The outer end, *C*, is slightly tapered. Set-screw *D* is made with a tapered section to fit the tapered hole, and, after splitting the end of the fixture with two slots at right angles to each other, the fixture is ready for use. When the pieces that are to be ground are put in place and the set-screw *D* is tightened, the contact of the tapered section of the screw with the tapered hole within the piece to be ground, opens the fixture so that it grips the work tightly and it is certain that the grinding will be concentric with the central hole.

In Fig. 2 is illustrated another fixture for use in the bench grinding machine. The working end of this fixture consists of a part *A* recessed to accommodate the work *B*. The work is held in the fixture by means of two screws *C* and a washer *D*, after which the conical recess is ground in the edge. One

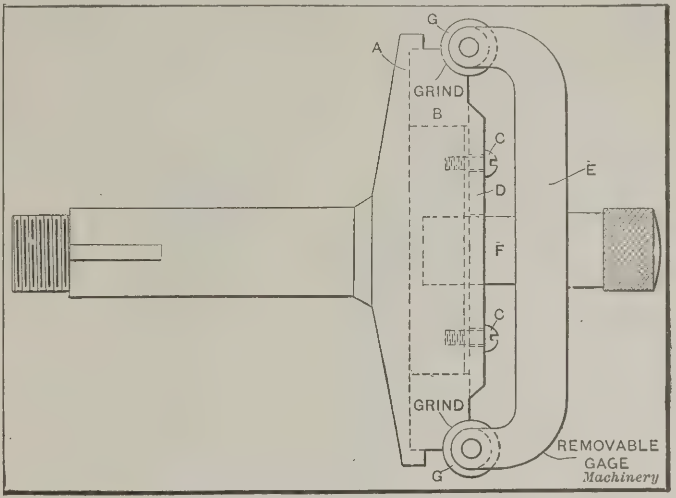


Fig. 2. Fixture for Holding Ball Races for Grinding, and Gage for Testing Work

of the interesting parts of this fixture and work is the method used in checking the grinding. This is done by means of gage *E*. The central plug *F* of gage *E* is made to fit a hole in the fixture, which is ground accurately to the same size as the stud. At the two extremities of gage *E* two steel disks *G* that have been beveled to a knife edge are mounted. By means of this fixture the shape of the ground portion may be checked as well as the overall diameter and the concentricity of the grinding with the bore.

A somewhat different proposition is illustrated in Figs. 3, 4, and 5. Fig. 3 illustrates the piece that must be ground. This piece, it will be noticed, has a hole crosswise of the cylindrical part. The problem is to grind this cylindrical part exactly true with the hole; that is to say, the distances from the center of this hole to the outside of the piece must be

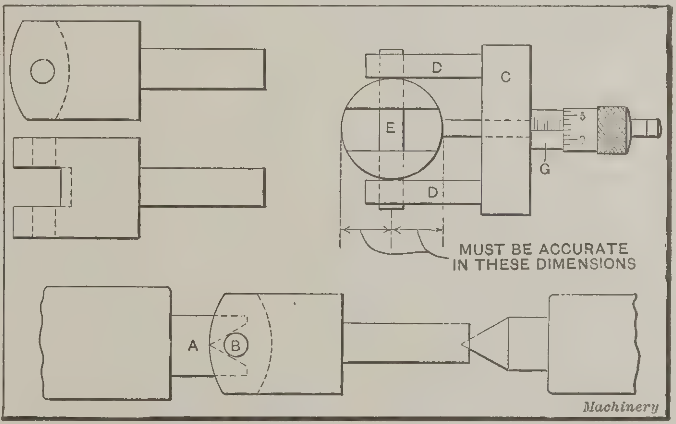


Fig. 3. Piece to be ground. Fig. 4. Method of Testing Accuracy of Grinding. Fig. 5. Method of Holding Work

exactly equal and accurate as to size. This point can be best illustrated by referring to Fig. 4, in which the dimensions that must be accurate are noted. The method used in holding this work for grinding is illustrated in Fig. 5 and consists essentially of a stud *A* whose end is milled with a V-slot that is exactly in the center of the stud. The other end of the work is held in the usual manner by the tail center of the grinding machine. Fig. 4 illustrates the method used in checking the accuracy of this grinding. This gaging fixture consists of a bar *C*, having two arms *D* that are drilled and reamed to receive the pin *E*, which, in turn, may be slipped through the holes of the piece and the holes of these arms *D*. The measuring part of the gage consists of a micrometer head *G* that is mounted in the center of bar *C*. By means of this micrometer head the distances from the center of the hole to the outside of the work in either direction may be readily and accurately measured. C. L. L.

* The titles and dates of publication of the complete series of articles on the Brown & Sharpe automatic screw machines are: "Magazine Attachments—1," February, 1912; "Milling Cross-Drilling and Burring Attachments—1-2-3-4," September to December, 1911; "Thread Rolling," August, 1911, engineering edition; "Knurls and Knurling Operations," July, 1911; "External Cutting Tools—1-2-3-4-5," January (except May) to June, 1911; "Internal Cutting Tools—1-2-3," September to November, 1910; "Designing Screw Machine Tools and Cams," August, 1910; "Threading Operations—1-2," June to July, 1910; "Circular Form and Cut-off Tools—1-2," March to April, 1910; "Knurls and Knurling Operations—1-2," June to July, 1909, engineering edition.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A THREE-SPINDLE DRILLING ATTACHMENT

As the demand for the product of a manufacturing concern increases, new tools must be designed to increase the output. The company with which I am employed makes a large number of cast-brass rings of different diameters and thicknesses.

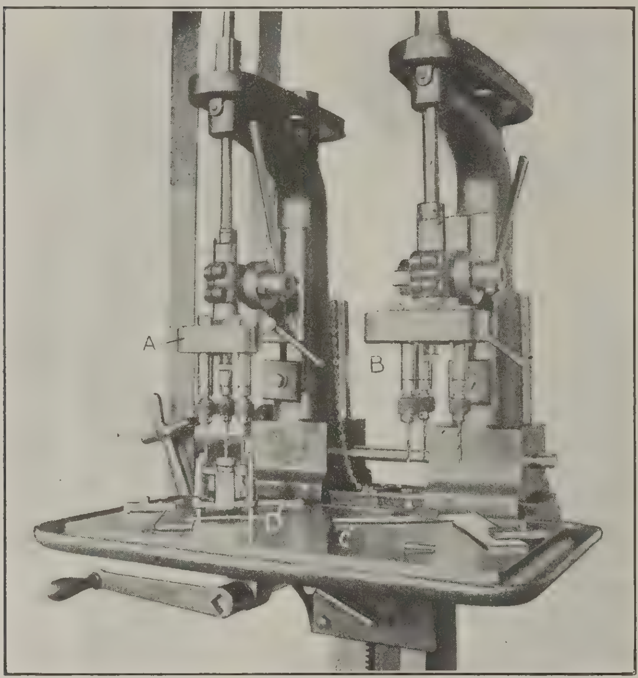


Fig. 1. Drill Press equipped with Two Three-spindle Drilling Attachments

These are attached to plates with three fillister-head screws. The three-spindle drilling attachments, shown in Fig. 1, were made by the writer to drill the three holes in these plates and the three tapped holes in the sides of the brass rings. The diameter of the hole circle is larger on one side of the ring than on the other, thus requiring two drilling attachments.

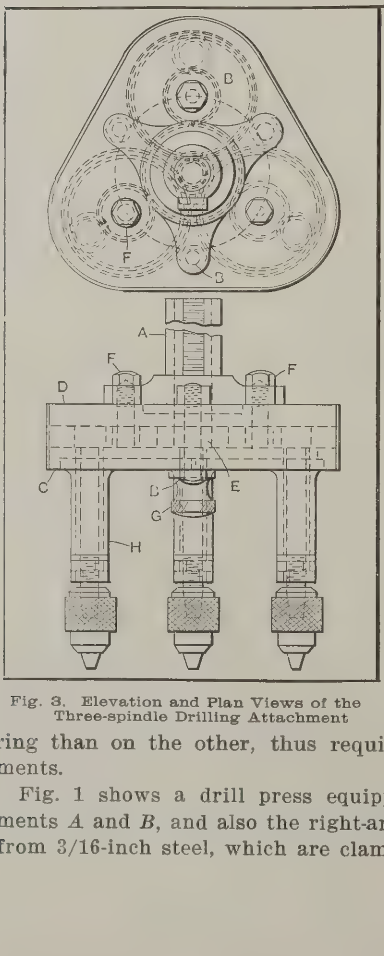


Fig. 3. Elevation and Plan Views of the Three-spindle Drilling Attachment

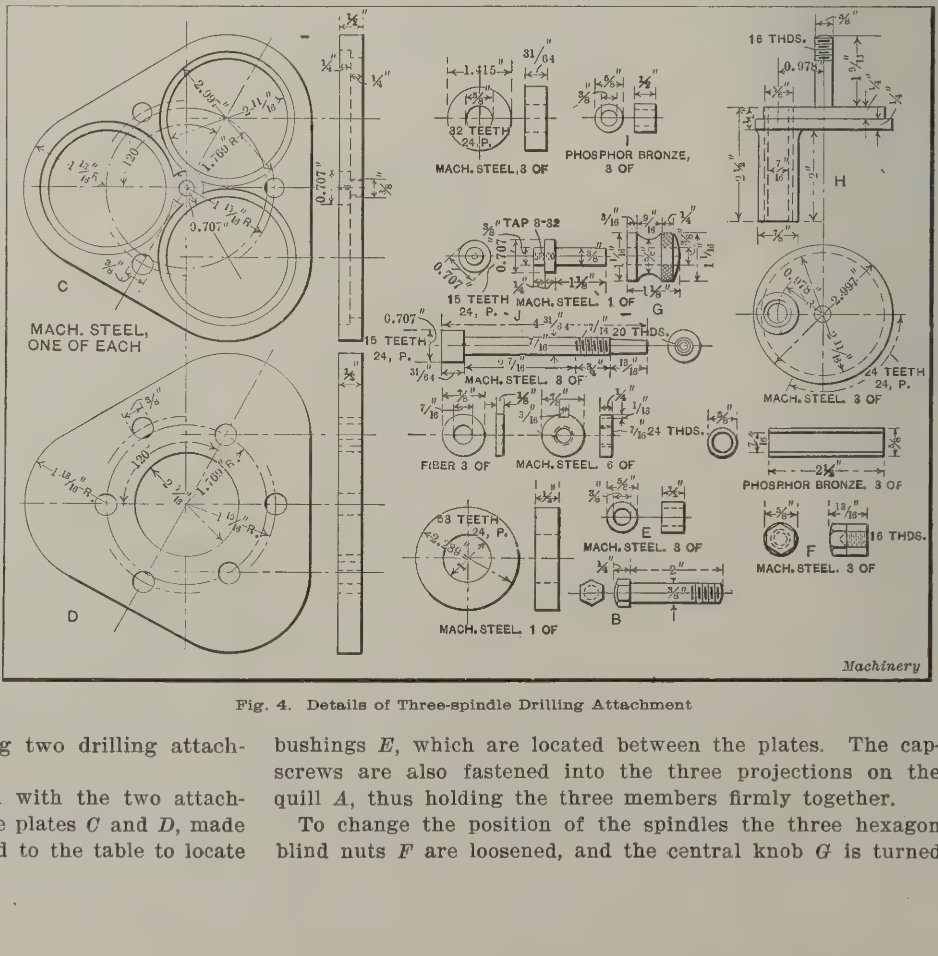


Fig. 4. Details of Three-spindle Drilling Attachment

Fig. 1 shows a drill press equipped with the two attachments *A* and *B*, and also the right-angle plates *C* and *D*, made from 3/16-inch steel, which are clamped to the table to locate the bushings in the drill jig quickly in line with the drills. The attachment *A* will drill three equally spaced holes in any circle from 2 5/8 inches in diameter up to and including 4 7/16 inches in diameter, while the attachment *B* will handle hole circles varying from 3 3/16 inches up to and including 5 1/2 inches in diameter.

At *A* in Fig. 2 is shown a view of one of these attachments looking directly at the chucks, and by close inspection it will be seen that teeth are cut on part of the circumference of the spindle members. There are 24 teeth, 24 pitch, cut in each spindle member in such a position that when the central knob *B* is revolved, the spindles are moved in toward the center of the attachment. The chuck spindle gear has 15 teeth and just clears the driving gear having 53 teeth, which is fastened

Fig. 2. Views looking directly on the Chuck and Gears

to the drill press spindle. The arrangement of the gears can be seen at *C* in Fig. 2, and also in Fig. 3. All gears are cut 24 pitch.

The feed or spindle quills were removed from the drill press, and a special type attached to the fixture as shown at *A* in Fig. 3; then the two drilling attachments *A* and *B* shown in Fig. 1 were put in place, making the machine a permanent multi-spindle drill press. The attachments are made of steel except the quill *A*, Fig. 3, which is made of brass; provision is made to save the expensive parts from excessive wear by making the bushings in the chuck spindle member and the intermediate gear of phosphor-bronze. The 3/8-inch cap-screws *B* pass through the two plates *C* and *D* and the 1/2-inch steel bushings *E*, which are located between the plates. The cap-screws are also fastened into the three projections on the quill *A*, thus holding the three members firmly together.

To change the position of the spindles the three hexagon blind nuts *F* are loosened, and the central knob *G* is turned

in the required direction, moving the spindles H to the proper diameter, so that the drills will line up with the bushings in the drill jig. When the nuts F are tightened, the spindle member is drawn up against a shoulder in the bottom plate C, and the phosphor-bronze bushings I, see Fig. 4, in the intermediate gear are drawn up against the top-plate D, thereby locking each spindle firmly.

The details of this three-spindle drilling attachment are shown in Fig. 4, similar parts in Figs. 3 and 4 bearing the same reference letters. The central knob G is forced onto the ⅜-inch end of the stud J after the teeth are cut, and is held in place in the bottom of the plate C by a tight fitting screw and washer, which projects into a recess turned in the driving gear on the main spindle. The construction of the other parts are clearly indicated in Fig. 4 so that further references are not necessary.

The fact that three of these drilling attachments have been made speaks well for their efficiency. Besides using these attachments for drilling three holes they are also used for drilling two holes where the distance between centers or the distance across the chord with a 6-inch hole circle comes within the range of the attachments. The capacity of the chucks is from the smallest size drill up to and including a No. 1 drill. The spindles rotate at 1400 R.P.M., and provision is made for oiling the spindles by drilling oil holes in the top plate D and tapping it for flat-head screws. Oil grooves are also cut in the drilling spindles, so they are furnished at all times with a copious supply of lubricant. The gears also are well lubricated.

Dorchester, Mass. ALBERT C. SAWYER

TWISTING IRON ON THE BULLDOZER

When it is desired to twist one or both ends of a rectangular bar which is considerably wider than it is thick, the twisting can be done on a bulldozer without the aid of any complicated mechanism. The twisting device may also be used in connection with a former, for bending the bar in the direction of its greatest width. The method employed is illustrated in Fig. 1.

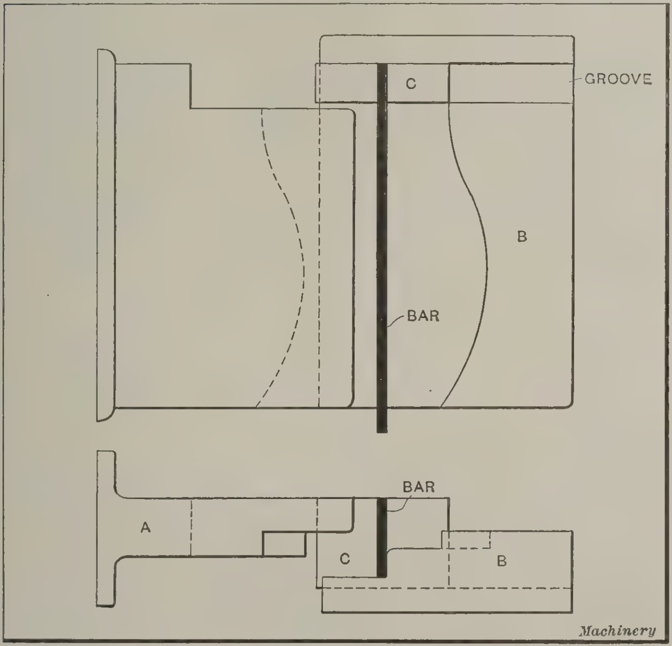


Fig. 1. Formers for Twisting Iron on the Bulldozer

The casting A is attached to the crosshead of a bulldozer, and corresponds to the movable die in the ordinary former, while the casting B corresponds to the stationary die. It will be seen that if the bar, which is shown standing on edge, is firmly held in this position at one end, it will be twisted when the dies come together. To hold the end of the bar in position, a block C is used, provided with a slot to fit the bar. It is evident that this block C must move forward with the movable die; otherwise the bar would be distorted at the point of the bend. This is easily done by cutting a groove in the stationary die, into which the block will slide. The curved lines on the formers represent the shape to which the bar is to be bent.

In Fig. 2 is shown some of the work which may be accomplished by formers of this kind. C shows a bar which is both twisted and bent, and B shows a bar twisted at both ends. Should it be desired to bring the twisted end on either side of the center of the straight portion of the bar, and have

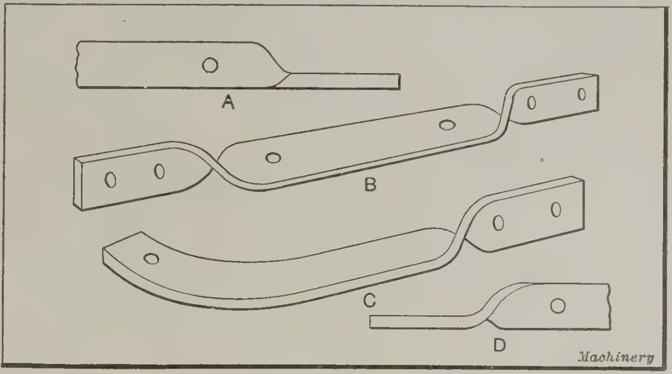


Fig. 2. Examples of Twisted Iron Bars

the flat surfaces at right angles to each other, as shown at A and D, this is easily done by lengthening or shortening the projection on the movable die, which bears against the block.

By the additional provision of a link connecting the block C to the movable die A, Fig. 1, the block can be brought back to the first position with the backward stroke of the machine. If the block is short, it will be necessary to use a guide or some other means of preventing it from tipping up as the bar twists.

W. L. B.

DIAGRAM OF EFFICIENCIES OF WORMS AND SCREWS

The accompanying diagram shows at a glance the percentage of efficiency of worms and screws when the ratio between the lead of the screw or worm thread and the pitch diameter is known. The inexperienced designer is apt to overlook the question of efficiency, but unless this is considered, it is possible that an apparently ample leverage will be so reduced by the inefficiency of the screw that hand adjustment will be difficult or power adjustment subject to severe wear. The diagram given is similar to one published in a book entitled "Worm and Spiral Gearing," by Frederick A. Halsey, but is easier to apply on account of the introduction of the factor of the ratio of lead to pitch diameter in place of the angle of the thread.

It will be seen that two curves are given, one for the efficiency of the worm alone and one for the efficiency of worm and step. The first curve is used in cases where the end thrust is taken by a ball bearing, while the second curve is

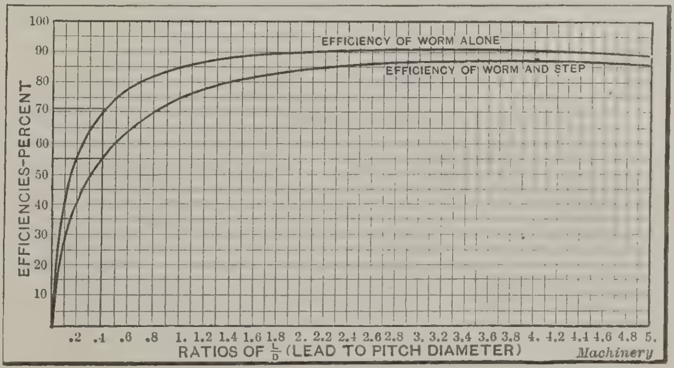


Diagram of Efficiencies of Worms and Screws

used when the end thrust is taken by an ordinary washer, causing friction at the end of the worm. The formulas upon which these curves are based are as follows:

$$\text{Efficiency of worm alone} = \frac{\tan \alpha\,(1 - f \tan \alpha)}{\tan \alpha + f}$$

$$\text{Efficiency of worm and step} = \frac{\tan \alpha\,(1 - f \tan \alpha)}{\tan \alpha + 2f}$$

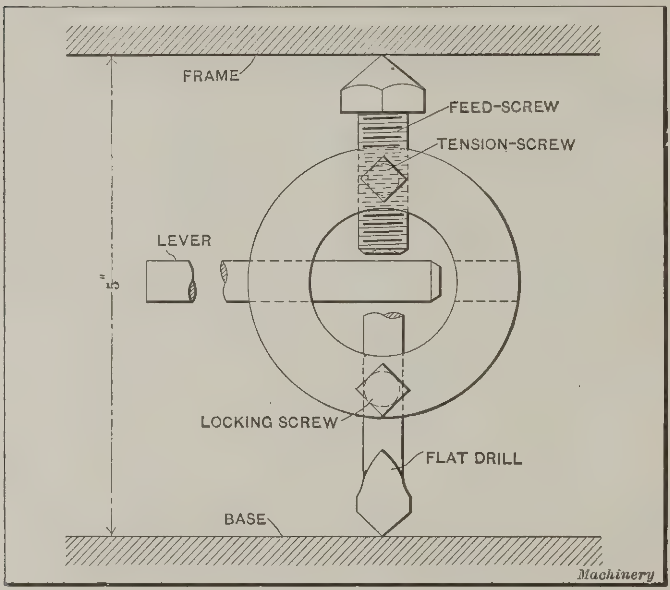
In these formulas α = angle of thread.
f = coefficient of friction, assumed as equal to 0.05.

As an example of the use of the diagram, find the efficiency of a worm with ½-inch lead, single thread, and 1¼-pitch diameter; the ratio of lead to pitch diameter is $0.5 \div 1.25 = 0.4$. From the curves we find that the efficiency is 71 per cent for the worm alone, and 55 per cent for the worm and step.

Scottdale, Pa. F. D. BUFFUM

AN IMPROVISED DRILL AND FEED

It was at one time necessary to drill two 1/2-inch holes in the base of a machine where there was only 5 inches of space available, as shown in the accompanying illustration. Our shortest ratchet drill was 7 inches over all, so that it could not be used. The job was in a hurry, so the man doing it picked up an old collar, drilled a few holes in it, arranged the



An Improvised Drill and Feed

two set-screws as shown, the lower one bearing against a flat spot on the drill, and the upper one screwed against a copper plug and the feed-screw. The latter set-screw provided a tension to prevent the screw from feeding too fast. A piece of 7/16-inch iron was then applied as a lever to turn the drilling device, and a wrench was used to work the feed-screw, which was a common set-screw with the head ground to a sharp point.

Newark, N. J. H. E. WOOD

[The tension-screw was unnecessary if the feed-screw was properly pointed on the outer end. The resistance to turning of the screw in its nut, under ordinary conditions, is always greater than that of a pivot of smaller mean diameter when both are carrying the same load.—EDITOR.]

STRAIGHTENING SHAFTING

There is one operation in machine shop practice to which even the best mechanics look forward with dread, *i. e.*, straightening a screw or shaft. This is due largely to the lack of understanding of the principles of straightening on the part of the majority of mechanics. While some shafts require more time to straighten than others, the operation becomes comparatively simple if approached with the proper understanding and appliances.

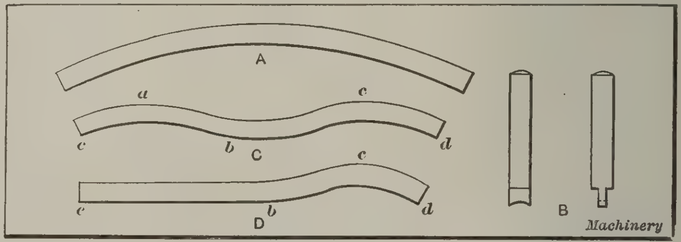
Every shop worthy of the name should have some good straightening devices. These, as a rule, can be made cheaply and are so simple that they need not be discussed. If nothing else is at hand an I-beam, a couple of V-blocks and a jack-screw serve the purpose, and these are especially good for straightening long shafting. A shaft becomes bent through various causes, *e. g.*, it may be strained beyond its elastic limit, as when overloaded; or it may be subjected to too much heat, causing unequal internal strains, as when taking a cut over a piece of rough iron or steel, or when keyseating a shaft especially when it is made from commercial cold-rolled steel.

By referring to the accompanying illustration it will be seen that the shaft which is shown at *A* has a single bend and is considerably longer on the top side than on the bottom. In order to produce this effect the fibers on one side were stretched and those on the other, compressed. Now to bring the shaft back to its normal state, this condition of the fibers must be reversed.

If through some accident a shaft is strained beyond its elastic limit it should never be used for the same purpose even though it be made to run practically true, unless the load is not excessive in proportion to its size. A shaft once distorted will never have the same resisting qualities that it had before the accident. Shafts running at a high rate of speed having keyways cut between the journals, even though splined on both sides, give trouble on account of the vibration caused by the shaft being out of balance. This can be avoided either by designing the shaft stronger than necessary, to give it additional stiffness, or by cutting a slot in each side one-half the proper width for that size of shaft. For instance, a ½-inch keyway being standard for a 2-inch shaft, cut a ¼-inch slot on each side of the shaft in diametrically opposite positions. This leaves the shaft strong and easy to straighten.

Shafts which have to withstand suddenly applied loads, such as the crankshaft of a gasoline engine, can be made to hold the flywheel so that it will not loosen by making the keyway wider than the standard width and having the key a good fit sideways. Crankshafts turned by the ordinary method in the lathe will invariably be found to spring slightly. This is caused by clamping too tightly the screw that is placed between the arms when turning the journals, so that when the screw is removed, the arms spring in, causing the shaft to bend. To remedy this, place a small jack-screw between the arms and by repeated trials, applying a little more pressure each time, spring the arms outward until the journals run true.

Shafting, arbors, lead-screws, etc., are straightened in three different ways. First by means of hammer blows, second, by steady pressure, and, third, by peening. To straighten a shaft by the first method support it upon its ends or between the ends, as the case may be, and strike it with a hand hammer or sledge, depending on the size of the shaft, upon the high or tension side. This forces the long side inward and the



Methods of Straightening Shafting

short side outward. The second method consists in supporting the shaft near its ends or between centers in the lathe (this is not good for the lathe) and applying pressure upon the high side by means of a lever or screw. The third method is a combination of the first and second and consists in stretching the low or compression side by tapping with a hammer at the same time that pressure is applied to the high side.

At *B* in the accompanying illustration is shown a tool for straightening shafting having a square thread cut on it. This tool can be made from an old chisel and will not mar the threads. It is placed between the threads, and while pressure is being applied underneath the shaft, the top of the tool is struck with a hammer. A shaft which is badly bent should be heated and straightened as true as possible. If worked when cold, the shaft will crystallize and break easily.

To straighten the shaft shown at *C*, center each end true, or, if it is too long to go between the centers of the lathe, rest each end upon V-blocks. Now rotate the shaft, and with a piece of chalk find the high spots which would be at *a* and *c*. If the shaft is rough and not very large, it can be quickly straightened by placing it upon an anvil or hollow block and

striking the high spots with a hammer. If the shaft is finished—having a smooth surface—commence at one end, the left-hand end, for example, and work towards the other end. To proceed, fasten end *e* and part *b* with the high side down, apply pressure at *a* and tap the opposite or low side with a hammer, care being taken to use some soft metal, such as sheet copper on both sides to prevent bruising the shaft. A point which should not be overlooked is this: While straightening a shaft by any of the methods given, the pressure or blows should be gradually increased. If it is found upon trial that the shaft is still sprung in the place where the pressure has been applied, the pressure has not been enough. If unfamiliar with the kind of steel, use very little pressure at the first trial.

If the part of the shaft between *e* and *b* shown at *C* is straight, as shown at *D*, fasten the shaft at *b* and *d* with the side *c* down, and apply pressure at *c*, proceeding in the same manner as before described until that part is straight. If the shaft is made from cold-rolled steel or common machine steel, it will be found that some of the bend has returned in the other end of the shaft previously straightened. In this case go over the shaft from the right-hand end in the same manner, and with a little patience and judgment it will be found that what was at first considered drudgery will become an interesting task. John W. Brandle

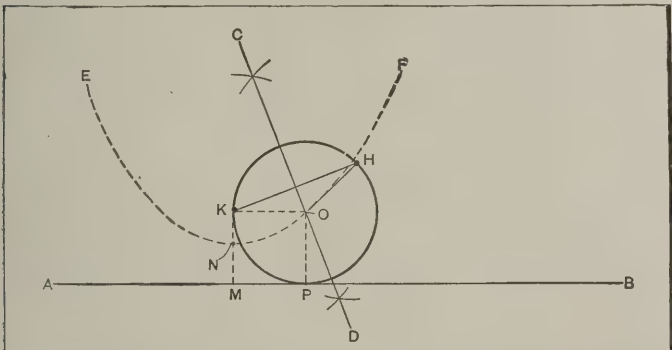
Nashville, Tenn.

A GEOMETRICAL PROBLEM

The following geometrical problem and its solution will probably be of considerable interest to the readers of MACHINERY. If this problem were given unaccompanied by its solution, it is probable that many good mathematicians would spend some time trying to obtain a solution. As far as the writer knows, this problem and its solution are original with him.

Given a straight line *AB* and any two points without it, but on the same side of it, as *K* and *H*. Required a circle passing through *K* and *H* and tangent to *AB*.

Draw *KH*, and bisect it by line *CD;* then the center of the required circle will be somewhere on line *CD*. From *K* draw a line *KM* perpendicular to *AB*; bisect line *KM* as at *N*. With *K* as the focus and *AB* as the directrix, construct a parabola



An Interesting Geometrical Problem

ENF. The point where the parabola intersects line *CD* is the center of the required circle.

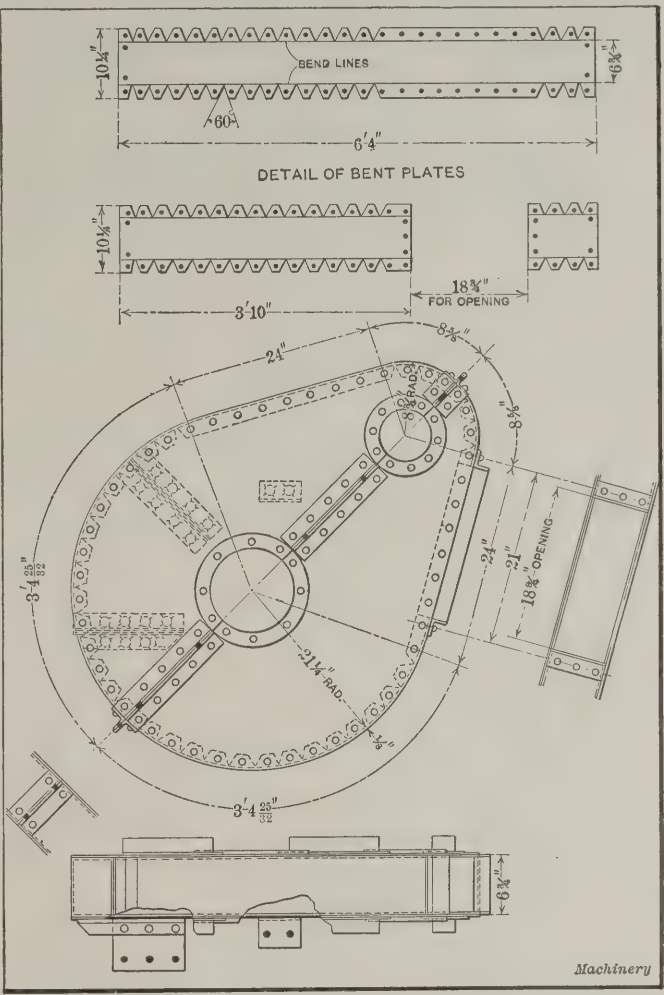
The proof is very simple. In any parabola, any point on its curve is always at an equal distance from its focus and its directrix, hence, $KO = OP$; but *KO* also equals *HO*; hence *O* is the center of a circle which satisfies the given conditions.

Chicago, Ill. C. W. Hinman

SHEET-STEEL GEAR CASES

All gears should be provided with cases that will permit them to run in a bath of oil or grease. We provide carefully for oiling all bearings, slides, etc. Why should we then expect gears to run with haphazard lubrication? A gear case prevents spattering and waste of the lubricant, and it deadens the noise. It also keeps dust out of the teeth, and most important of all, it prevents accidents more efficiently than any guard which does not entirely encase the gears. The day is rapidly approaching when the unguarded or unencased gear will be a thing of the past, and purchasers of machinery ought always to specify gear cases when ordering new machines. It will save money in the end, in addition to all the other benefits mentioned.

The gear case construction shown in the accompanying engraving may be of interest. The rigidity of such cases is surprising and their cost is very small; moreover, they weigh but a small fraction of what a cast-iron case would weigh in any given instance. If they are bent, they can be easily repaired, and they are hardly liable to any more serious injury. The accompanying engraving shows the construction of the



General Design of a Sheet-steel Gear Case

gear case somewhat in detail, but an ordinary sheet metal worker has made at least one hundred of these gear cases, nearly all of different sizes, with no information except the sizes of the gears and shafts. The case should fit over the hub of the gear, or over the box, instead of over the shaft, wherever this is possible. A large hand-hole is always a convenience, and there should be an inch or so of clearance between the teeth and the cases in the radial direction. Even in cramped quarters, inside clearance is sometimes of more importance than clearance on the outside, and it leaves room for various articles that might fall into the case and prevents them from being picked up by the teeth. There is no comparison in cost between the construction shown and one with bent corner angles. There is no trouble about making this case tight enough to hold grease or heavy oils.

Scottdale, Pa. F. D. Buffum

[The opening in the case should, of course, be in an upper side and not in a lower side, as erroneously shown in the engraving.—Editor.]

COMBINATION BENDING AND TWISTING DIE

Fig. 1 shows a latch for a go-cart which was formed and twisted in the die shown in Fig. 2. This latch is first cut off and formed to the shape shown at *A* in Fig. 1, after which it is placed in the die shown in Fig. 2, and bent and twisted to the final shape shown at *B*.

The lower bending die A, Fig. 2, is held in a cast-iron base B, and pins C, driven into the former, extend down through the base and come in contact with a pressure plate D operated by a rubber pad E. The top forming die F is held by screws and dowels, as shown, to the holder G, which has a shank to fit the hole in the ram of the press. This holder G is lined up with the base B by standards H, and holds two pins I which oper-

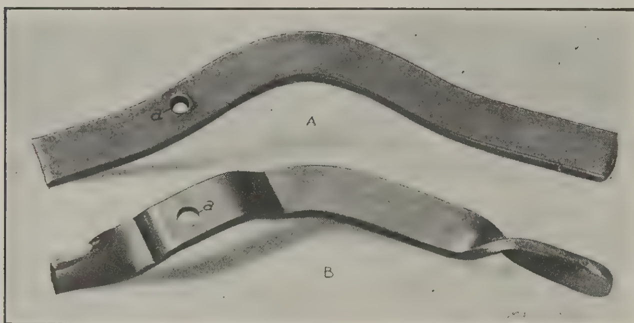


Fig. 1. The Go-cart Latch before and after Bending and Twisting

ate the lower twisting dies J and K. The twisting dies J and K correspond in shape to the dies L and M, which are provided with shanks and are held in the holder G by screws and dowels.

The lower twisting dies J and K are given a slight upward movement by means of the pins I, which come in contact on the downward stroke of the ram with fulcrumed levers N held on pins O. These fulcrumed levers are connected to the twisting dies by pins, as shown more clearly in Fig. 3, where the operation of the twisting dies K and M is illustrated.

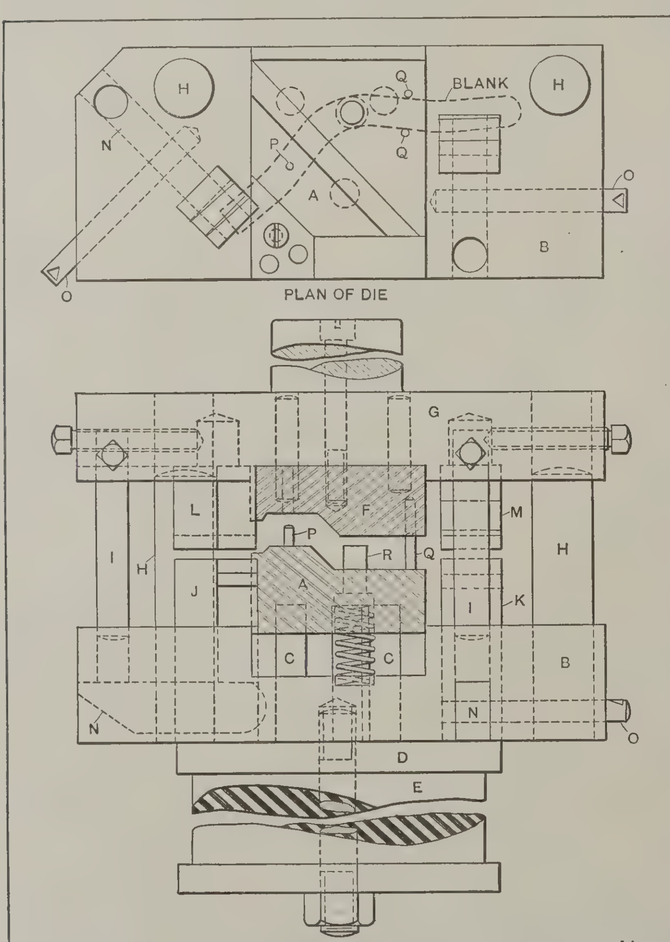


Fig. 2. Elevation and Plan Views of the Combination Bending and Twisting Die

In operation, the blank shown at A in Fig. 1 is placed on the lower die A, Fig. 2, the hole a fitting on the pin P and the blank being located between the pins Q. A spring plunger R, operated as shown in Fig. 2, prevents the blank from dropping down, holding it flush with the highest surface of the lower forming die. As the ram of the press descends, the upper former forces the blank down, bending it to the shape shown at B in Fig. 1, and as the ram still continues in its downward movement, the pins I operate the lower twisting dies through the levers N. The combined action of the upper and lower twisting dies forms both ends of the blank to the shape shown at B in Fig. 1. The lower die A, while the twisting

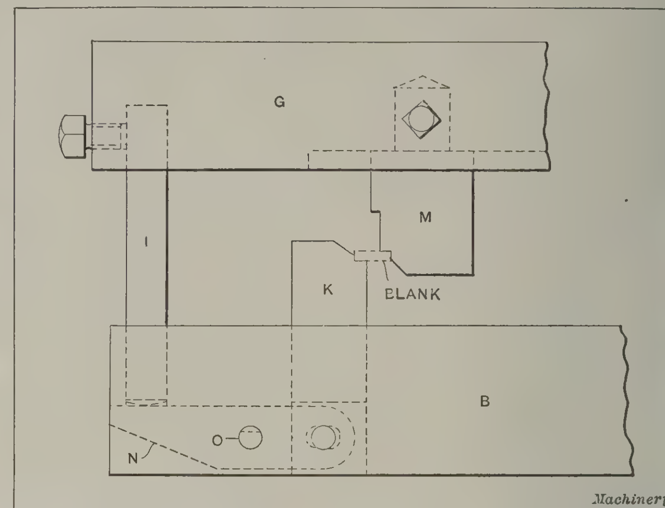


Fig. 3. Part View showing how the Twisting Dies K and M are operated

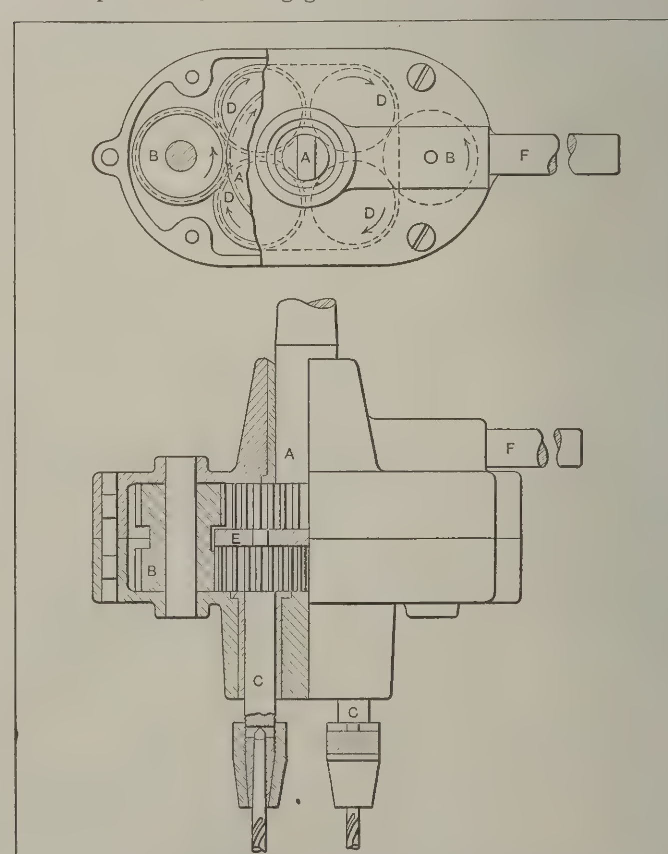
operation is taking place, has been forced down to the lowest point of its travel, compressing the rubber pad E, which returns it to its former position when the ram of the press ascends.

F. W. JONAS

Sturgis, Mich.

A FOUR-SPINDLE DRILLING HEAD

Having a large number of pieces to drill, each with four 3/16-inch holes, spaced 1 1/2 inch apart on a square, we designed this fixture to drill the four holes simultaneously. On account of the small space between the gears, and to avoid the necessity of making special left-hand drills, the arrangement of the gears shown in the accompanying illustration was adopted. The driving gear and shank A are made in one



A Four-spindle Drilling Head of Compact Design

piece, and the intermediate gears B drive the four spindles C through the gears D. The thrust of the four spindles is taken by a bronze plate E, and the intermediate gears B are cut out to clear this plate. The whole mechanism is enclosed

in two cast-iron covers, and is prevented from turning by the handle *F* which comes in contact with the column of the drill press. The intermediate gears *B* run on pins which are driven into one side of the case, and all of the spindles are provided with bronze bushings.

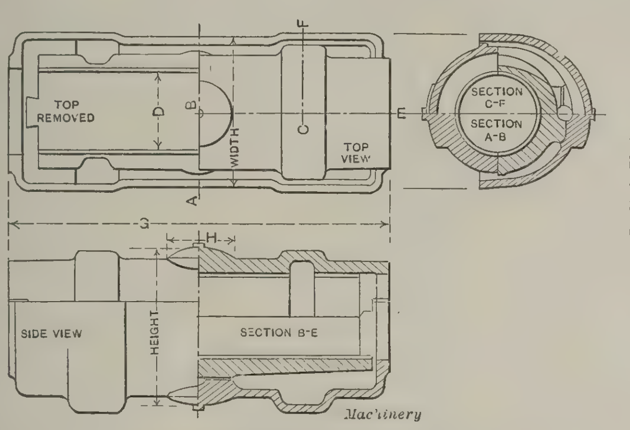
Stamford, Conn. KINGSTON FORBES

RING OR CHAIN OILING SELF-ALIGNING BEARINGS

The illustration shows side, plan and section views of a ring- or chain-oiling self-aligning box that I designed in eighteen standard sizes for 1 3/16-inch to 5 15/16-inch diameter shafts.

The table gives the length of bearing, length over-all, approximate weight complete, diameter of the spherical part *H*

RING OR CHAIN OILING BOXES



Size of shaft D	1 3/16	1 7/16	1 11/16	1 15/16	2 3/16	2 7/16	2 11/16	2 15/16	3 3/16
Length of bearing	6	6	7	8	9	10	11	12	13
Length over-all, G	8	8	9 1/4	10	11 1/4	12 1/4	13 1/4	14 1/4	15 5/8
Height	4	4 1/8	4 3/8	4 7/8	5 1/8	5 3/8	5 5/8	5 3/4	6 3/8
Width	3	3 1/4	3 1/2	3 7/8	4 1/8	4 1/2	4 7/8	5 1/4	5 7/8
Approx. wt., lbs.	11	12	14	20	22	26	30	36	48
Dia. of boss, H	1 1/2	1 3/4	1 3/4	2	2	2 1/4	2 1/2	2 1/2	3
Thickness of babbitt	5/32	5/32	5/32	5/32	3/16	3/16	3/16	3/16	3/16
Size of shaft D	3 7/16	3 11/16	3 15/16	4 3/16	4 7/16	4 11/16	4 15/16	5 7/16	5 15/16
Length of bearing	14	15	16	17	18	19	20	22	24
Length over-all, G	16 3/8	17 1/2	18 1/2	20	20 1/2	22	23 1/2	25	27 1/2
Height	6 5/8	7 1/8	7 1/2	7 3/4	8	8 1/4	8 5/8	9	9 3/8
Width	6 1/8	6 1/2	6 3/4	7	7 1/4	7 5/8	8	8 1/4	8 3/4
Approx. wt., lbs.	60	65	70	75	78	86	95	105	120
Dia. of boss, H	3	3 1/4	3 1/4	3 1/4	3 1/4	3 1/2	3 1/2	3 1/2	3 1/2
Thickness of babbitt	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4

and other data necessary for the patternmaker and machinist.

The advantages of the ring-oiling self-aligning type of bearing should commend it to every designer of machinery, and I hope that these standard sizes may be of as much use to others as they have been to my friends and myself.

San Antonio, Texas. A. W. WINTERBORNE

NEAT'S-FOOT OIL AS A CUTTING LUBRICANT

Some time ago we had a lot of small iron nuts to tap. This job was done by boys in a lathe using taps about 5 inches long made from drill rod. Considerable trouble was experienced with the taps' breaking, and as an experiment we tried neat's-foot oil as a cutting lubricant. This ended the breakage of taps and they lasted until worn out. Since then we have used neat's-foot oil in the threading and difficult forming of steel, and it has always given good results.

We are now broaching soft steel pieces, and using this oil as a lubricant with success. The holes being broached are enclosed on three sides, the fourth side being open. This work has always given trouble because of the seizing of the broach which necessitated sawing the piece in two in order to remove the broach. Since using this oil we have not spoiled a piece, and the holes are smooth and correct to size. While a great many know that neat's-foot oil makes a good, if not the best, belt dressing, I have not met anyone who used it as a cutting oil.

New Haven, Conn. FRANK K. LOVELAND

PHYSICAL HEALTH AND DRAFTING

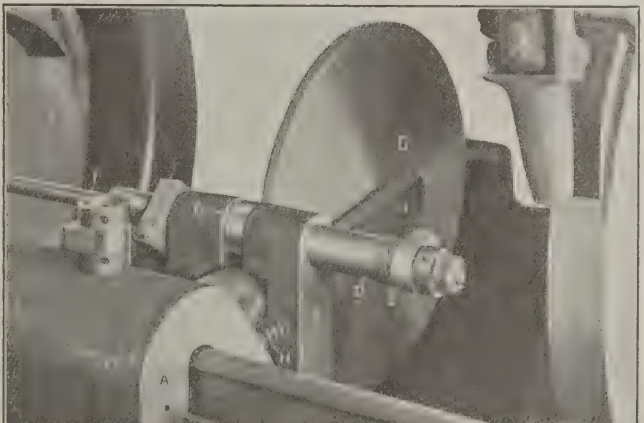
The question of physical health is of prime importance to draftsmen, and it has been freely discussed of late, but it still remains open. We do not all agree with L. R. W. A., in the November number of MACHINERY, in his denunciation of the "apron" type of draftsmen. It is practically, if not absolutely, impossible to avoid pressure on the abdomen in working. You must "get there" and produce, and the only way to reach the top of the board one moment and the bottom the next, is to use the body. There are, of course, extremes in this as in all other cases. I call to mind one "knight" of the board who used his abdomen as a pivot, (he was possessed of a fair-sized bay window) to enable him to roll to the top of the board. This "feat" in time will produce disastrous results—indigestion and its companion ailments. A moderate use of this part of the body, however, can have no very bad effects. If it were possible to avoid this altogether, why does not the instructor show the pupil the "only correct position" to assume when drawing? In teaching penmanship, stress is laid on the importance of proper posture, and why not in drafting? That is the time to correct the evil if it exists, as life-long habits are hard to break.

Exercise seems to me to be the one important factor in a draftsman's health. He needs something to take the kinks out of his system which are acquired in the "daily grind." A few simple bending and breathing exercises practiced morning and night will work wonders. Ventilation is also important. A stuffy steam-heated room is more of a health destroyer than anything else. Right here arises a difficulty: A opens a window and B growls, "Shut that window! Were you brought up in a barn?" That is human nature, but a draftsman should get all the fresh air he possibly can. It seems that a little more attention paid to details would eliminate all of this "slow death" idea and make drafting an attractive proposition, as it should be.

New Britain, Conn. J. M. HENRY

A CAM GRINDING FIXTURE

The accompanying illustration shows a cam grinding fixture applied to a Norton plain grinder. The base *A* of the fixture is clamped to the bed of the grinder, and carries a rocker arm *B*, which is hinged to it. The master cam *C* is keyed to the shaft *D* on which the cam *E* to be ground is held. This shaft is revolved by a flexible coupling *F* driven from the regular driving mechanism, and is held against the center



A Cam Grinding Fixture applied to a Norton Plain Grinding Machine

in the grinding head by a spring located in the shaft. The master cam *C*, when revolved, is kept in contact, by springs *H*, with the roller *G*, which is pivoted to the base *A*. These springs *H*, only one of which is shown, force the master cam against the roller, thus imparting an oscillating movement to the rocker arm, which controls the shape of the cam to be ground. A brake *I* is used to prevent the work from jumping away from the wheel on the relieved side of the master cam. With this attachment, which was designed and built in the apprentice department of the General Electric Co., we are able to make cams at the rate of one every ten minutes to within 0.002 inch of the master cam.

West Lynn, Mass. CHARLES K. TRIPP

REMARKS BY THE ONLOOKER

In reading the interesting article on ball making in the February number of MACHINERY, I recall one of my first jobs in an American shop—the finishing of a number of balls for a floating crane. I was quite proud of my achievement when after much labor the work was done. At noon some of the boys began to caliper the balls, the polish of which was of a considerably higher standard than their uniformity of size, and I suddenly began to lose my pride; in fact, what little remained after they were all calipered, quite disappeared when an old Scotchman said, "Well, my lad, the first one is alike anyway." The present perfection in ball making shows what can be done in the manufacture of great numbers, with proper application of energy and thought.

For years I have had an idea in my mind of some kind of a coating to protect certain parts of a piece when being hardened. Enamelite, as described on page 482, engineering edition, meets with the requirements. Time and time again I have wished for just such a preparation, and it seems to me that it ought to sell like the well-known "hot cakes."

The new design of milling cutter shown by the National Twist Drill & Tool Co., on page 97 of the advertising section, is something that interests me a great deal. It is not an easy thing to combine solidity and simplicity in an inserted tooth milling cutter, and to me it seems that this is almost, as they say down East, "the end of the asking"—just a turned up disk, a few drilled holes, some plain milling, a few pins, and there you are.

If Mr. F. B. Jacobs' article on "Sharpening Milling Cutters" could not only be read, but also acted upon, by those that have to do with the sharpening of these tools, the output of milling machines, I believe, could be increased by 25 per cent. I recall an old man once who, when taking charge of the milling department of a shop, remarked, "Yes, they have got a lot of millers up there that hiccough and grunt the stuff off," and that, I fear, is too often a true description of the way in which milling machines are allowed to do their work.

For years, drill press tables have been weak on account of their overhang, and many a careful mechanic has blocked up the table for heavy drilling or for heavy pieces by means of a screw-jack, or by some other means if no screw-jack was available. To-day this is not often required in modern machines, as drill makers are providing a support as indicated in the Barnes drilling machine, shown on page 480, and in the Taylor & Fenn radial, shown on advertising page 184, which, by the way, is a most convenient tool, although I think it would be an improvement if a slotted tie-rod were provided from the arm to the table. This would stiffen the tool and add but little to the cost. In the Gang radial drill, advertising page 162, a support for the table is also provided, and in some makes of shapers the idea is introduced to advantage. To a very large extent, this stiffening of machine tools is called for by the heavy cuts taken by high-speed steel tools, but the added accuracy of the work produced on solid machines has also acted as an incentive for tool builders to produce something which is not only strong enough, but also "non-vibrating" enough, to produce accurate work. The Lees-Bradner Co. says that "overhanging is a vital error in design," and mechanical designers are beginning to recognize this fact to a marked degree.

To change the subject, let us talk of twist drills. Just look at the row of "maimed soldiers" on advertising page 31. Of course the number of drill presses and collets now in use, scattered all over the world, could not be thrown away or changed without great expense, but the advertisement referred to shows a way to help matters. I do not believe that all the trouble with twisted tangs is due to their actual weakness, but very largely to neglect in seeing that the slots in the collets of drill presses are in proper order. I have often asked a foreman or superintendent if he ever inspected the slots in the drill-press spindles, and have seldom been answered in the affirmative. I feel sure that if the taper is a proper fit, and the tang also, the latter will rarely twist off with regular work.

Your editorial on the "efficiency engineer" is just to the point. That expression is a slur on the engineering profession, as it intimates that an "inefficient" engineer is also a calling. In my experience, the aim of all conscientious engineers has been the production of high quality at low cost—to get all that was possible out of the plant under the existing conditions. What is that if not efficiency?

I cannot quite join you in your time-saving idea mentioned in the editorial entitled "Saving Time in Machine Work." It is safe to say that we will find, if we analyze the operation of drilling a single piece, that not over 10 per cent of the total time is actually used in cutting metal. Drawing down the lever and throwing in the feed are not operations which require much time, and it is my belief that great time saving could be accomplished in securing the work rather than in handling the machine. Often the appliances for securing work on drill presses consist of a number of bolts and straps in a box which have to be dumped on a bench or on the floor in order to find the desired bolts. Usually a trip to the store-room for missing nuts is required, unless they can be conveniently appropriated from the very carefully guarded collection of the planer hand, who is generally the autocrat of the machine shop. To cut a long story short, I believe that time saving in drill press work is in the direction of appliances to quickly get the drill to do its actual work, and not in automatic adjuncts to the press. However, the reciprocating motion in the drill press shown on page 471, is certainly a very convenient addition. We have all worked the hand-feed lever at times to cut a keyway on a drill press, and wished for just such an attachment as this.

It is perhaps not difficult to understand why a drill press has so few appliances, and why those that are provided are so poor. Most likely it is because this machine is especially everybody's tool, unless the shop is a very large one. All hands do work on it, feeling no responsibility towards it, and only considering it their duty to get the job done, and the sooner they can get away from the machine the better. Unless a man is caught "red-handed," the drill marks on the table are done at night when it is positively known that the drills play "tag," and just get into the drill-press sockets all by themselves, which, of course, accounts for the disreputable appearance of the table. This curious night behavior of tools needs scientific investigation. I have known milling cutters or special tools to be taken in perfect condition to a tool-room at night, only to be found in bad shape the next morning, and even when a broken piece is found with the work done by it, it is merely a strange coincidence.

It seems strange to me that the multiple drill makers do not provide some kind of adjustable drill guides, as it would greatly enhance the value of these tools.

In answer to D. A. H.'s question as to rejected parts, my advice would be to destroy them at once, so that they cannot be used, or else you may be tempted to make use of them to the detriment of your reputation. Just be a Pharaoh and harden your heart, but do it at once, and make it part of your system.

"Amateur," judging from his letter on page 464, certainly is in trouble. The explanation of using a lathe for fine drilling "beats" anything that I have so far seen in print, and it is somewhat on a par with the advice given in a celebrated hand-book of engineering, where the following appears: "Boring.—For brass the speed is *one-half* that for cast iron." This shows the truth of the statement of the school-boy who said, "If it wasn't for books, we wouldn't know nothin'." W. D. F.

* * *

The development of electric rock drills of the percussion type has imposed the most severe requirements on steel used for the drills and hammers, but the economy of electric installations has made the development worth while. It is claimed that the electric drill using from one-half to two horsepower will equal the work of a compressed air drill using twelve to eighteen horsepower at the compressor. The changing of line wires is simple as compared with the shifting of pipes. Countervailing disadvantages are the dangers of short circuits and sparks and the lack of the fresh air that is a feature of the exhaust of compressed air drills of some importance.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

WIGGLESWORTH BORING, DRILLING AND TAPPING MACHINE

The Western Machine Tool Works, of Holland, Mich., has recently placed on the market a boring machine especially adapted for heavy boring, drilling and tapping operations. This machine is capable of driving 4-inch drills in steel and will operate an 8-inch pipe tap in cast iron. The general features of the machine may be seen by referring to Figs. 1 and 2,

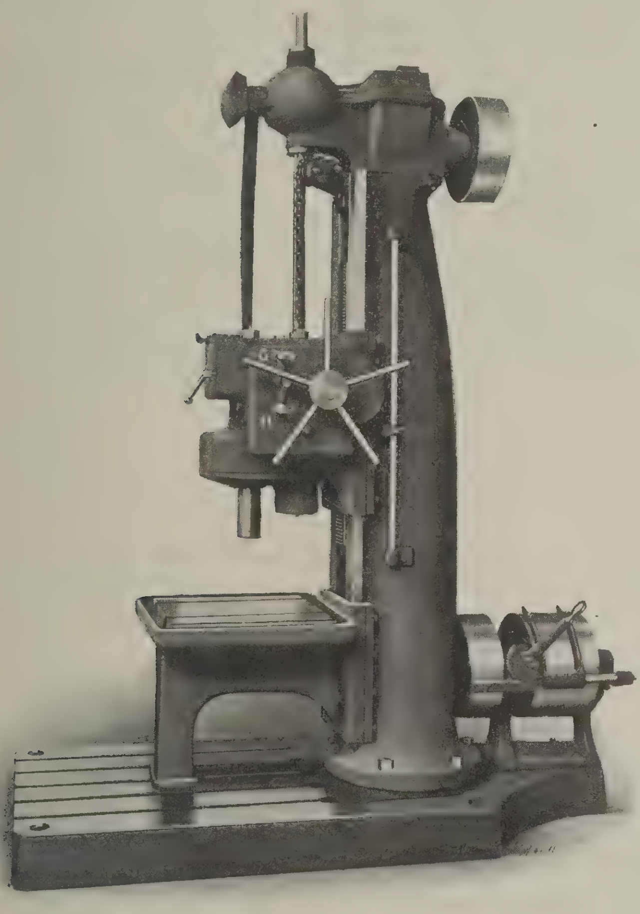


Fig. 1. Boring, Drilling and Tapping Machine, built by Western Machine Tool Works

of the accompanying illustrations, which show views of each side. When the machine is in operation, the spindle remains in a fixed longitudinal position with relation to the driving mechanism and spindle-head and the latter is automatically fed downward on the face of the column. The machine has nine changes of positive geared feed, ranging from 0.006 inch to 0.042 inch per revolution of the spindle, and, in addition, three positive geared "leads" for tapping eight, eleven and one-half and fourteen threads per inch. These tapping leads are independent of the feed changes and any desired lead may be obtained by means of extra change gears.

As will be noted, a belted connection is made between the countershaft on the base and the quick-change speed gear-box on the top of the column. By means of the speed change gears, eight different spindle speeds are obtained and this number is doubled by back-gears located in the head, thus giving a total of sixteen speeds, ranging from 25 to 400 revolutions per minute. From the gear-box the power is transmitted to the spindle head through horizontal and vertical shafts connected by bevel gears. There are three of these bevel gears and a friction clutch, which form the reverse mechanism for tapping. The lever *D*, Fig. 2, for operating this friction clutch, is located conveniently on the left-hand side of the head.

The spindle is driven by a large gear in the head. This gear is located in a fixed position near the lower end of the spindle and close to the work. This arrangement reduces the torsional strain on the spindle and tends to eliminate the chattering incident to heavy cuts. The automatic down-feed to the head is derived from a spiral gear located near the upper end of the spindle, the power being transmitted through feed change gears (as explained later) and a pinion which meshes with a rack in the face of the column. With this arrangement, the feed operates in conjunction with the spindle movements.

Figs. 3 and 4 show the construction of the quick-change gear-box which is located on top of the column and governs the spindle speeds. Shaft *A* is keyed to the belt pulley and, consequently, rotates at a constant speed. A cone of four gears, *B*, is splined to shaft *A* and can be shifted longitudinally by fork *C* which slides on a fixed stud in the gear casing. To the rear of this fork there is a straight rack engaging gear *D*, which is keyed to the vertical shaft *E* so that rotating the latter shifts the cone of gears *B*. The variable speed is transmitted to shaft *F* on which is mounted a rocker arm *G* having pivots *H* and *H'* supporting two sets of intermediate gears *J* and *J'*. Gears *J'* are directly geared to pinion shaft *F*, whereas

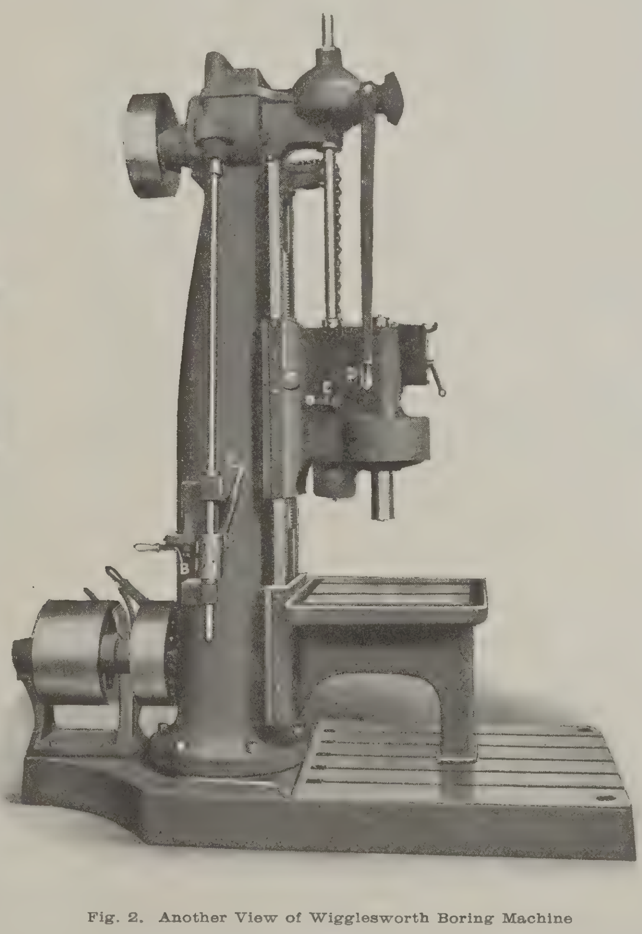


Fig. 2. Another View of Wigglesworth Boring Machine

J is connected by compound gearing as shown. On the upper end of rod *E* there is a circular rack which engages corresponding teeth in the sector face of rocker arm *G*. This rod may be raised or lowered and it can also be rotated to the right or left. Any vertical movement rocks arm *G* and permits either *J* or *J'* to mesh with one of the gears on shaft *A*, whereas rotating *E* to the right or left shifts cone *B* on shaft *A* to bring any one of the four gears into engagement with *J* or *J'*. By varying the gear combinations in this way, eight spindle speeds are obtained. The vertical and rotary movements of rod *E* are effected by the two levers *B* and *C*, Fig. 2,

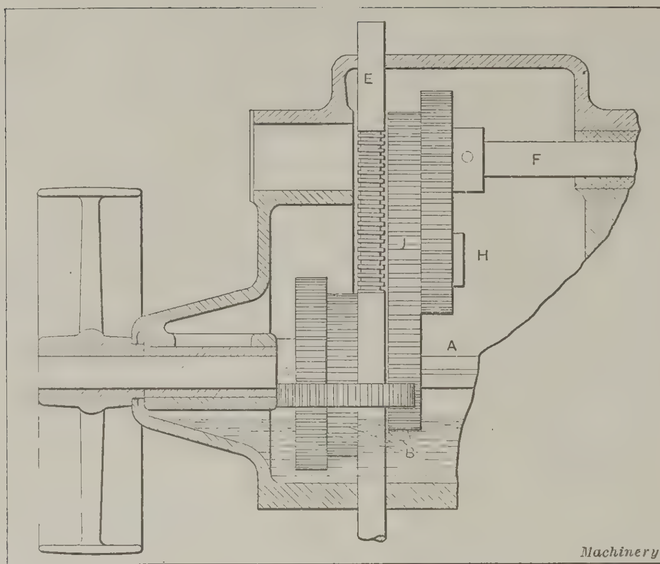


Fig. 3. Side View of Speed-changing Mechanism

which operate through the medium of a cylindrical part attached to the rod.

The method of driving the spindle either directly or through

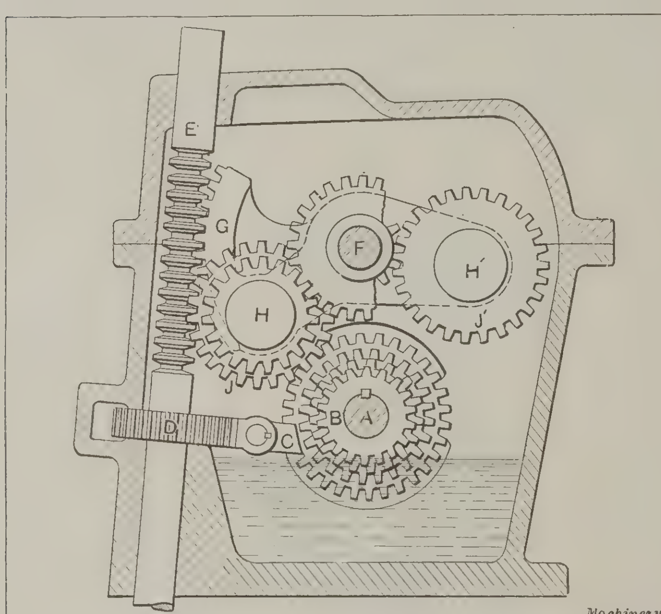


Fig. 4. End View of Speed-change Gears

back-gears, is clearly shown in Fig. 5. The vertical shaft *P*, which receives its motion at the top of the column, carries gears *B* and *X*, and the spindle carries the mating gears *Y* and *Z*. Gear *B* is splined to shaft *P* and when in the position shown, the spindle is driven through back-gears. To obtain a direct gear drive, gear *B* is dropped down inside gear *X* (which is bored out to receive it) by means of lever *E*, Fig. 2. Gear *X* has a large hub on its lower side and on the inside of this hub a two-jaw clutch is cut. This clutch is engaged by the corresponding clutch on gear *B* when the latter is lowered, and then the drive is direct from *X* to *Z*.

The details of the positive geared feed mechanism are shown in Figs. 6, 7 and 8. The power is derived from the spindle by a spiral gear *Q* which drives shaft *C*. The latter transmits movement to shaft *D* through three spur gears located in the small box seen on the front of the head in Figs. 1 and 2. (Incidentally, the different tapping leads are obtained by replacing gear *T*, Fig. 9, with another size). Shaft *D* carries five gears as shown in Fig. 7, all of which run loose on it excepting gear *X*, which is attached by a key. The two gears to the left on *D* are locked together and any one of the three middle gears may be keyed to the shaft by a diving key mechanism. This diving key is operated by lever *G*, Figs. 1 and 8, located on the right-hand side of the head. Above the three middle gears referred to, there is a cone of mating gears *E* (Figs. 6 and 7) which run loose on their shaft and are all joined together. Shaft *F* also carries three gears

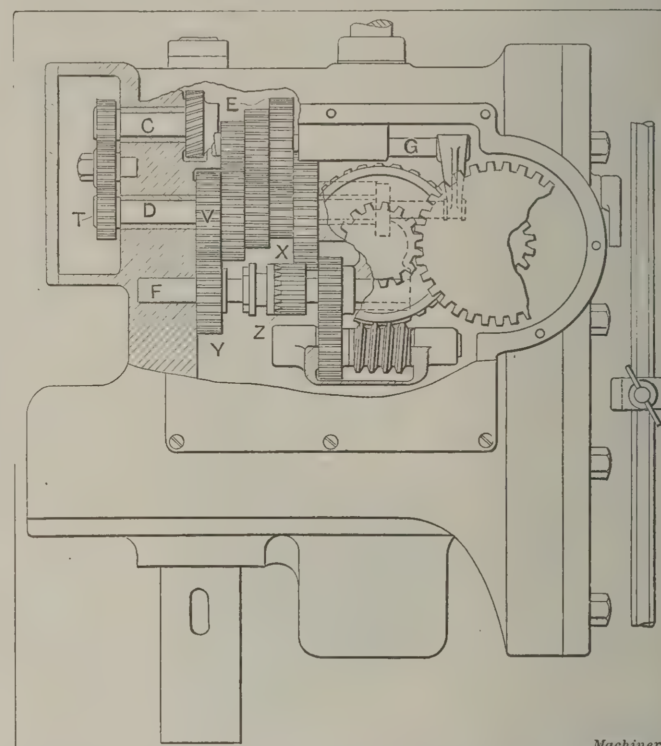
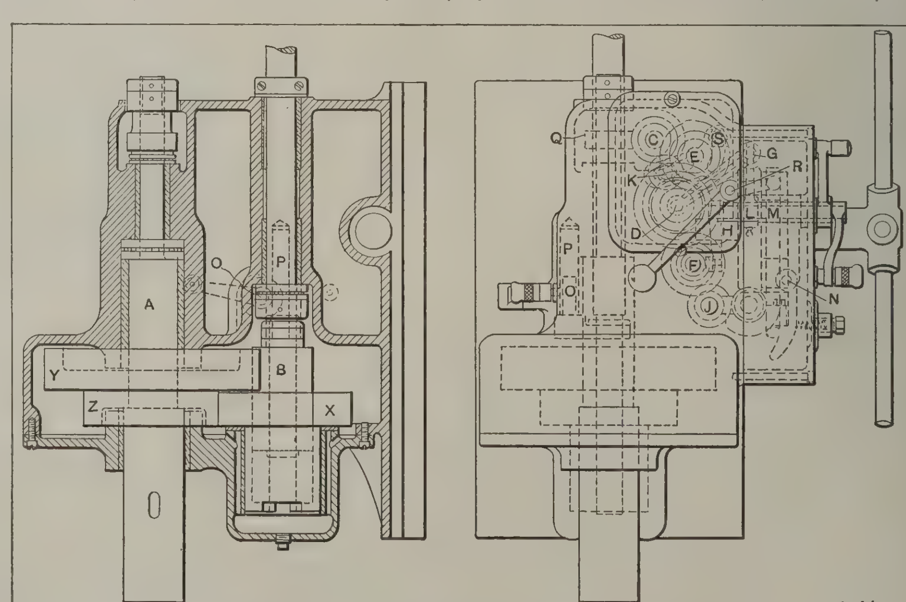


Fig. 7. The Positive Geared Feed Mechanism

and the one to the extreme right is attached by a key. Gear *Y* runs loose on the shaft and gear *Z* has a positive clutch formed on the hub and is splined to the shaft. When tapping is being done, the drive is from shafts *D* to *F* through gears *X* and *Z* and when the regular spindle feeds are desired, gear *Z* is shifted to the left (by lever *H*, Fig. 8) until its clutch engages a corresponding clutch on gear *Y*, thus locking the latter to shaft *F*. The feed movement is then transmitted from *D* to *F* either directly through gears *V* and *Y* or indirectly through the cone of gears *E*, depending on the position of the dive key. Three feed changes are obtained by shifting the dive key and, by the use of two change-gears at *T*, six



Figs. 5 and 6. Spindle Driving and Feeding Mechanism

additional variations are secured. From shaft F power is transmitted to the feeding worm by a spur gear on shaft J, Fig. 6. The worm is hung in a bracket pivoted around shaft J and it can be raised into mesh with the worm-wheel by lever F (see Fig. 9) on the front of the head. When the worm is in mesh, it is secured by a finger f (Fig. 8). The feed is transmitted from the worm-wheel through the spur gearing shown in Fig. 7, to a rack secured to the face of the column which gives the vertical movement. The power feed can be automatically tripped at any point by means of an

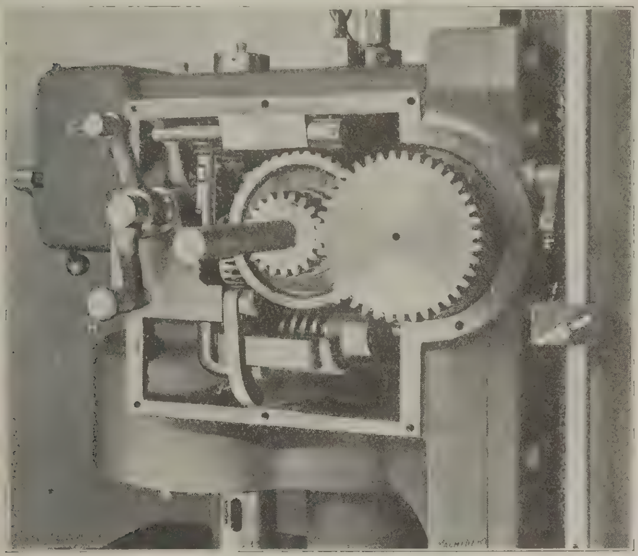


Fig. 8. Feed Box with Cover Removed

adjustable stop t, Fig. 8, which engages with lever r, thus releasing trigger f and allowing the worm-wheel to drop out of mesh. The spindle-head has an automatic down-feed on the column of 40 inches, and the distance from the column face to the center of the spindle is 14½ inches.

The design of this machine is compact and extremely rigid throughout. In case it should be desired to bore open-end cylinders or similar work, provision has been made for steadying the lower end of the bar, it simply being necessary to drill and bore a hole through the table into a hub on the under side and insert the necessary bushing. The lower end

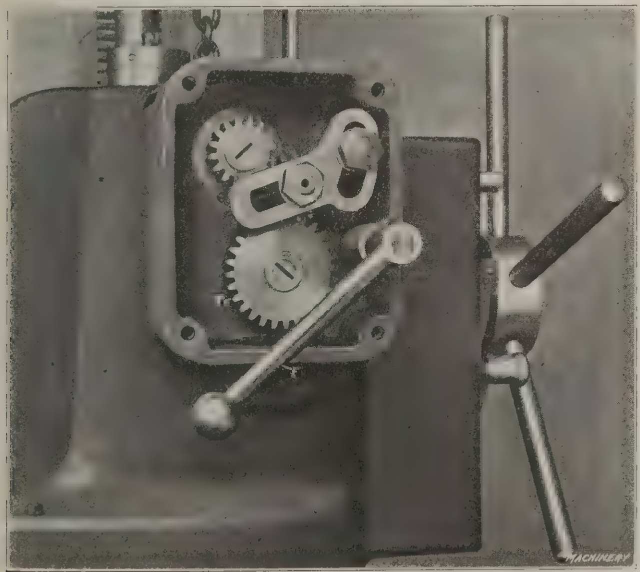


Fig. 9. Front Gear Box with Cover Removed

of the boring-bar can then be passed through this bushing which forms a rigid support.

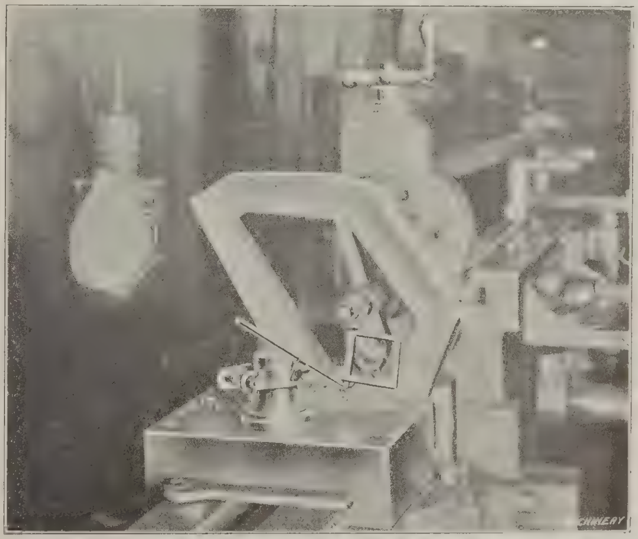
The lubrication of this machine has received careful attention. All gears in the head and quick-change box run in a bath of oil, and the head alone will hold seven gallons of lubricant. The bearings are made self-oiling by means of wicks fitted into slots milled in the bearings, the ends of the wicks dipping into oil reservoirs. The loose pulley on the countershaft also has a wick, the end of which dips into a reservoir cored out of the hub. These reservoirs hold enough oil to last for several months.

In case a motor drive is desired, the motor can be mounted on the back of the column in place of the countershaft. The weight of the machine is about 8500 pounds. It may be seen in operation at the demonstration shops of Hill, Clarke & Co., Inc., in Boston and Chicago, and in the branch offices at New York, Philadelphia, Cleveland, Milwaukee and Rochester.

UNIVERSAL CHIP GUARD

In the department of New Machinery and Tools for April, 1911, we illustrated a lathe chip guard manufactured by the Universal Stamping Co., 47 Poultney St., Buffalo, N. Y. This guard is now equipped with a stationary base block as shown in the accompanying illustration to adapt it for use on the shaper. The bottom of this block is covered with rubber, which prevents any slipping from the jar incident to the shaper's motion. Either a plain glass or a magnifying glass may be inserted in the holder. The magnifying glass not only protects the eyes of the operator but magnifies the layout lines on the work, which is often desirable, especially in connection with toolmaking.

The utility of a guard of this kind is shown by a report on the cause of shop accidents. From a total of 670 accidents in connection with lathe work, 127 were caused by flying chips, or by the flying out of articles being turned. Of course, most of these accidents were not very serious and



Method of using Chip Guard in Connection with Shaper Work

did not result in permanent injury, but the figures show that the protection afforded by a chip guard is very much needed for certain classes of work.

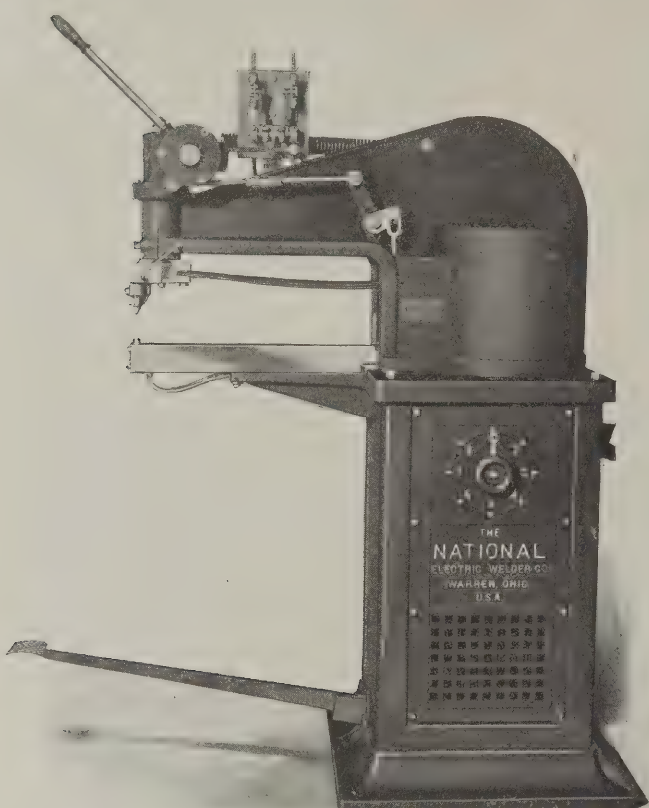
NATIONAL ELECTRIC SPOT WELDER

The use of the electric welding process, especially in connection with sheet metal work, is rapidly superseding the older method of riveting, in the manufacture of a great many parts. Many articles formerly made of wood are now constructed of sheet steel, which has resulted in still further increasing the use of the electric welding process. The spot welder not only gives an increased production, but a neater finish, which is an important feature in connection with many classes of work.

The electric spot welder shown herewith is a product of the National Electric Welder Co., Warren, O. This is a 24-inch size, which means that it will weld to the center of a 48-inch sheet. When this machine is equipped with points or dies not more than ⅜ inch in diameter where they bear on the work, it is said to make 1000 spot welds in 16 gage steel or iron for ten cents, with current costing four cents per kilowatt hour, or three cents per horsepower hour. An alternating current is used, and the 12- and 24-inch standard spot welders have an improved shell-type transformer of 15 kilowatt capacity, designed to reduce the line voltage to 4½

volts, which is the highest voltage required. The machine also has a regulating coil which gives eight different voltages at the welding points. These variations are indicated by a dial at the side of the machine, which is placed in the proper position by the handwheel shown. This feature is necessary, as the voltage required to spot weld varies with the thickness of the material.

This machine is equipped with an automatic switch so designed that it is absolutely impossible to turn on the operating current until the welding points are brought firmly into contact with the metal to be welded. The act of releasing the pressure on the points also immediately opens the switch, which prevents burning the work or destroying the



Electric Spot Welder, built by National Electric Welder Co.

copper points. The welding points are cooled by a continuous stream of water flowing through them, which increases their durability.

The machine can be operated either by hand or independently and without making any changes or adjustments. The use of the foot-lever permits the operator to hold and adjust the work between the welding points with both hands. The use of the foot-treadle, however, gives exactly the same results as when the hand lever is employed. When the machine is operated by the hand lever, the foot lever does not move and it can be removed readily if desirable. The extended hand lever can also be easily taken out as it is fitted into a socket in the clutch plate.

The switch is a new design of the double-pole, double-break type, having four points of contact. This switch opens both sides of the primary circuit in two places, which avoids excessive flashing with currents of high amperage and voltage. This switch is placed on top of the machine and it has the advantage of being stationary, which avoids any trouble from the crystallizing and breaking of the flexible leads. The contacts of the switch are so designed that they can be removed readily. A complete set of contacts costs only a few cents and will ordinarily last from six months to one year.

Two pieces of ⅜-inch boiler plate can readily be welded together with this machine. Sheet steel 1/16-inch thick can be welded at the rate of thirty spots or welds per minute, and ⅛-inch steel stock can be welded at the rate of twenty spots per minute. This machine is designed to be "foolproof," which not only minimizes the cost of maintenance, but increases the output.

BARNES DRILLING MACHINE

The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now manufacturing a 26-inch all-geared drill of the sliding-head type. This machine, with the exception of the sliding head, is designed along the same general lines as the all-geared type formerly built by this company. Fig. 1 illustrates a standard machine, and Fig. 2 is a view showing the opposite side of a machine equipped with a motor drive.

This design is said to have the power of an ordinary 36-inch, cone belt driven type. There are eight geared speeds and a similar number of geared feeds, all of which may be controlled from the front of the machine. The feed for any position of the controlling lever is shown by plain figures, and the feeds range from 0.005 inch to 0.086 inch per revolution of the spindle. The spindle is 1 15/16 inch in diameter in the sleeve and it is double splined. The crown and pinion gears are of extra large diameter and have teeth of four pitch, thus giving a strong drive. The head and spindle are counterbalanced by a weight inside the column which is suspended on a roller-bearing sheave wheel. The head is securely locked to the column face at any point within its travel, by two quick-

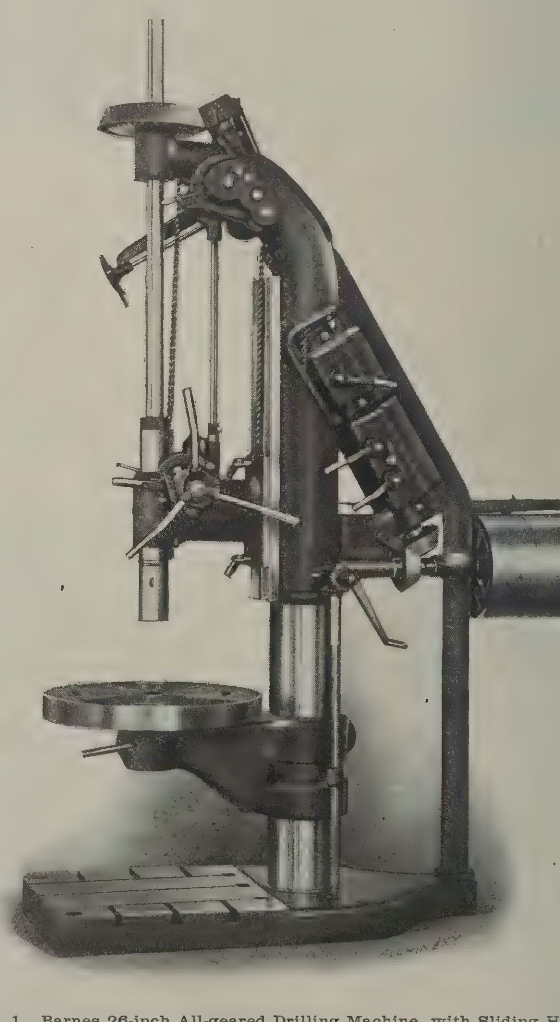


Fig. 1. Barnes 26-inch All-geared Drilling Machine, with Sliding Head

acting clamp screws, and it is raised and lowered by a crank pinion and rack which may be seen in Fig. 2.

This machine is guaranteed to drive a 2-inch high-speed twist drill with a feed of 0.041 inch per revolution of the spindle and at the rate of 6½ inches per minute, in cast iron without using the back-gears. A drill of this size has been driven at the rate of 8¼ inches per minute during tests. A 1-inch high-speed twist drill can be driven through cast iron at the rate of 13½ inches per minute, provided the drill itself will stand this pace.

Suitable feeds are available for boring-bar work, and the machine will bore holes 8 inches in diameter or even larger.

The machine illustrated in Fig. 2 is equipped with a special boring-bar which is used for boring and reaming the exhauster bodies of vacuum cleaners. The holes are 6 inches in diameter and 6½ inches deep, and the work is said to be done very accurately. The sliding head is necessary in connection with this work, in order to remove the tools. The adjustment of the head can be easily effected by the rack and pinion movement, previously referred to. It will be seen that the boring heads, two of which are shown on the base of the machine, are equipped with pilot bars. This same machine is also used for boring the bearings, one of which is shown at the foot of the column.

Some of the general dimensions of this machine are as follows: Distance from column to center of table, 13¼ inches; diameter of column, 7½ inches; diameter of table, 23 inches; vertical travel of table, 20 inches; vertical travel of spindle for one position of the head, 14 inches; adjustment of the sliding head, 23 inches; maximum distance from spindle to base, 54 inches; minimum distance, 18½ inches; maximum distance from spindle to table, 40 inches; ratio of back-gearing, 4 to 1; diameter of the crown gear, 10 7/16 inches; diameter of bevel pinion, 5 inches; net weight of machine, 1750 pounds.

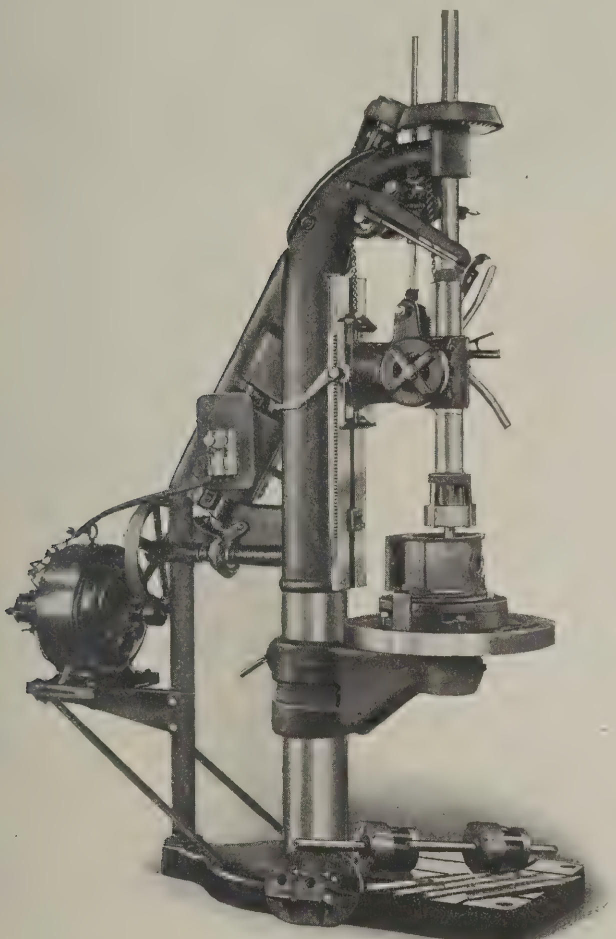
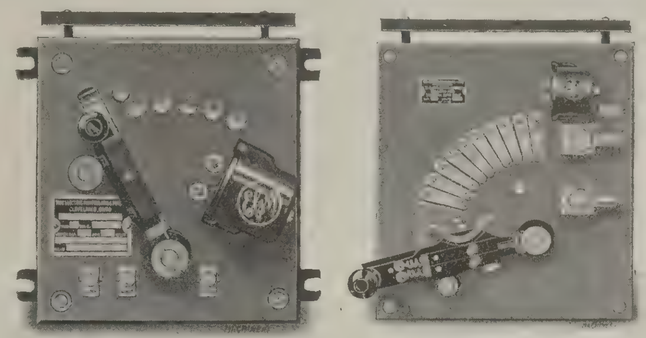


Fig. 2. Barnes Drill equipped with Motor Drive

MOTOR-STARTING RHEOSTATS

The Electric Controller & Mfg. Co., Cleveland, O., has brought out a new line of starting rheostats for series, shunt or compound wound, direct-current motors. The contacts on all sizes of these rheostats, can be removed from the front without disassembling or interfering in any way with the wiring or resistance. The retaining magnet is iron-clad, thus being protected from mechanical injury. The resistance wire, the capacity of which is liberally proportioned, is wound on asbestos-covered, metallic tubes through which a draft of air flows. This draft of air conveys the heat away from the resistance, but does not at any time touch the hot resistance wire; the result is an unusual freedom from oxidization of the resistance wire.

These rheostats are regularly furnished in sizes varying from ¼ horsepower to 35 horsepower for 110 volts, and from ¼ horsepower to 50 horsepower for 220 and 550 volts. Starters similar to the style shown in Fig. 1, are supplied for motors up to and including 7½ horsepower with 110 volts, 15 horsepower with 220 volts and 20 horsepower with 550 volts. For larger sizes, the type shown in Fig. 2 is used.



Figs. 1 and 2. Rheostats made by Electric Controller & Mfg. Co.

BROWN PYROMETER WITH ILLUMINATED DIAL

The Brown Instrument Co., of Philadelphia, Pa., has added to its line of electrical pyrometers, a new illuminated-dial indicator having an exceptionally long scale. Frequently an instrument is desired which can be read easily by the operator of a furnace or kiln, at some distance, and this pyrometer with an illuminated dial is particularly desirable for just such conditions. This instrument has a scale 12 inches long and it can be furnished without the illuminated dial if desired. Where the illumination is sufficient, the instrument does not require an illuminated dial, as the long scale affords very open graduations and accurate readings. In many plants, however.

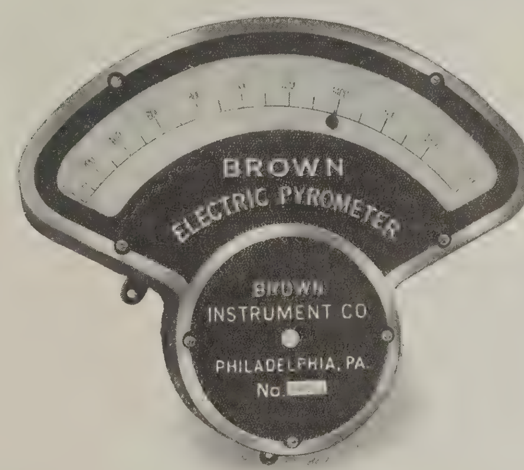


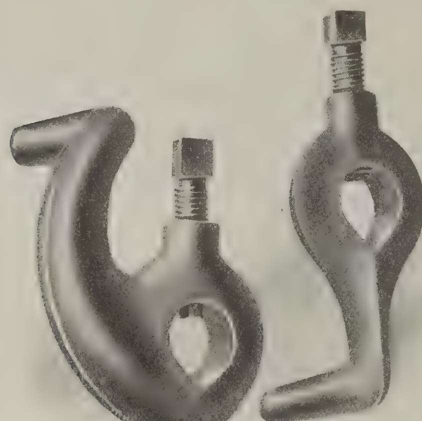
Fig. 1. Brown Pyrometer

Fig. 2. Rear View of Pyrometer showing Method of Illuminating Dial

where there are dark rooms for hardening and heat treating steel, and where work is carried on day and night, the illuminated instrument is preferable. The scale is drawn on opaque glass, and a sixteen candle-power lamp is placed behind the scale, which makes the graduations and the pointer stand out clearly at a distance. Better results are often secured with this instrument because more accurate readings of the temperature can be obtained.

SAFETY LATHE DOG

Every machinist who has operated a lathe realizes the danger connected with the use of the ordinary lathe dog with its unguarded set-screw which tends to catch in the clothing, especially when filing. A safety lathe dog has been brought out by Elmer J. Michaud, S. Windham, Conn., which is so



Safety Dog and Ordinary Type

shaped that the set-screw is guarded. This new dog and also the ordinary type is illustrated herewith. The "tail" of the safety dog is curved around in front of the set-screw on the leading side—as determined by the direction of rotation—thus affording protection. This feature does not affect the convenience of loosening or tightening the set-screw.

UNIVERSAL EMERY WHEEL GUARD

The emery wheel guard illustrated in Fig. 1 is designed to be applied to practically any make of shop tool-grinder. It will cover emery wheels up to 8 inches in diameter and 1½ inch thick. This guard covers the outside of the wheel and also the end of the spindle and retaining nut. The inner side of the wheel is left open to permit using the full width

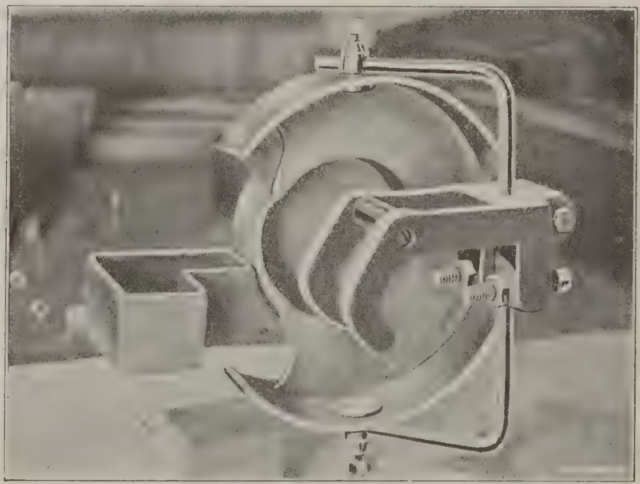


Fig. 1. Emery Wheel Guard made by Universal Stamping Co.

in case this is necessary. The application of this guard to a tool-grinder of the bench type is illustrated in Fig. 2. The guard proper is supported by a steel rod which, in turn, is held by a clamp attached to the spindle bearing box. This clamp, the form of which is clearly shown in Fig. 1, is made in two pieces which are held together by two cap-screws. It is clamped over the bearing boxes by two set-screws, which are locked with jam-nuts. By loosening the rear cap-screw on the clamp and the two binding posts seen above and below the guard, the supporting rod can be raised or lowered or swung to the right or left, thereby allowing the guard to be adjusted as the wheel wears. The water pan is located just below the grinding rest and is attached to the guard proper

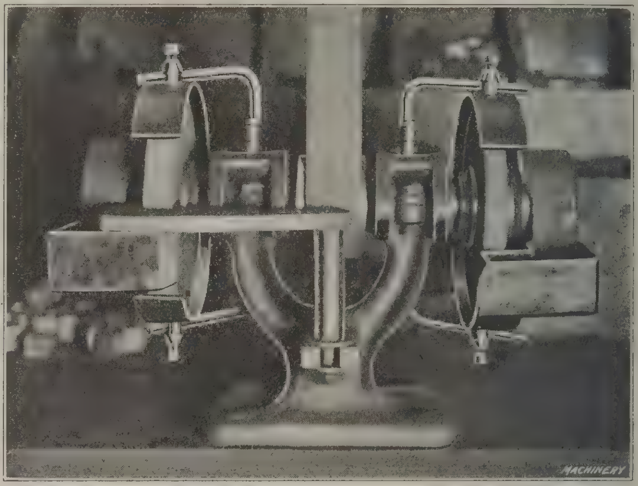


Fig. 2. Tool-grinder equipped with Universal Wheel Guards

by a screw. This pan is not only useful for cooling purposes, but aids greatly in settling the dust. It can be attached or removed quickly for cleaning or filling. When this guard is properly adjusted there is no chance of emery or grindings flying into the eyes of the workman. It is manufactured by the Universal Stamping Co., 47 Poultney St., Buffalo, N. Y.

SENECA FALLS 12-INCH QUICK-CHANGE LATHE

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has just placed on the market a 12-inch quick-change lathe of the same design as the 14-inch size described and illustrated in the department of New Machinery and Tools for December, 1910. The quick-change feed mechanism of this lathe provides forty-eight changes for the lead-screw, which is also used as a feed-rod. All standard threads from 1½ to 92 per inch, including 11½, can be cut, and feeds varying from 0.0023 to 0.142 inch per revolution of the spindle are available.

The index plate shows clearly how to obtain any thread or feed. There is a micrometer stop for the cross-slide by means of which minute adjustments can easily be made. The stop is adjusted by a worm-gear operated by a screw having a knurled knob. The graduations on the micrometer barrel are about ⅛ inch apart and represent 0.00025 inch. The stop mechanism is thrown in or out of engagement by a knob inside the handwheel. The reverse mechanism for the cross and longitudinal feeds and lead-screw consists of a set of spur gears and clutch in the headstock. The reverse mechanism is operated through levers connected by a rod with a hand lever arm on the apron. An automatic stop for the carriage operates in either direction by means of adjustable stops on the reverse rod. The headstock is a deep web pattern and has a forged crucible steel spindle revolving in large bearings provided with oil rings. A draw-in chuck with collets up to ¾ inch can be furnished. A new binding device secures the plain and compound rest to the cross-slide. An automatic safety device prevents engaging opposing feeds, and the feed gearing is disengaged when cutting threads so that the longitudinal handwheel does not revolve.

POLISHING STAND OR JACK

The general appearance and interior arrangement of a new polishing stand or "jack" built by F. E. Wells & Son Co., Greenfield, Mass., is shown in the half-tone engraving, Fig. 1, and the line illustration, Fig. 2. This machine was first built for the company's own use and proved so satisfactory that it has been placed on the market. By referring to Fig. 1, it will be seen that the machine is intended to be driven from beneath the floor. With this form of drive any chance of accidents from the driving belt is eliminated and

all of the mechanism is self-contained. The enclosed construction also furnishes an ideal protection for the bearings from dust.

The interior mechanism is shown by the sectional and side views Fig. 2. The driving belt which connects with a driving pulley beneath the floor, runs over pulley *C* on the main shaft *D* of the machine. This shaft runs in bronze boxes the bearings of which are lubricated by means of ring oilers *L*. The driving belt normally runs slack and then the spindle or polishing shaft *D* is at rest. The machine is started by simply depressing the hand lever *H* at the side of the column. This lever controls the movement of an idler pulley *F* which is

Fig. 1. Polishing Jack built by F. E. Wells & Son Co.

mounted on shaft *E*, contained in a yoke that fulcrums about shaft *G*, so that when lever *H* is depressed, the idler pulley is forced against the driving belt thus tightening it. Lever *H* has an adjustable weight *I*, and when the idler pulley is thrown into contact with the belt it is retained in that posi-

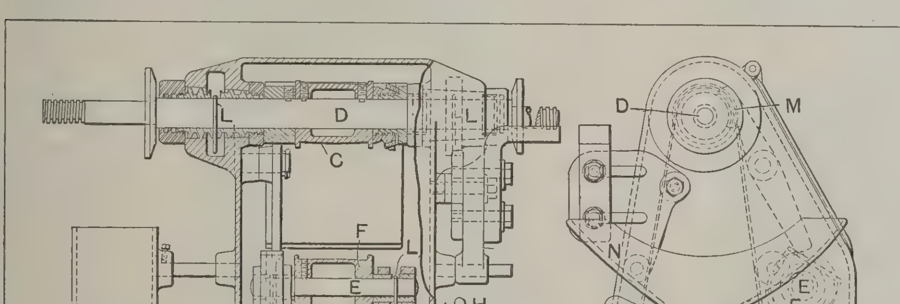


Fig. 2. Views showing Idler Belt-tensioning Device of Wells Polishing Jack

tion by the engagement of pin *J* with a projection *K* on the frame of the machine. As soon as the idler is swung away from the belt, the spindle *D* is quickly stopped by a brake *M*, which is automatically applied by the backward movement of the idler yoke. This machine can be equipped with a special shaft for carrying two wheels in case this is desirable. A swinging arm with a table for disk grinding can also be furnished.

FARWELL UNIVERSAL GEAR HOBBING MACHINE

The Adams Co., 874 Market St., Dubuque, Iowa, has added to its line of gear hobbing machines, a No. 4 size adapted to the cutting of spur or spiral gears, worm-wheels and worms,

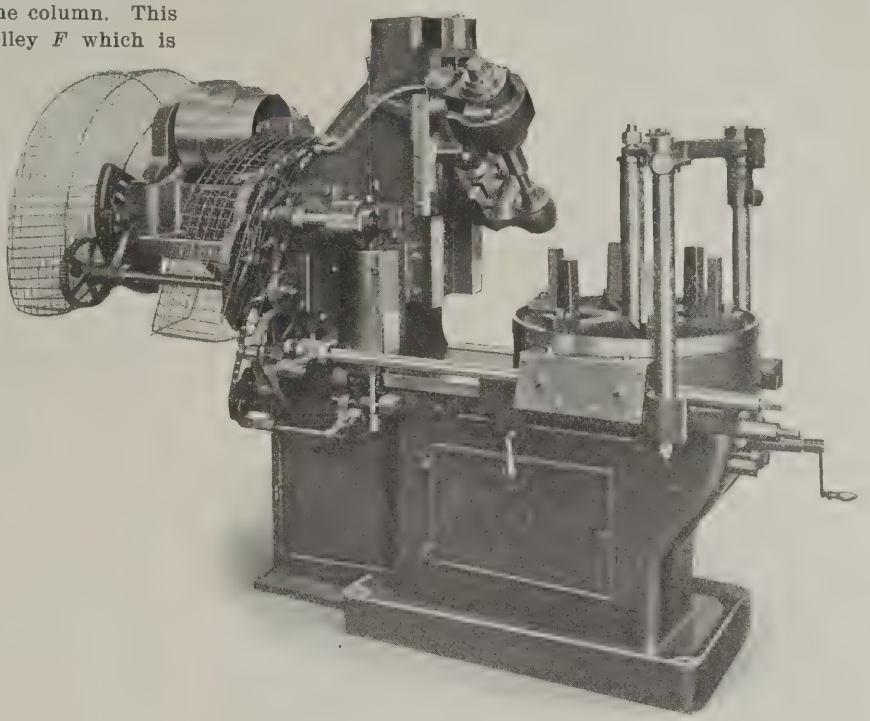


Fig. 1. Farwell Universal Gear-hobbing Machine

up to 24 inches in diameter and with 3 diametral pitch in cast iron and 3½ pitch in steel. This machine, a general view of which is shown in Fig. 1, has such a wide range of feeds and table speeds as to make it universal.

Change gears can be furnished for cutting a single-thread worm or a screw of fine pitch and, in addition, worm, spiral or spur gears, having a wide range as to the pitch and number of teeth, can be hobbed. The vertical feeds of the cutter head range from 0.002 to 0.500 inch per revolution of the table. The table may be geared to make one revolution to two revolutions of the cutter, or it may be geared to make one revolution to a thousand or more revolutions of the cutter. This wide range of feeds and table speeds is, of course, unnecessary for ordinary spur, spiral and worm-gear cutting, but no additional complication was incorporated in the design to obtain this range. The drive for the table and feeds is such that the compounding of a comparatively small number of moderate size gears enables this range to be obtained.

This machine is especially designed for gear- and worm-hobbing, but the slow table travel relative to the cutter speed, which is available, enables the machine to be used also as a continuous or circular milling machine. A special spindle and bracket, such as is shown in Fig. 3, may be secured for this purpose. The cutter-head has been made as rigid as possible by using a wide saddle and swivel of heavy construction. The cutter spindle is large and has a hole through which the arbor proper passes. The arbor is driven by a long key, and adjusting nuts on the arbor at each

end of the spindle provide a longitudinal adjustment of the hob. The spindle is driven by a steel spur gear and pinion, and both the spindle and pinion shaft run in adjustable bronze bearings located on each side of the gears, thus equalizing the strain.

There is but one pair of bevel gears in the spindle drive. A reducing gear of large diameter is interposed between the cone-pulley shaft and a universal-joint shaft which transmits power to the spindle. This is the same drive which has been satisfactorily used on the No. 3 machine. The universal joints are of special design and are provided with large wearing surfaces of steel bearing on bronze. Wear can be compensated for readily, and there are felt oil retaining pads to facilitate lubrication. The cutter-head has an automatic stop and a rapid power return movement.

The table saddle has a power inward feed ranging from one-quarter thousandth to three-eighths inch for each revolution of

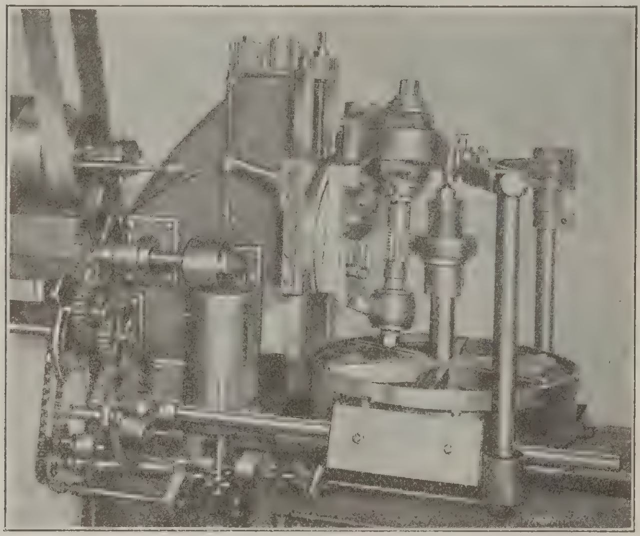


Fig. 2. Farwell Machine cutting Spiral Gear having Tooth Angle of over 80 Degrees

the table. An automatic depth stop is provided for worm-wheel hobbing. The table may be geared to cut anything from a single-threaded worm to a gear having a thousand or more teeth, including all prime numbers. A regular set of change gears (120 in number) will give all the feeds mentioned and will enable gears having any number of teeth up to 200, to be

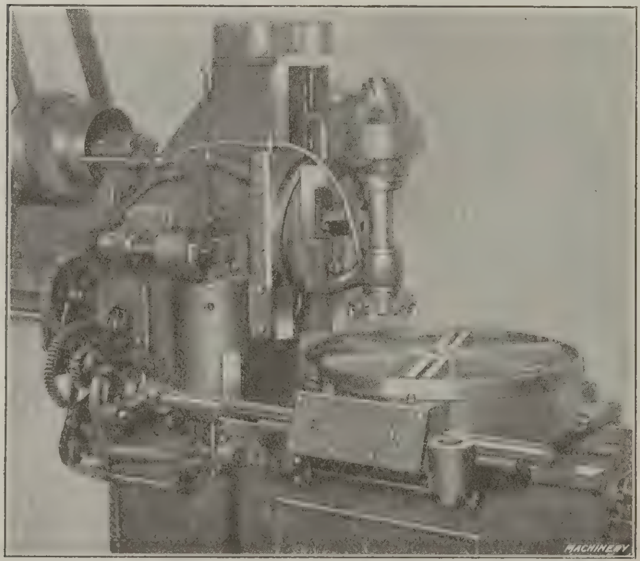


Fig. 3. Gear-hobbing Machine arranged for Continuous or Circular Milling

cut, and many composite numbers above the figure mentioned. Special gears can be furnished to cut all other numbers including prime numbers.

The countershaft furnished is provided with three clutch pulleys, giving a hobbing speed in both directions and a slow speed for driving milling cutters. The lubricating pump is arranged to run in the right direction when the direction of the spindle is reversed. The table is driven by a steel worm engaging a bronze ring worm-wheel. This worm-wheel is 20 inches in diameter which is within four inches of the machine's maximum capacity. Provision is made for easily taking up any wear, either in the mesh or end motion of the worm. The table is of heavy rib or spoke-and-rim construction, and the top between the ribs, instead of being level, is

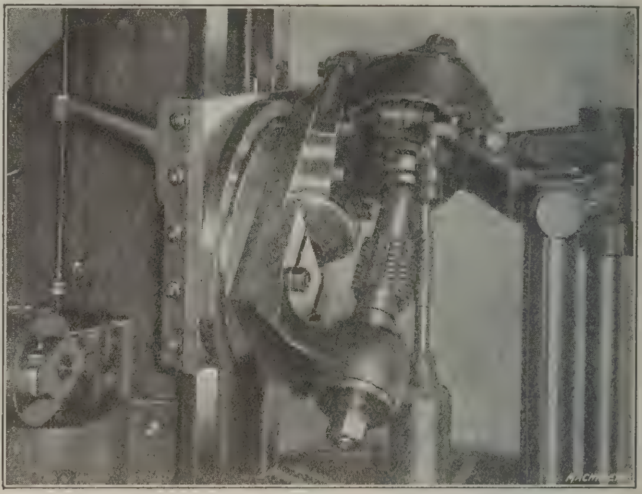


Fig. 4. Hobbing Small Five-threaded Worm on Gear-hobbing Machine

depressed to a cone shape. This conducts all chips and lubricant into a pan in the base of the machine. The lubricant drains out of the pan into a tank below. The pan may be removed easily through the door shown, when necessary. The weight of the machine, complete, is about 3900 pounds.

NIAGARA POWER DOUBLE SEAMER

The machine shown in Fig. 1 of the accompanying illustrations, is made by the Niagara Machine & Tool Works, Buffalo, N. Y., and is especially designed for double-seaming the heads of drums and other sheet-metal packages. The

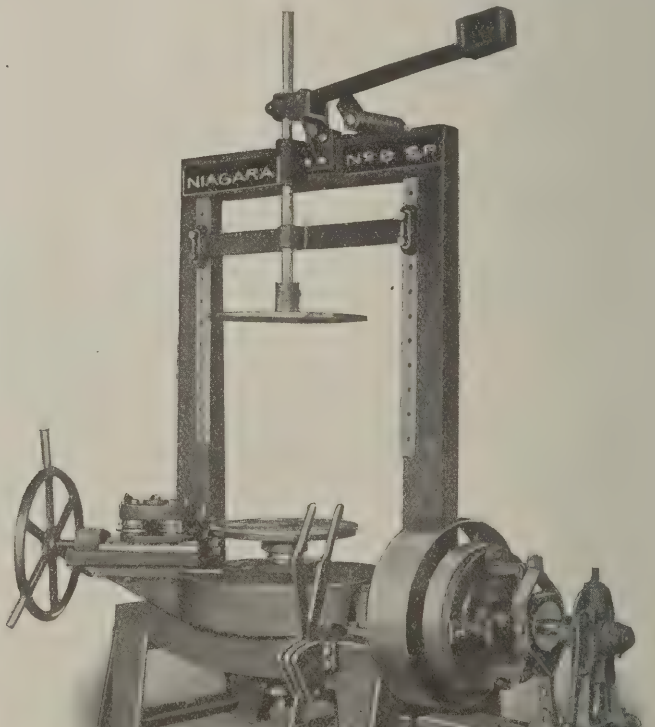


Fig. 1. Niagara Power-driven Double Seaming Machine

heads must be previously stamped to the proper shape by means of a press and dies. The work to be double-seamed is clamped between the top disk and the lower double-seaming chuck, which is shaped to suit the work. The chuck is driven by means of bevel gears, and the spindle carrying the chuck

has an adjustable end thrust bearing. The carriage with the double seaming rolls mounted in a turret head, is actuated by means of a screw and the handwheel shown. Either two or three rolls are used according to the type of the seam and thickness of the material. The motion is controlled by a friction clutch actuated by one of the hand levers seen at the right side of the lower chuck. The other lever is used to bring down the upper clamping plate, which is counterbalanced.

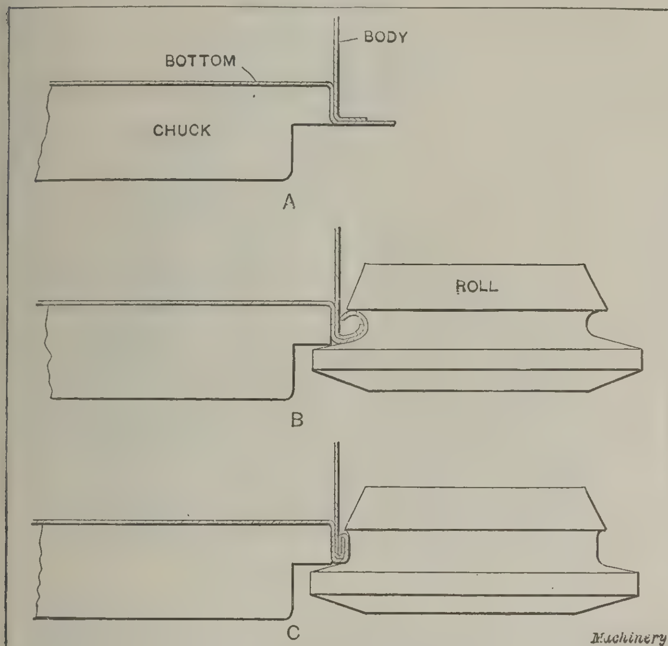
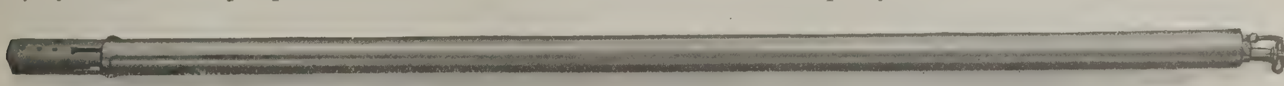


Fig. 2. Forming a Double Seam

The successive steps connected with forming a double seam are illustrated in Fig. 2. The first view at *A* shows the body and bottom of the work assembled and ready for seaming. The first seaming roll is then brought up against the flanges on the work which are turned over as indicated at *B*. The turret is then indexed, thus bringing the finishing roll in position. This roll is then moved in against the work, thus flattening and locking the seam together as indicated at *C*. This seamer has a capacity for work varying from 10 to 32 inches in diameter and not exceeding 45 inches in height.

TURNER HOT BLAST TUBULAR TORCH

The Turner Brass Works, Sycamore, Ill., has designed a hot-blast gasoline torch, which is about five feet long, two inches in diameter and is made of heavy gage brass tubing. This new torch produces a very hot blast flame which is easily controlled by the gasoline valve. There is a powerful burner at one end, and the gasoline valve and pressure pump is located at the other end, as shown in the accompanying illustration. The long tube forming the body contains the gasoline that is delivered to the burner. This tube holds about three quarts. A controlling valve inside the tube regulates the flow of fuel in such a manner that the torch can be used in any position, the flame being pointed up or down, as required. Air pressure for the blast is pumped into the gasoline chamber, the same as in any other torch, by means of a pump at the end of the tube. The flame is about two inches in diameter at the burner and approximately twelve inches long.



Turner Hot-blast, Tubular Gasoline Torch

This torch is intended for foundry use in connection with drying and baking sand molds, and it can also be used for preheating purposes, burning paint (especially on a large scale) thawing out frozen pipes, melting ice, and for heating the ground in advance of general construction work. Other uses for a torch of this form will readily suggest themselves. The weight of the torch is about seven pounds.

UNIVERSAL VISE AND SURFACE TABLE

The vise illustrated in Fig. 1 has a universal adjustment which makes it possible to hold odd-shaped parts, as well as ordinary shapes in the best position for the workman. The swiveling base gives an angular adjustment and the vise can be raised or lowered to the most convenient height. The vise can also be turned about the axis of its supporting column. These various adjustments enable the workman to secure the best light on lines or prick-punch marks indicating finished surfaces, and they also prevent stooping or working in an awkward attitude as is often necessary with the ordinary fixed vise. The vise is rigidly held in any position by a single clamping lever, and when a vertical adjustment is made, the vise is held automatically until the lever is tightened by a locking collar on the stem. These vises are made in four styles and four sizes.

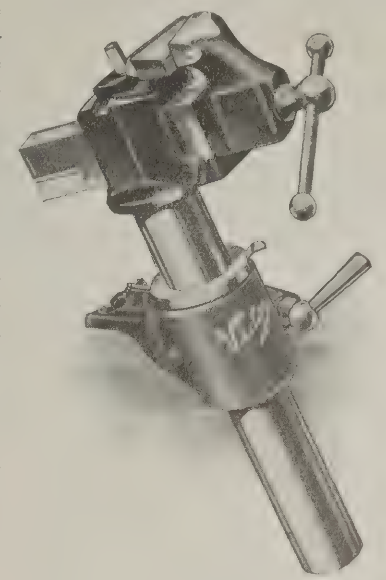


Fig. 1. Vise having Universal Adjustment

An accessory to this vise is illustrated in Fig. 2. This is a surface-table or plate which can be mounted in the base as shown. This plate can also be detached from the stem and used on the bench, the same as an ordinary surface-plate. The sizes of these plates are made to suit individual requirements. These vises and surface tables are the product of the Victor Vise Co., 15-19 W. Washington St., Springfield, O.

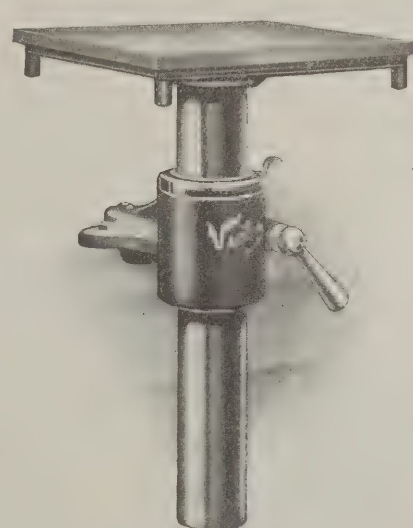


Fig. 2. Surface-table mounted on Vise Base

ROCKFORD HAND MILLING MACHINE

The No. 3 hand milling machine built by the Rockford Milling Machine Co., Rockford, Ill., is now equipped with a power longitudinal feed whenever such a feed is desirable. The arrangement of the feed mechanism is very simple. The power is derived from the rear end of the main spindle, which carries a three-step cone-pulley. This pulley connects by belt with a lower pulley mounted on the end of a universally-jointed shaft which transmits motion, through gearing, to the work-table. By reversing the cone pulleys, six changes of feed can be obtained. This machine has the regular combination screw and lever feed. These two feeds do not interfere, and the change from one to the other can be quickly made. The advantage of this double feed arrangement is obvious. This machine can be used for either horizontal or vertical milling, and, by means of special attachments, it is adapted to a wide range of work. There is a longitudinal power feed of

11 inches, a transverse feed of 4 inches and a vertical movement of $6\frac{1}{4}$ inches. The working surface of the table measures 18 by $4\frac{1}{4}$ inches.

BRADFORD GEARED-HEAD MOTOR-DRIVEN LATHE

The Bradford Tool Co., Cincinnati, O., has brought out a geared-head, motor-driven lathe, which is a departure from conventional designs, as will be seen by referring to Fig. 1. This lathe is designed to eliminate top-heaviness and vibration, and, at the same time, secure a more compact machine by locating the motor as indicated in Fig. 2. The lathe has a mechanical reverse movement and mechanical speed changes which are easily and quickly made. If a constant speed motor is used, eight spindle speeds varying from 12 to 398 revolutions per minute, are available, and an indefinite number of speeds can be obtained by using a $1\frac{1}{2}$ to 1 variable speed motor, having a simple starting and regulating rheostat.

An effort has been made to arrange the speed controlling levers so conveniently that the operator will always use an efficient speed. A selective type, automobile design of speed-box is incorporated in the drive and provides four of the speed changes. The revolutions per minute of the lathe spindle are plainly marked on a plate which shows the four positions of the speed-box lever and the right and left positions of the lever seen on the head. All of the changes are obtained by these two levers, and the speed-box lever is locked automatically when the lathe is running, thereby preventing breakage. The lower gear-box shaft is continued to the left of the gear-box and is in driving connection by means of a pair of gears as well as by a pair of Morse silent chain gears, with a short countershaft driven direct by a pinion on the end of the motor shaft. Either the gear or chain drive is engaged by friction clutch members controlled by the long shifter handle seen above the lathe. This feature enables the lathe to be run forward or backward and also provides an effective brake for stopping quickly when working up to shoulders. A shot-bolt in positive operating connection with the main clutch operating lever, prevents shifting the gears under load. The peripheral speed of the gears is very low. All parts are of easy access, and particular attention has been given to the matter of lubrication.

The head has for its first driver a short shaft carrying a Morse chain-wheel and a gear-wheel, both of which are in driving connection, respectively, with a chain-wheel on the right-hand upper gear-box shaft and a friction-clutch-operated gear on the main spindle. The latter gear is in driving connection with a gear on the back-gear shaft. This shaft also carries another gear which is, in turn, in driving connection back again to the lathe spindle by means of a second positive clutch-operated gear on the spindle. The lever seen on the head is in operative connection with the friction and positive clutches which respectively engage the high- and low-speed gears with the spindle. All supplementary speeds are obtained by the simple regulating rheostat, which is located just below the quick-change gear screw-cutting mechanism.

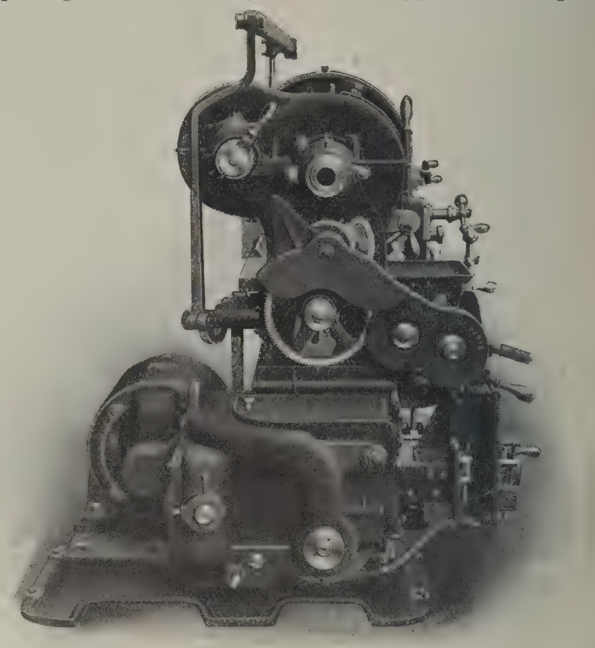


Fig. 2. End View of Bradford Lathe showing Location of Motor

The quick-change gear device is of the well-known Bradford type and enables the cutting of all standard and pipe threads, including $11\frac{1}{2}$ per inch. The gears are of forged steel, and ordinary change gears can be used direct between the spindle and lead-screw for cutting any odd thread. An automatic stop for the longitudinal feeds is provided regularly. The apron is equipped with a thread indicator and chasing dial, the worm-wheel of which can be disengaged from the lead-screw by a cam and knurled knob, thus avoiding unnecessary wear. All exposed gears are carefully guarded as the illustrations show, thus protecting both the operator and machine.

The spindle is made from high carbon crucible steel and it is mounted in adjustable, taper, bronze bearings. The bed

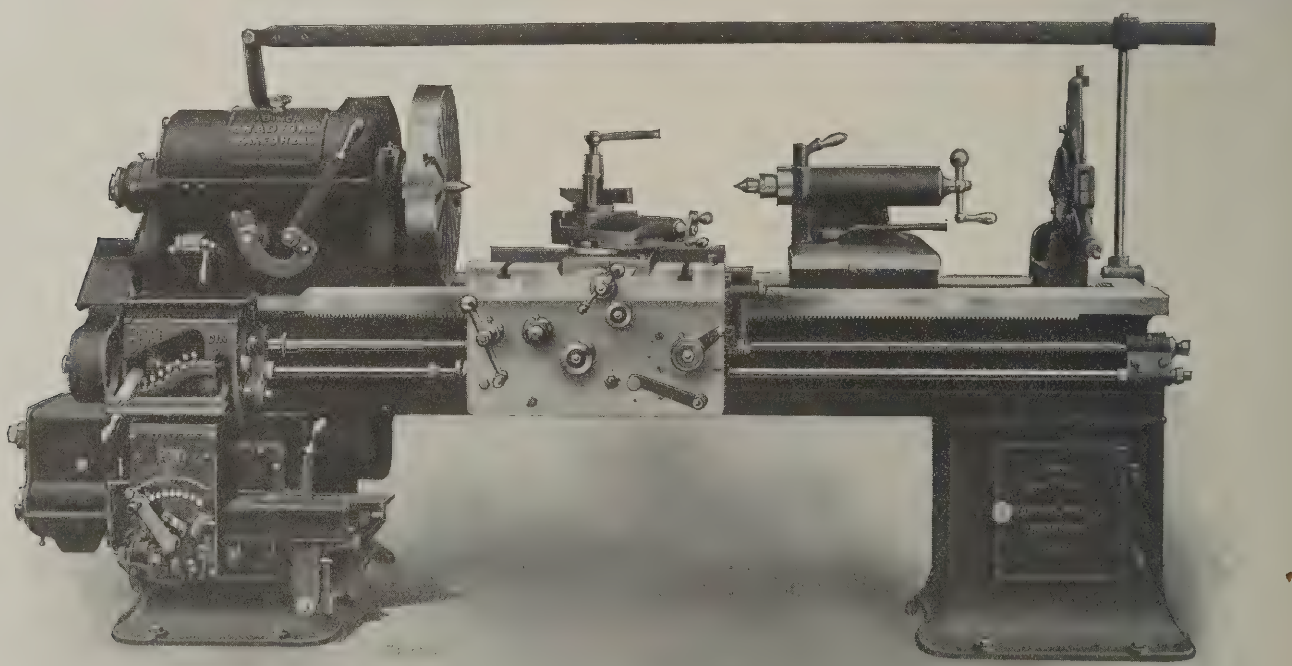


Fig. 1. Bradford Geared-head Motor-driven Lathe

is of extra weight and depth and is webbed in two-foot sections. The carriage has a full bearing on the vees its entire length and is gibbed front and back. The apron is of the double-plate pattern and has a non-interfering device to prevent the feed-rod and lead-screw from being engaged simultaneously. The pinions and studs are of high-grade steel, hardened and ground. The feeds cover a wide range and they are all positive geared. This lathe can also be arranged for a single-pulley drive instead of a motor drive. If a two-speed countershaft is used in conjunction with the selective speed-box and geared head, sixteen forward speeds may be obtained. The drive can be direct from the lineshaft if the latter is suitably located. The motor-driven and single-pulley lathes are made in 18-inch heavy pattern, 22- and 26-inch sizes.

HENDEY RELIEVING ATTACHMENT

The Hendey Machine Co., Torrington, Conn., has brought out an improved form of relieving attachment which can be used to relieve hobs or taps having spiral flutes. This new attachment can also be employed for relieving any of the work for which the design formerly built is adapted. The advantage of the spiral flute is that it gives a cutting edge that is square with the body of the tooth, which is conducive to better and faster cutting. This attachment is shown applied to a lathe in Fig. 1.

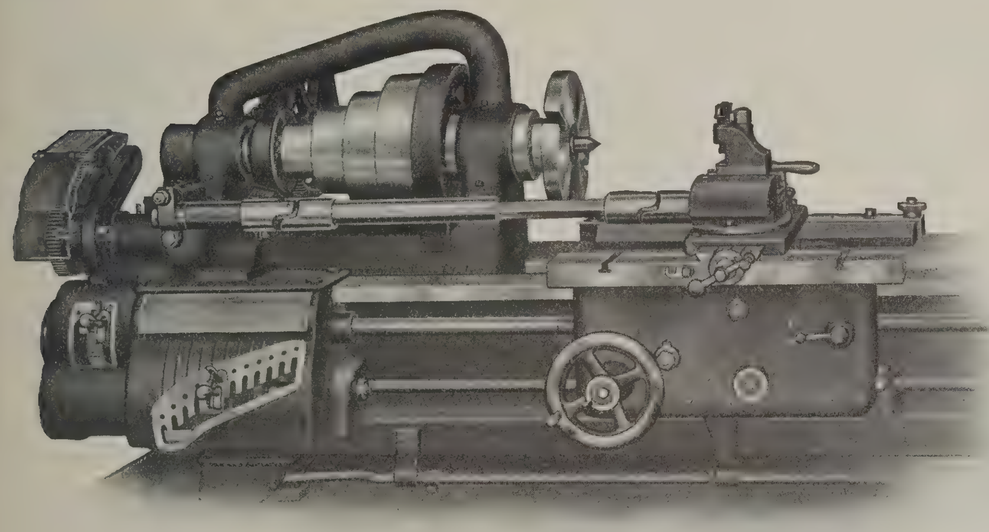


Fig. 1. Hendey Relieving Attachment applied to Lathe

The actuating mechanism is mounted on the main gear-box, the tool pan or cover of which is removed. The tool-slide interchanges with the compound or other rest on top of the cross-slide, and it can be swiveled to different angular positions for side and end relief work, as will be explained later. The mounting of the complete attachment requires but a few minutes. The amount of relief can be varied in a simple and easy manner, by means of a toothed coupling at the ends of the oscillating shaft and cam-lever, which permits the relative position of the eccentric on the tool-slide and the cam-lever to be changed, thereby lengthening or shortening the reciprocating travel of the tool. This adjustment gives the tool-slide a movement varying from zero to 5/32 inch on the 14-, 16- and 18-inch lathes, and the movement is increased to 3/16 inch on the 20-inch lathe, and to 1/4 inch on the 24-inch size.

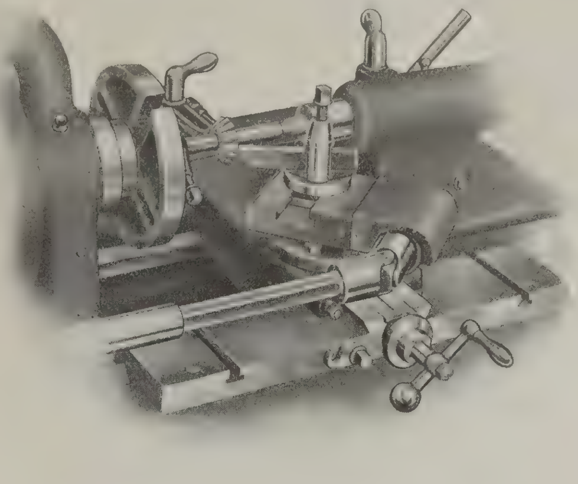


Fig. 3. Relieving Sides of Angular Cutter

If a hob or tap having spiral flutes is to be relieved with this attachment, the pitch of the spiral and the gears necessary to drive the attachment, are first determined. After the attachment is geared to suit the spiral and number of flutes, the lead-screw is engaged and the backing-off operation is performed the same as for straight flutes. The lead-screw should not be disengaged but the carriage is reversed by power, the lever at the right of the apron being used for that purpose. When determining the pitch of the spiral, it should be remembered that quite a variation in length can be made without any serious drawback. Fig. 2 shows the attachment relieving a spirally fluted hob.

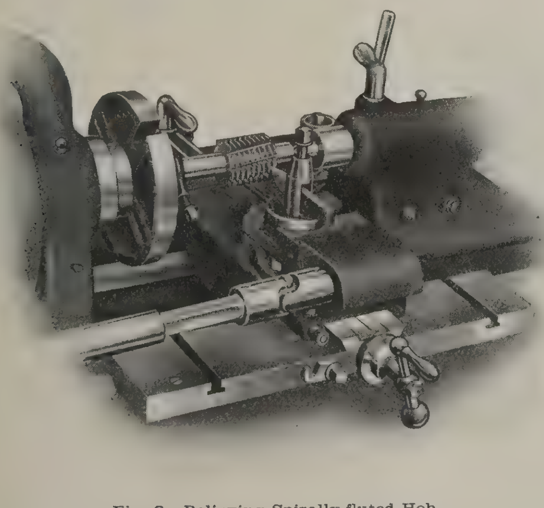


Fig. 2 Relieving Spirally-fluted Hob

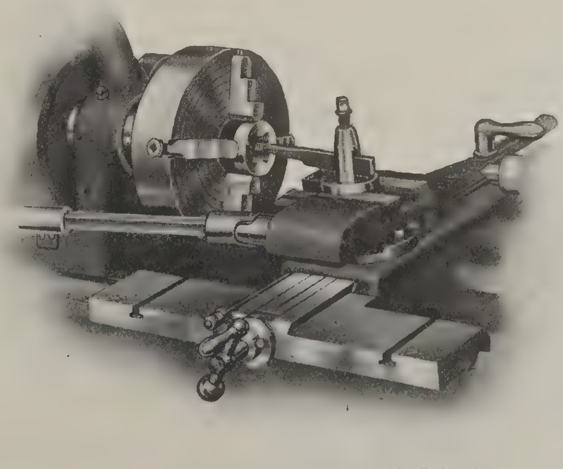


Fig. 4. Attachment arranged for Inside Relieving

Fig. 3 shows the method of relieving the side of an angular cutter. This application is made possible by means of the swiveling tool-slide which enables the tool to be placed in the

proper position. By the use of an additional universal joint and bearing to permit the tool-slide to be swung to a 90-degree angle, counterbores can be relieved as indicated in Fig. 5.

When the attachment is used for relieving inside work such as hollow mills and threading dies, the eccentric which controls the travel of the tool-slide is set so that the relieving movement is away from the axis of the cutter instead of toward it. This change is made by the toothed coupling connecting the cam lever and oscillating shaft, the latter being turned beyond the zero mark in a clockwise direction as far

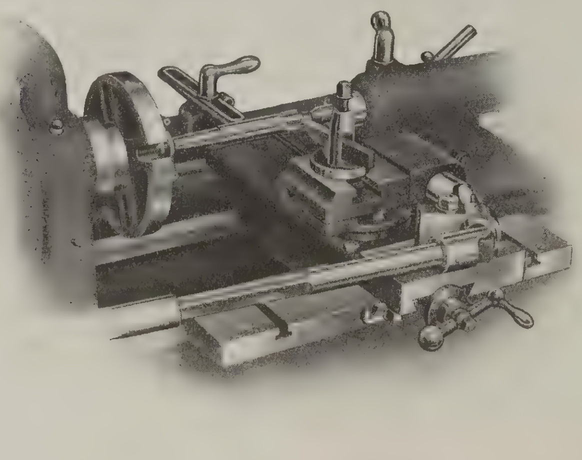


Fig. 5. Relieving a Counterbore

as is necessary to get the desired amount of travel. It is also necessary, for internal work, to change the position of the opposing spring in the tool-slide, so that it will press against the end of the slide and prevent the tool from "jumping" into the work. Fig. 4 shows an example of internal work.

When relieving a right-hand tap, the ordinary practice is to first set the tool as for cutting a thread. The tool is then accurately set with reference to the thread space by rolling

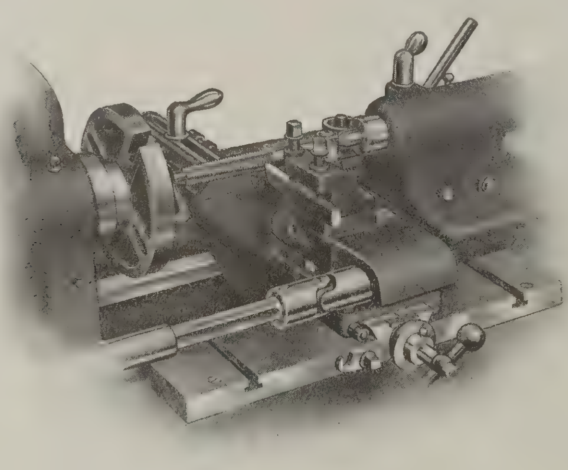


Fig. 6. Relieving Left-hand Tap having Spiral Flutes

the work in the dog or by disengaging the gears in the gear-box. The motion of the tool-slide is then adjusted so that the forward movement of the tool will meet the front of the tooth and the return movement begin promptly after leaving the end.

Left-hand taps can be relieved by two different methods. By the first, the cut is started at the cutting edge and ends at the "heel," and by the second, the start is made at the heel and discontinues at the cutting edge, the tool being drawn out from the work during the cut. When the first method is employed, the tap is placed with the point towards the headstock spindle and the shank end is supported by the tail-center as indicated in Fig. 5. An extension or blank end long enough to take the driving dog, is provided at the point of the tap. With the second method, the tap is held between the centers the same as a right-hand tap, but the travel of the tool-slide is set as for inside relief. As will be recalled, the necessary adjustment is made by the toothed coupling, and the opposing spring, in this case, is left in the same position as for right-hand work.

When work is being relieved, it should be revolved much more slowly than when turning, to give the tool-slide time to operate properly. A maximum of 180 teeth per minute is recommended, and if wide forming tools are used, the speed may be reduced to as low as 8 teeth per minute. It is also essential to use tools having a keen edge, and the tool-slide should work freely but without undue looseness. After a cutter has been formed, it is a good plan to color it either by heating or dipping it in a strong solution of copper sulphate. The operator can then plainly see the work done by the relieving tool and stop at the proper time. Re-milling after the backing-off operation, insures a sharp edge and reduces the amount of grinding necessary after the cutter is hardened.

D. & W. FUSE CO.'S MAGNETIC CHUCKS

As a labor saver, there is probably no form of electrical device which has proved of greater benefit in the machine shop and tool-room than the magnetic chuck. When a large number of pieces are to be machined, the time and labor saved by the use of a magnetic chuck, as compared with the old methods of clamping, or holding one piece at a time in a vise, will often pay for a chuck within a short time. Magnetic chucks of the flat and rotary types now being manufactured by the D. & W. Fuse Co., Providence, R. I., are illustrated in Figs. 1 and 2.

The flat chucks (see Fig. 1) have a horizontal face and are

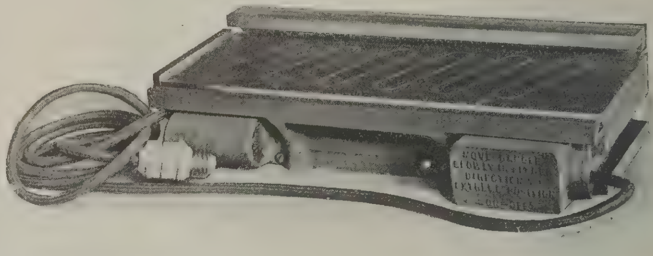


Fig. 1. Magnetic Chuck of Flat Type, built by D. & W. Fuse Co.

equipped with adjustable end and side stops, providing convenient means for locating and steadying the work. This form is particularly useful for holding such work as file blanks, scale blanks, thickness gages, punches, dies, accurate shims, gibs, or practically any part on which it is necessary to grind flat surfaces. Milling operations can also be performed with great facility, if the shape of the work is such that the end stop of the chuck can be raised to take part of the thrust. When used in this way, the smallest flat chuck built by this company will hold a 1- by 2- by 6-inch bar of tool steel, tightly enough to permit milling 0.050 inch from a surface 2 inches wide, and with a feed of 1 inch per minute. This chuck is also useful for holding stock requiring light planing and shaping operations.

The rotary chucks have been used effectively in plants manufacturing ball and roller bearings, for holding ball races dur-

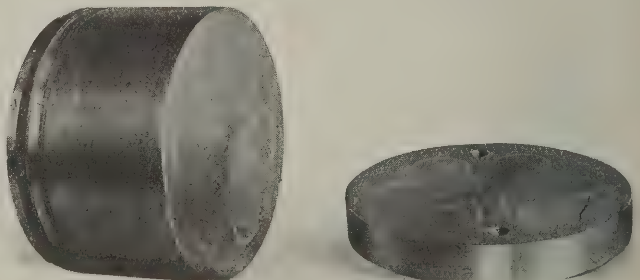


Fig. 2. Rotary Magnetic Chuck and Auxiliary Plate

ing the grinding operations. Rotary chucks are also used for holding pistons and piston rings which must be accurately ground. The rotary chuck illustrated in Fig. 2 is equipped with an auxiliary plate.

This company also manufactures vertical chucks which have a perpendicular holding face when clamped to a horizontal machine platen. They are especially adapted for grinders having a cup-wheel mounted on a horizontal spindle. The chuck proper

is similar to the flat type. The magnet coils of these chucks are wound with "Deltabeston" wire, having a special heat-proof insulation of pure asbestos. This insulation can safely withstand temperatures as high as 400 degrees F. In addition, the coils are wound by a special process which still further protects them from heat and moisture. This construction prevents burning out of the magnet coils when subjected to variations of voltage, moisture or prolonged service. The coils are rigid units which are interchangeable, and the arrangement of the chuck is such that they can be replaced readily. Auxiliary plates, which are made to fit these chucks, are used as jigs or fixtures for holding special pieces of irregular shape. By means of these plates, one chuck can be made to cover a wide range of operations, as any number of plates can be used.

Both the flat and vertical chucks have their ends machined true so that several of them can be lined up end-to-end for holding long work, or for machining many small parts at one operation. This feature permits the units to be used separately on different machines, or to be assembled into one long chuck controlled by a single switch. With the exception of the smaller sizes, the chucks are designed for use on direct-current circuits of 105 to 125 volts. If it is desirable or necessary to energize them on circuits of higher voltages, such as 210 to 250 volts, or even 550 volts, a convenient form of auxiliary resistance is supplied, which can be inserted at any suitable point in the circuit. The small chucks are equipped with standard external resistance units for use on 105- to 125-volt direct-current circuits.

The chucks are both oilproof and waterproof and are equipped with demagnetizing switches for readily releasing the work. When possible, a special switch is used, which is attached directly to the chuck. This switch, by a simple movement of the hand, automatically and positively demagnetizes the chuck. Where it is not practicable to mount this device on the side of the chuck, an independent control base is provided on which is mounted a knife switch with the demagnetizing unit. When the switches are mounted directly on the chucks, they are entirely enclosed in water-tight iron boxes. This affords thorough mechanical protection and serves to keep emery dust from cutting out the moving parts. Magnetic chucks can only be operated on direct-current circuits, and under no conditions can alternating currents be used. Where direct current is not available, direct-current generators are supplied.

REMINGTON GRINDING ATTACHMENTS

The external grinding attachment illustrated in Fig. 1 is for bench lathes and is of rigid design with a capacity for grinding wheels 4 inches in diameter and ½ inch face width. The grinding head may be removed and a head for internal grinding substituted if desired. The spindle of the internal grinding attachment is capable of speeds up to 30,000 revolutions per minute. The circular swivel base is graduated in degrees for grinding taper work. The lever movement is novel in that it is adjustable for quick short strokes, as well as for longer strokes. The method of making this adjustment is clearly shown by the illustration. There is a cross-movement of 7 inches from the center. The small lever just above the micrometer feed-screw, serves to release the feed so that the grinding head may be quickly moved to or from the work by means of a rack and pinion actuated by a lever. This feature facilitates the fitting of gages and replacing of the work. The grinding wheel is covered and is provided with an adjustable tube to direct the flow of water for wet grinding.

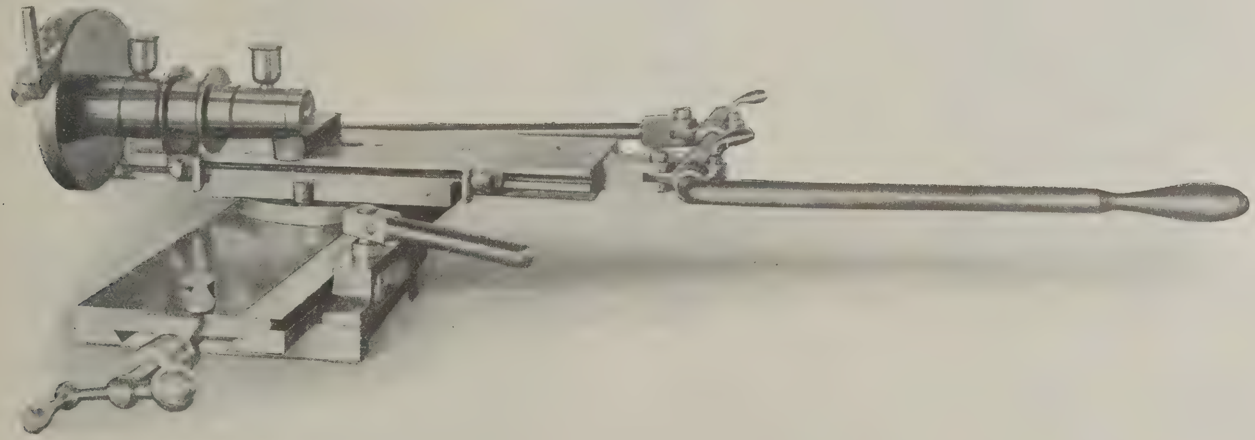


Fig. 1. Remington External Grinding Attachment for Bench Lathes

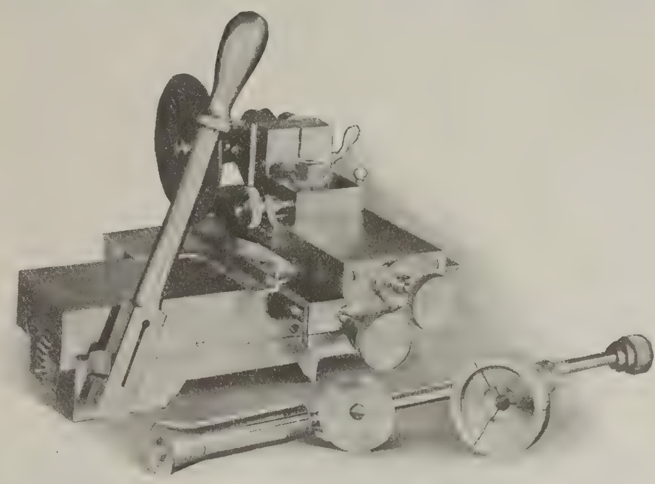


Fig. 2. Another Remington Grinding Attachment

Fig. 2 shows another external grinding attachment for bench lathes, which can be used in connection with the grinding of irregular forms without the necessity of re-setting the work for different angles. This attachment is particularly adapted to grinding hardened steel paper cutters. The illustration shows a paper cutter which has been ground on the plane, concave and bevel sides at one setting. Fine adjustments are provided throughout, both for setting the wheel and to compensate for wear. The circular swivel base is graduated in degrees for obtaining different angular adjustments.

Both of these attachments are recent developments of the Remington Tool & Machine Co., Woburn, Mass., and are designed to be used with the bench lathes manufactured by this company.

CHAMBERSBURG BOARD DROP HAMMERS

A new line of board drop hammers made in capacities from 400 pounds to 3000 pounds falling weights has recently been brought out by the Chambersburg Engineering Co., Chambersburg, Pa. A hammer of the new design is shown in the accompanying three engravings, illustrating the front, side and back views, respectively. The principal features of the new design are the manner of adjustment for lining up the dies, the manner in which the front rod is lifted up into place, and the knock-off construction. All the features incorporated have been subjected to most rigid and exacting tests in regular service.

The head or lifter is securely held in place on the top of the frames, by four through bolts, which pass through drilled

holes and which have spiral springs to absorb shock. The rolls are furnished either plain or geared, as desired. Together with their driving spindles they are located in hooded eccentrics—the front eccentric being used for operating, while the rear eccentric is for adjustment only. These eccentrics are made from steel castings, in one piece, this method insuring exact alignment. Provisions are made for preventing oil getting onto the rolls where they bear against the boards. The spindle bearings are made of ample size; they are bronze bushed and provided with oil reservoirs.

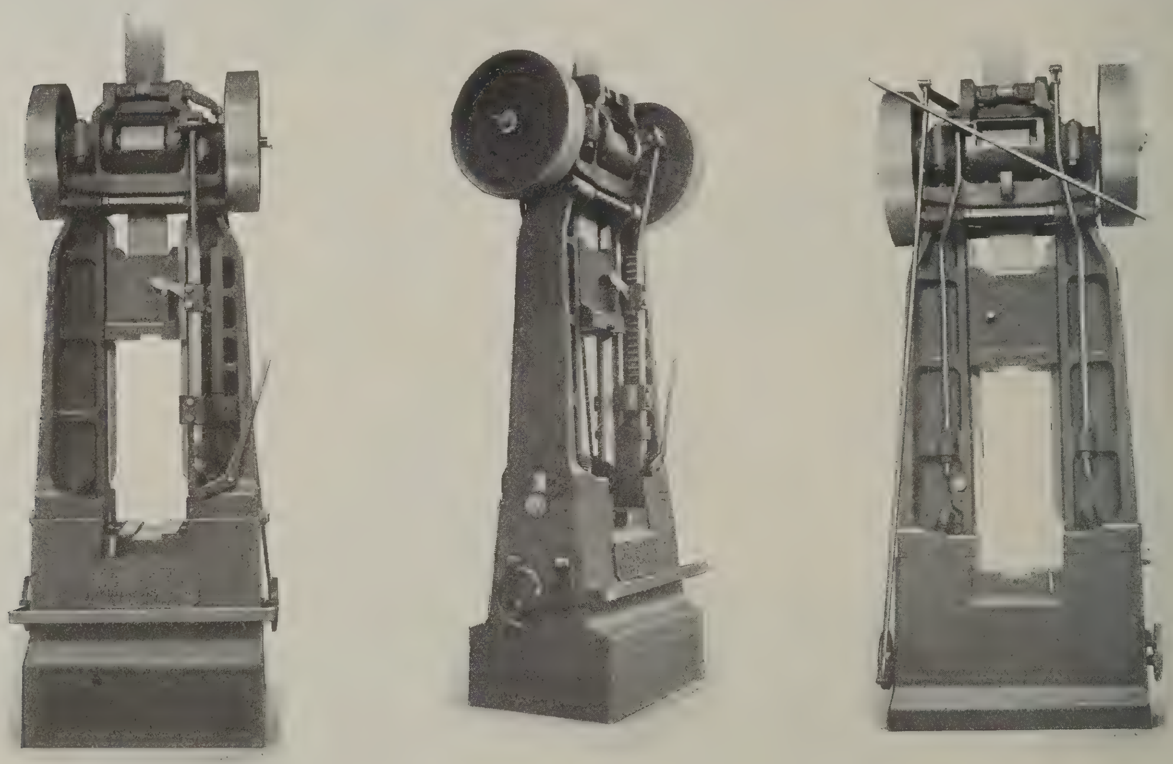
The board clamps are located at the extreme top on double eccentrics. A permanent alignment of both rolls and board clamps is insured, even if the operator is careless. When the ram is suspended the board is so gripped that it hangs free of both rolls. The board clamps are so designed that they will grip instantly the heaviest rams in any position without sliding, even if the board is badly worn. When the treadle is fully depressed, the board falls freely, no matter how worn it is at the point of pick-up. The trouble of drag through the clamps just before the blow is struck, which is a common difficulty, is thus overcome.

The adjustments necessary to the back roll and board clamp to take up the wear of the board, are quickly made from the floor by means of adjusting bars led down the back of the machine to within easy reach of the operator, as shown in the rear view of the hammer, Fig. 3. Adjustments can be made for wear of the board up to 7/16 inch. The pulleys may be either Rockwood compressed paper pulleys, or pressed steel pulleys, as desired.

The frames are of reinforced I-beam section to withstand the heavy strains imposed on them in "break-down" work. They are about 2 feet shorter than is the general standard, although the extreme fall of the ram is greater than the average. This feature of design insures greater rigidity. The frames are free from cores, and are of uniform section throughout. They are deeply pocketed in the anvil, having a bearing on their outside edges for the entire length of the tongue, and also bearing on the entire bottom surface, thus insuring satisfactory and permanent alignment of the frames and ram. The tops of the frames are tongued and fitted to the lifter head. The frames are spaced, and held in line with the lifting rolls, by steel tie-bolts with distance pieces. The bearing surface of the V-guides has been made especially large, so as to provide amply for wear.

The frame adjustment to align the top and bottom dies is made by large tension bolts, the construction being such that in case of fracture the bolts can be passed out into the die space and quickly replaced without dismantling the machine. In the usual construction it is necessary to dismantle the entire superstructure to make such repairs. The bolts are supported for their whole length in bored holes. Lock washers are provided to positively hold the adjusting nuts in any position. The frames are designed for the minimum adjustment of 0.0026 inch. The ram or hammer is of 40-point carbon open hearth steel, properly balanced, and made deep enough from front to back to insure the alignment of the dies. The lifting boards are of well seasoned maple, let into the ram and secured by an under-cut plate with teeth on one side so as to enable the use of a straight board, and at the same time prevent the board from pulling out.

The anvil is made of cast iron in one piece, and the anvil cap is made from 40-point carbon open hearth steel. Anvils weighing from fifteen to twenty times the rated falling weight of the ram can be furnished, and can be made of steel, if desired. The anvil is secured to the frames by four bolts, spiral springs being provided to reduce the shock. These bolts are set at a slight angle in order to locate the pocket for the bolt head on the compression side of the anvil, so as to prevent the possibility of breakage due to bolt-head pockets on the tension side.



Figs. 1 to 3. Front, Side and Rear Views of Board Drop Hammer built by Chambersburg Engineering Co.

The front rod lever has a safety stop, which will positively prevent accidents while adjusting dies, etc., as it automatically drops and locks the front rod release when the hammer is not in use, or when the operator is adjusting the dies. This provision prevents many accidents that occur from this source. As indicated in the engravings, the foot treadle does not extend across the back of the anvil, but leaves this space free for forgings.

The stroke is adjusted by means of a rack and segment lever, and the adjustment can be quickly and easily made. The front rod, due to the eccentric construction, is practically straight, and is lifted up into place without the usual shock and jar, as the releasing lever is rolled along in the rack, and gives the front rod a direct and gradual "pick-up." The adjustment for various heights of dies is made by means of a knock-off, clamped to the lower part of the front rod, this adjustment allowing the use of any thickness of dies. The incline for the knock-off is so laid out that no impact is imparted to the front rod. The breakage of the front rod, due to crystallization, which has been a constant source of trouble in this

class of machines, is thus obviated. This design permits the hammer to run at a higher speed than is ordinarily used, thus increasing the output.

RELIANCE SPEED DIAL FOR MACHINE TOOLS

As the output of a machine tool depends to a great extent on the use of the most efficient cutting speed, it is very important to have some accurate method by which the operator can easily adjust the driving mechanism, so as to obtain the prescribed speeds for the cutting tool under different conditions. When the speed changes are effected by means of cone-pulleys or gears, the spindle has a definite number of revolutions per minute and the speed for different gear combinations is usually shown on a plate attached to the machine. It is a comparatively easy matter to embody in a blueprint specified instructions showing the step of the cone-pulley, or the gear combination, which will give the most efficient speed for each operation to be performed. With an individual adjustable-speed motor drive, the number of speed changes is, of course, greatly increased and it is more difficult to indicate the proper combination for a given cutting speed. Consequently, the speed adjustment is usually a matter of guesswork, with the result that the efficiency of a given machine depends largely on the judgment of the operator.

The Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, O., has developed a speed dial which enables the operator to obtain the required cutting speed under different conditions. This dial is calibrated for use with the Reliance adjustable-speed motors, and can be applied to shapers, drills, lathes, milling machines, boring mills or any machine tool having speed variations. The Reliance adjustable-speed motor is of the armature shifting type and has an infinite number of gradual speed changes, so that it is always possible to obtain a given cutting speed, provided the operator has some means of accurately adjusting the speed of the motor in accordance with the cutting speed required. The function of this speed dial, one form of which is illustrated in Fig. 1, is to

Fig. 1. Reliance Speed Dial for obtaining Proper Cutting Speed—This Particular Dial is intended for a Back-geared Crank-shaper

enable the proper adjustment of the motor to be made. The dial can be mounted on the machine at any convenient place and it is simply necessary to provide a positive connection with the means employed for shifting the armature of the motor. Fig. 2 shows one of these dials applied to a drilling machine. As the illustration shows, positive connection is made with the motor by a chain and sprockets. The upper sprocket is mounted on a shaft carrying a handwheel which is used in making the adjustments. As the armature of the motor is shifted and a gradual change in speed is obtained, a pointer moves on the speed dial and shows what adjustment must be made to obtain the desired cutting speed. The scales on the dial are, of course, graduated differently for different types of machines, and take into account the different gear ratios between the driving motor and the cutting tool. Therefore it will be seen that this speed dial is not a means of indicating the speed at which the motor is running, but is an automatic calculator which enables the operator to quickly adjust the motor speed so as to obtain any desired speed at the cutting tool and, as previously stated, the dial is arranged to take care of all the variable factors which would affect the problem. All the operator has to do is to set the dial for the

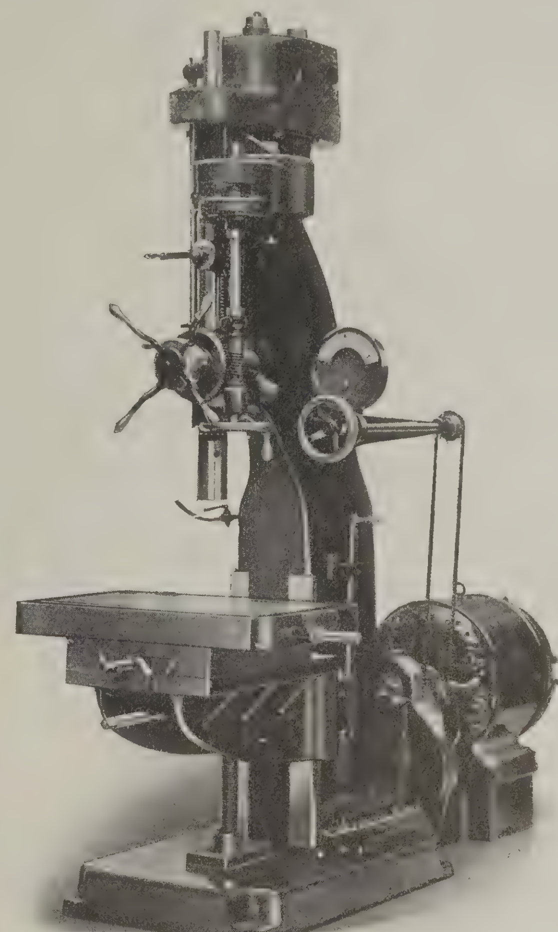


Fig. 2. Foote-Burt Drilling Machine equipped with Speed Dial which is positively connected to Reliance Adjustable Speed Motor

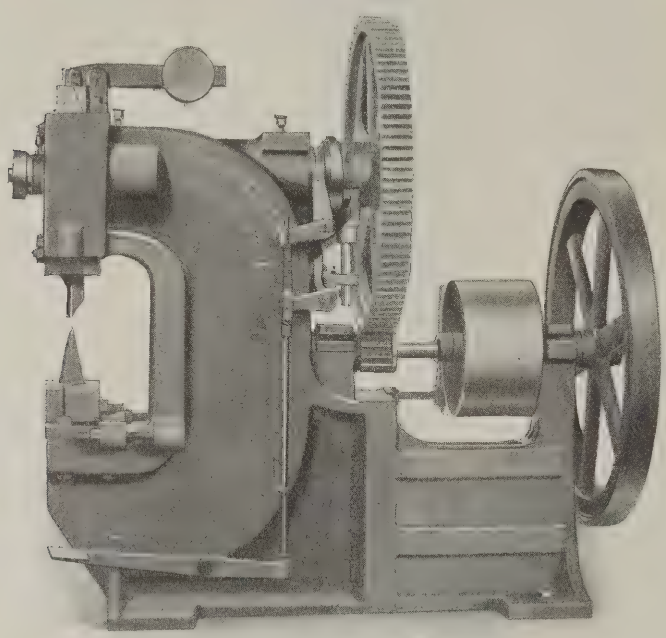
cutting speed required and then shift the armature of the motor, in the usual manner, until a pointer indicates the diameter of the cut to be taken (in the case of lathe work) on the proper scale for the gear combination used.

The particular dial illustrated in Fig. 1 is intended for use on a crank-shaper. This dial has an upper scale which shows the cutting speed in feet per minute, and two lower scales indicating inches of stroke. The upper scale for the stroke is used when the back-gears of the shaper are engaged, and the bottom scale is used when the back-gears are out and the drive is direct. The scale showing the cutting speed in feet per minute, is stationary and the small pointer seen opposite figure 40, is mounted on revolving disks with the two lower scales. When mounted on revolving disks with the two lower scales. When the shaper is to be set for a given cutting speed, the lower scales and the pointer referred to, are turned, by means of the small knurl seen just below the center of the dial, until the pointer is oposite the desired cutting speed. The armature of the motor is then shifted by turning the handwheel seen in Fig. 1, until the pointer over the lower scales (which is geared to the handwheel rod) is opposite the stroke to be used. Of course when making this adjustment, the operator uses the lowest scale if the back-gears are out, and the one above it if the back-gears are in mesh. The illustration shows the dial set for a cutting speed of 40 feet, with a stroke of 20 inches, and the back-gears engaged. It should be remembered that the cutting speed of a crank-shaper depends on the length of

the stroke for a given motor speed, and that is why the scales are graduated for the different lengths of stroke. The convenience and advantage of this dial and its effect on the efficiency of a tool, are obvious. It not only serves as a guide in setting the speed accurately, but is always in plain sight so that the foreman can see what speeds are being used.

WHITING GEARED SPRUE CUTTER

A geared sprue cutter recently designed and built by the George Whiting Co., 1701 Elston Ave., Chicago, Ill., for use in steel foundries, is illustrated herewith. The knives on the particular machine illustrated are intended for cutting off risers, gates and sprues up to the capacity of the machine, but if desired, an extra pair of cutters can be furnished for



Geared Sprue Cutter for Steel Foundries

trimming light fins from steel castings. These cutters are made so that the cutting edges come as close to the casting as practicable. The knives can be set either at right angles to the throat or with the cutting edges parallel to the throat.

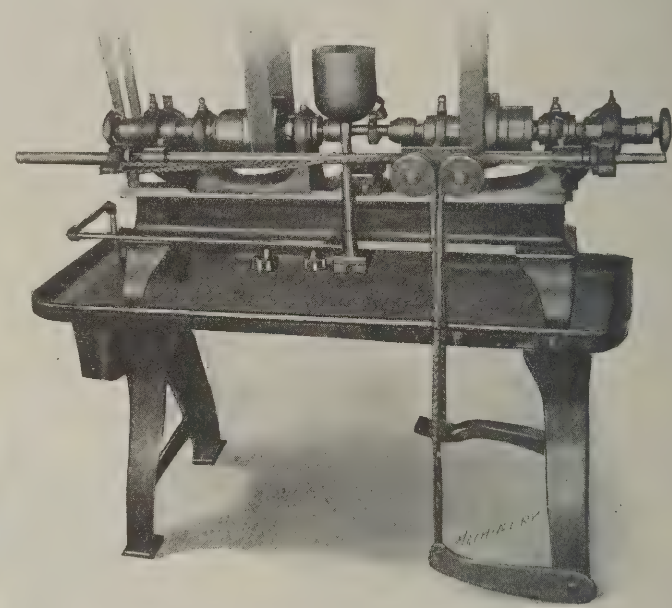
This machine is fitted with an automatic stop and is equipped with tight and loose pulleys. The large flywheel at the rear is crowned for a belt in case a motor drive is desired, and provision is made for attaching a motor directly to the machine. There are means of compensating for the wear of the lower blade, and the knives have been designed so that they can be re-ground economically and, at the same time, have serviceable edges for general work.

The machine is made in different capacities and either with or without the geared drive. The geared type runs about thirty strokes per minute and the quick-acting machine makes about ninety strokes per minute. The lower block which holds the cutter, is provided with an adjustment for aligning the blades to secure accurate cuts. The upper head can also be adjusted vertically for setting the top cutter in the proper position. This machine is designed to enable the operator to work as close to the casting as possible.

DUPLEX DRILLING AND COUNTERBORING MACHINE

A special drilling and counterboring machine built by the F. E. Wells & Son Co., Greenfield, Mass., is shown in the accompanying illustration. This machine operates on both sides of the work simultaneously, by means of opposed horizontal spindles. The particular machine illustrated is used for drilling and counterboring wrench parts. One spindle carries a combination drill and counterbore and the opposite spindle a counterbore only, so that a hole is drilled through the work and counterbored on each side.

The construction of the machine is very simple as the illustration indicates. The two spindles are moved toward each other by means of a foot-treadle. This treadle is connected

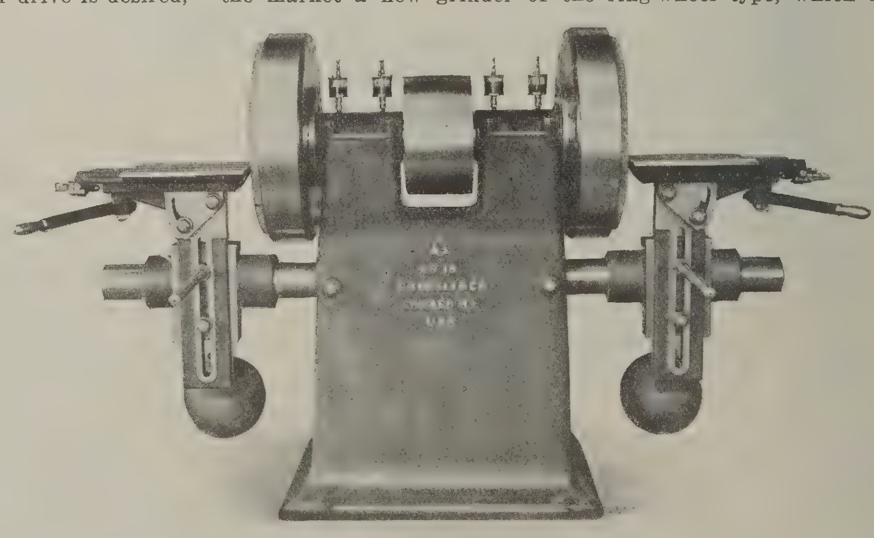


Drilling and Counterboring Machine

with the spindles by chains which pass over sheaves and are attached to arms connecting with the spindles. A guide rod at the rear of the machine takes up the torsional strain on the spindles when the drilling and counterboring tools are at work. Stops are provided for limiting the depth of the drilling and counterboring. When operating the machine, it is simply necessary to hold the work in position and apply foot pressure to the treadle for feeding the spindles. A drip tank is provided for supplying a cooling compound to the tools when machining steel or other metals requiring a coolant.

BESLY RING-WHEEL GRINDER

Charles H. Besly & Co., Chicago, Ill., have recently placed on the market a new grinder of the ring-wheel type, which is



Large Ring-wheel Grinder built by Charles H. Besly & Co.

heavier and more powerful than any grinder heretofore built by this company. This machine, which is illustrated herewith, is equipped with two, geared lever-feed work-tables and two pressed steel ring-wheel chucks holding ring or cylinder grinding wheels 24 inches in diameter. This grinder is intended for larger and rougher work than is ordinarily done on disk grinders. The vitrified grinding rings naturally will stand

more severe service than the emery-cloth-covered steel disk wheels. The design is massive and rigid, and the machine, as illustrated, weighs over 3500 pounds.

The geared lever-feed table weighs about 600 pounds and has a leverage of 18 to 1. The spindle pulley is 15 inches in diameter. It will take an 8-inch belt and transmits over 30 horsepower. The spindle is 3¼ inches in diameter and each bearing is 12 inches long. The rockershaft is 4½ inches in diameter and 7 feet long. The end thrust is taken on hardened and ground collars of over 20 square inches area. Each pressed steel ring-wheel chuck weighs 275 pounds and with a new grinding ring in place, weighs 415 pounds. A new grinding ring is 24 inches in diameter, 5 inches deep and has an 11-inch hole.

This machine will rough 1/16 inch stock from the bottom of a sad iron casting in about ten seconds, and the feeding pressure on the surface being ground is approximately 100 pounds per square inch of area. On a machine of this type, with hand-lever feed, the ratio of the leverage (18 to 1) is an important feature as it enables the workman, without undue exertion, to put sufficient pressure on the work to secure the maximum efficiency of the grinder. This large ratio of leverage is obtained through a gear and rack with a lever only 20 inches long. This geared motion gives the necessary table travel with a maximum ratio of leverage for the length of lever used. A longer lever would not be convenient for the workman. The lever is clamped to the pinion stud, and its position, relative to the stud, may be changed to suit the convenience of the operator.

RECENT DEVELOPMENTS IN LARGE PRESSES

A few years ago presses having more than two cranks and measuring over four or five feet between the housings, were rarely built, but at present the multiple-crank type having three or four cranks and varying in width from three to ten feet between the housings, is quite common. The accompanying engravings show several different types of large presses that have recently been built by the E. W. Bliss Co., 17 Adams St., Brooklyn, N. Y.

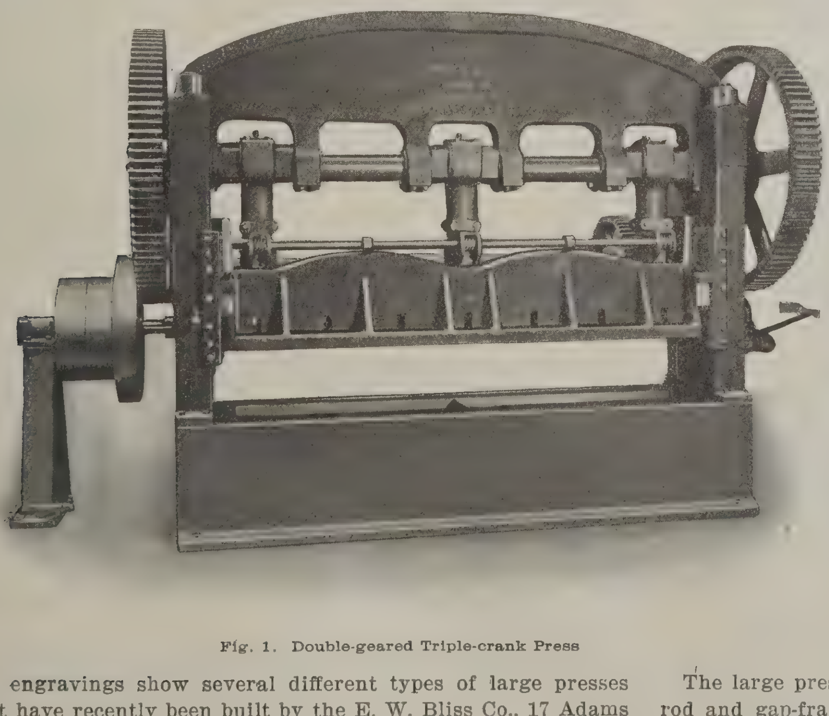


Fig. 1. Double-geared Triple-crank Press

Fig. 1 shows a multiple press having a triple crank. This machine has a width of 11 feet between the housings and a slide movement of 4 inches. Owing to the great width, it is equipped with a twin drive, a driving gear being mounted on each end of the crankshaft. This method of driving reduces the torsional strain on the crankshaft and also equalizes the pressure on the journals and gears. The action of this press is controlled by a hand-operated friction clutch. The flywheel is 40 inches in diameter and has a 6-inch face. The total weight of the machine is 59,000 pounds.

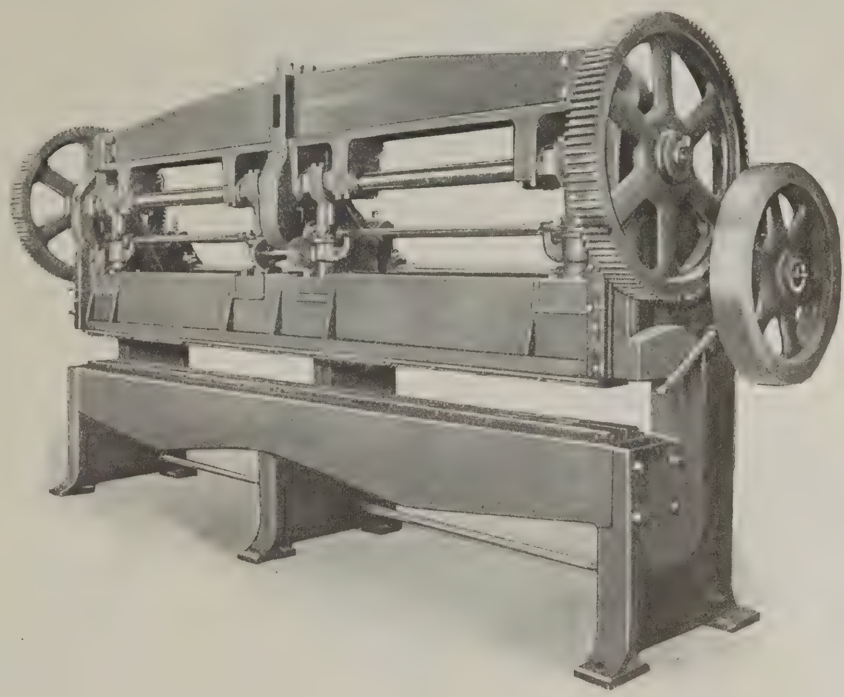


Fig. 2. Four-crank Press having Width of 14 Feet between Housings

A four-crank press is illustrated in Fig. 2. The capacity of this machine is comparatively small. but it is extremely wide, the width between the outer housings being 14 feet. The construction is of the built-up frame type with gap or overhanging housings. This press also has the twin drive, and the ratio of the gearing is 15 to 1. The crankshaft is 4 inches in diameter and has a 2-inch stroke. The flywheel weighs 600 pounds, and the weight of the complete machine is 25,000 pounds.

Fig. 3 shows a rear view of a large double-crank press. It usually takes from two to four men to operate large presses of this type, and, ordinarily, it is necessary to have at least one man back of the machine to handle the work. This is a dangerous position when the gearing is exposed and low enough to come within the workman's reach. For this reason all the large presses built by the E. W. Bliss Co. have the gearing mounted on the housings above the crankshaft, as shown in Fig. 3. With this arrangement of the driving shaft, the gearing is above the operator's head, where it is entirely out of the way. This machine and also the one illustrated in Fig. 1 are commonly known as the straight-sided, tie-rod type. The bed and crown are each a separate casting, and all the strain is taken by steel tie-rods which pass through the side housings so that the latter simply act as a guide for the slide. Machines of this type are used for blanking, forming and drawing operations on large sheets such as are used for steel range bodies, automobile parts and similar work.

The large press shown in Fig. 4 is a combination of the tie-rod and gap-frame type. The bed and crown are each a separate casting and the side housings are of box section and have a gap or opening at the front, as shown. The bed and crown are held in place by two large steel rods which pass through

the housings just back of the crankshaft and take all the strain. There are also two smaller steel rods in front of the crankshaft. These do not go below the gap and are to prevent the crown from rolling. There are also two additional rods

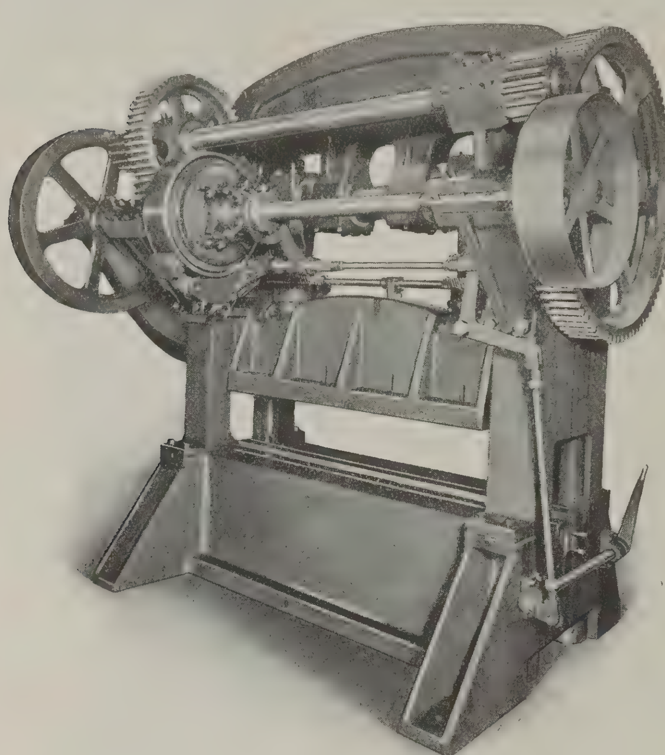


Fig. 3. Rear View of Double-crank Press

that pass through the bed and prevent the housings from springing away at the rear as they would tend to do when the main tie-rods, which pass close to the front, were shrunk in place. This construction is said to make a machine of the gap type as strong as a straight-sided press, as all the strain

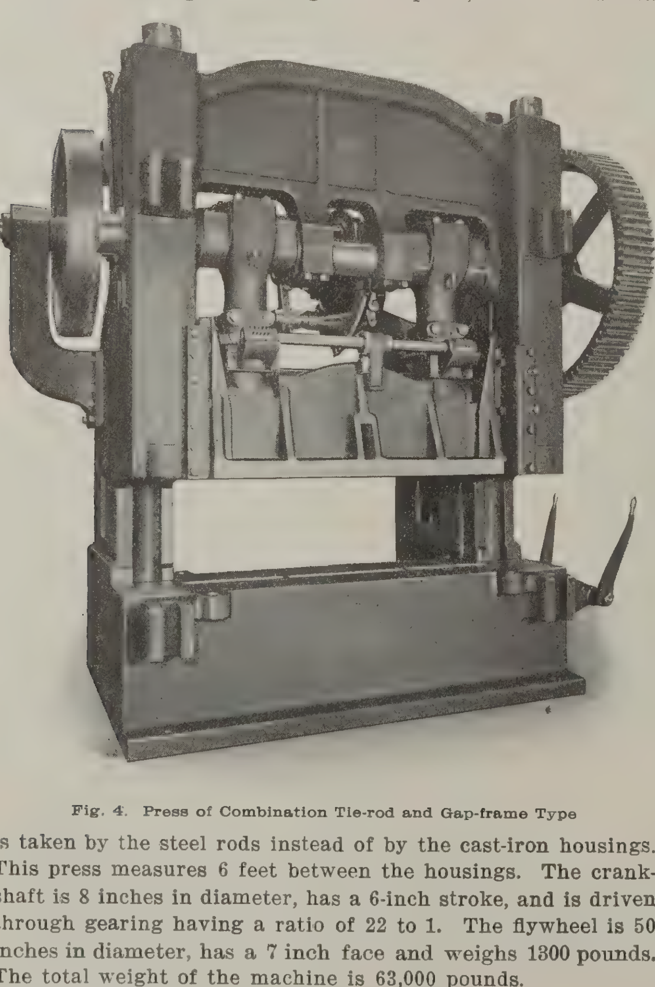


Fig. 4. Press of Combination Tie-rod and Gap-frame Type

is taken by the steel rods instead of by the cast-iron housings. This press measures 6 feet between the housings. The crankshaft is 8 inches in diameter, has a 6-inch stroke, and is driven through gearing having a ratio of 22 to 1. The flywheel is 50 inches in diameter, has a 7 inch face and weighs 1300 pounds. The total weight of the machine is 63,000 pounds.

NEW MACHINERY AND TOOLS NOTES

Light Holder: Ryede Specialty Works, Rochester, N. Y. Adjustable light holder which can readily be attached to the ceiling, wall or floor, and has universal adjustment which permits placing the light in the best position. The entire bracket is made of steel and is either nickel plated or oxidized.

Stock and Tool Trays: F. O. Weydell, 224 S. Jefferson St., Chicago, Ill. Cast-iron tool and stock trays made in different styles and sizes and intended for holding taps, drills, chisels and other tools. These trays consist of independent units which can be hung under a bench like a drawer or arranged in stacks, as required.

Shim for Bearings: Lindhe Shim Co., New York City. Shim or liner for bearings composed of a series of brass layers 0.002 inch thick which are firmly held together by a very thin film of solder. The thickness of the shim is varied by peeling off one or more layers. This shim is applicable to all classes of machinery having split bearings.

Pipe Threading Machine: Oster Mfg. Co., Cleveland, O. Machine for threading straight or bent pipe. The work is held in a swivel vise which can be adjusted to any angle for threading pipe bent to any radius from 6 to 24 inches. The vise is locked in position and the angle is shown by graduations. There is an automatic trip for cutting threads of a standard length.

Tool Grinder: W. W. Oliver Mfg. Co., 1500 Niagara St., Buffalo, N. Y. Tool grinder (No. 8) equipped with Hyatt roller bearings, which are oiled through dustproof cups. The spindle is made of machine steel accurately ground and machined, and the wheels are guarded. The height from the floor to the spindle is 38 inches, and the length of the spindle is 13⅞ inches. The net weight of the grinder is 96 pounds.

Die-plate: Scott-Rose Co., Marquette Building, Chicago, Ill. Die-plate covering a range of sizes from 3/16 to 3/4 inch. The hardened steel removable die blocks are fitted in parallel jaws. The distance between these jaws can be varied by a calibrated ratchet wheel which, through the medium of a cam, adjusts the jaws by small variations. This die-plate is 15 inches long overall, and it is furnished with U. S. standard threads unless otherwise specified.

Gas Forge: Simplex Tool & Supply Co., 125 Purchase St., Boston, Mass. Gas forge for forging or hardening lathe, planer or other tools made of carbon or high-speed steels. The width of the furnace is 10 inches and the height 8 inches. There are four burners, and 100 cubic feet of gas is consumed per hour. An air pressure of one and one-half pound is required. The advantages claimed for this forge are the facilities for watching the tool, a clean output and elimination of fusing of the tool-point.

Vertical Surface Grinder: Pratt & Whitney Co., Hartford, Conn. Vertical surface grinder which resembles the machine formerly built by this company, but is an improved design of heavier construction. It is adapted to either plain or circular grinding. A cup-shaped wheel 14 inches in diameter and 4 inches high is used. The table has a working surface 11⅜ by 36 inches, and the maximum distance from the table to the grinding surface of a new wheel is 14 inches. The machine can be equipped with a belt or motor drive.

Centering Tool: Robert H. Fay, Chicopee Falls, Mass. Centering tool for use on the lathe or hand screw machine. The body of the tool is composed of two sections which are screwed together and can be adjusted with relation to each other. The forward section carries a combination centering drill and it is beveled on the rear side to an angle of 60 degrees. The other section is in the form of a ring and is also beveled on the inside. By means of this adjustment the conical bearing can be varied to suit the angle of the lathe center, in case the latter should not be ground to the standard angle. The two sections are locked at any point by a small knurled screw.

Rolling Mill: Standard Machinery Co., Providence, R. I. Steel rolling mill designed for the cold rolling of sheet steel. The machine is driven by a sixty-horsepower motor, and there are three rolls to which power is transmitted through spur gears and cast steel herringbone pinions. The top and bottom rolls are 11 inches in diameter and have a 12-inch face. The center roll, which is known as the "baby" roll, is 5 inches in diameter and has a 12-inch face. The mill is so arranged that the 11-inch rolls can be replaced with 14-inch sizes when necessary for special work. The baby or friction roll is hardened, ground and mirror lapped. Both the 11- and 14-inch sizes are of the shell type forced over arbors, the shell part being hardened and ground tool steel. The weight of this mill is 26,470 pounds.

Crank Press: Niagara Machine & Tool Works, 639 Northland Ave., Buffalo, N. Y. Double crank-press, especially adapted to the requirements of sheet metal works manufacturing specialties of heavy and light gages. The frame is built in sections and the bed, the two housings and the arch are held together by four steel tie-rods which are shrunk in place and take the strain. Particular attention has been paid to the design of the slide cross-head and guides to adapt the

press for very accurate work. The Niagara automatic jaw clutch is used. This clutch has a safety lock which guards against accidental engagement in case the brake is not properly adjusted. The distance between the housings is 61 inches and the distance from the bed to the slide with stroke and adjustment up, is 25 inches.

Cylinder Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Special five-spindle cylinder boring machine having two uprights and a cross-rail. The right-hand upright can be shifted in or out whereas the left-hand upright is bolted to the bed. The cross-rail, which is mounted on top of the uprights, has a fore-and-aft adjustment. There are two vertical spindles on the cross-rail each having vertical and horizontal hand adjustments and a vertical feed. The left-hand horizontal spindle is mounted on a saddle attached to a knee having vertical elevation on the upright. This spindle also has a fore-and-aft hand adjustment as well as a cross-feed. The right-hand vertical saddle carries two spindles which operate in unison. This machine was especially designed for air brake cylinder work.

Safety Device: Benjamin Electric Mfg. Co., 120 S. Sangamon St., Chicago, Ill. Safety device for stamping presses which protects the hands of the operator by necessitating the removal of both hands from the point of danger in order to trip the press. The release of either hand permits the trip to return to its normal position, thus making it impossible for the press to repeat unless both hands are kept on the levers until the downward stroke begins. The operator then will not have time to get his hands back into the danger zone before the operation is completed. The device consists of an operating lever normally made inoperative, though free to move downward. This lever is made operative by an electro retaining magnet through a circuit closer. The press cannot be tripped by the operating lever unless the circuit through the magnet is first closed. This safety device can easily be applied to all standard presses.

Profiler: Pratt & Whitney Co., Hartford, Conn. Semi-automatic profiling machine capable of milling contours of practically any shape. The machine has a heavy base casting to which are bolted uprights and a cross-rail cast in one piece. The head on which the roughing and finishing spindles are mounted is clamped to the cross-rail and remains stationary when the machine is in operation. The rotary work-table is mounted on the front end of a swinging arm, journaled in the bed between the uprights. The table is actuated by worm-gearing and is provided with a change-gear mechanism by means of which any desired feed may be obtained. The table is oscillated by a cam or former under it, which is kept in contact with a roller mounted on a pin fixed to the bed. To generate this cam or former, the roller is removed and a milling cutter of the same diameter is inserted in its place. A model of the work is then mounted on the machine and a former pin of the same size as the cutter to be used, is inserted in the cutter spindle. The cam is then milled by the cutter previously referred to, which is driven independently from the main shaft.

* * *

PERSONALS

Otto R. Winter recently opened an office at 785 Bruck St., Columbus, Ohio, as tool and machine designer.

Robert Wilde has resigned as factory manager of the R. C. H. Corporation, Detroit, Mich., manufacturer of automobile and metal products.

F. H. Brown, formerly with Chas. A. Strelinger Co., Detroit, Mich., has been made sales manager of the W. P. Davis Machine Co., Rochester, N. Y.

W. Nicholson, of W. H. Nicholson & Co., Wilkes-Barre, Pa., sailed in February for a six-week's trip in Europe in the interests of the mandrel department of his company.

Paul J. Smith, assistant foreman of the tool and die room of the Ford Motor Co.'s pressed steel plant, Buffalo, N. Y., has been promoted to the position of chief inspector.

At a meeting of the board of directors of Manning, Maxwell & Moore, Inc., New York, January 26, Mr. James B. Brady was elected vice-president in place of Mr. W. O. Jacquette.

Emory T. Smith, for a long time draftsman for the Waltham Watch Tool Co., Springfield, Mass., has resigned to take a similar position with the Chapman Valve Mfg. Co. of Springfield.

C. R. McCullough, formerly connected with the Packard Motor Car Co., Detroit, Mich., has joined the sales organization of Manning, Maxwell & Moore, Inc., and will make his headquarters in Detroit.

E. J. O'Hayer, Jr., vice-president of the Miehle Printing Press & Mfg. Co., Chicago, Ill., has taken charge of the company's office at 38 Park Row, New York, succeeding Mr. F. L. Montague, resigned.

Frank P. Smith, formerly connected with the sales office of Manning, Maxwell & Moore, Inc., New York, has again become associated with this corporation. His work will be confined chiefly to the railway department.

L. H. Mesker, who has heretofore been connected with the Cleveland branch of Manning, Maxwell & Moore, Inc., has been appointed manager of the St. Louis, Mo., branch of this corporation, succeeding Mr. C. L. Lyle. The St. Louis office is in the 'Frisco Bldg.

Howard W. Evans has taken a position with the Best Mfg. Co., Pittsburg, Pa., as general manager of sales. Mr. Evans will supervise the company's sales, order and engineering departments. He was formerly connected with the Crane Co., of Chicago, in a similar capacity.

James McCrea, president of the Pennsylvania R. R., has been appointed a member of the American Honorary Committee of the International Congress for the prevention of accidents and industrial hygiene to be held in Milan in May, 1912. The Pennsylvania R. R. only recently received a medal from the American Museum of Safety for being the American employer to do the most in the past year for the protection of the lives and limbs of its workmen.

F. W. Boye, Jr. and W. T. Emmes have purchased the interest of Mr. W. A. Schumacher in the firms Schumacher & Boye and Schumacher, Boye & Emmes, and have incorporated a new company under the name of the Boye & Emmes Machine Tool Co., to take over these two concerns. Mr. Emmes is well known in the machine tool world, having been the general superintendent of the company for a number of years. He is the inventor of improvements in quick change gear devices and other features of engine lathes.

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OBITUARIES

William W. Young, purchasing agent of the Union Switch & Signal Co., Swissvale, Pa., died January 21.

S. S. Smith, of Dallas, Texas, manager of the General Fire Extinguisher Co., of Texas, died suddenly at New Orleans, January 20.

Frank D. Smith, for the past ten or twelve years traveling salesman for the Waltham Watch Tool Co., Springfield, Mass., died January 24 at his home in Springfield after a few weeks' illness, aged fifty-nine years.

C. P. Miller, general superintendent of the Weir Frog Co., Cincinnati, Ohio, died suddenly at his office of heart failure, February 9. Mr. Miller had been connected with the company as general superintendent since 1906. He was buried at Hilburn, N. Y., his former home. He leaves a widow and three children.

Walter A. Post, president of the Newport News Shipbuilding & Dry Dock Co., Newport News, Va., died February 12, aged fifty-five years. Mr. Post was a civil engineer, and his connection with the Newport News Shipbuilding & Dry Dock Co. dates back to 1890, when he was put in charge of the erection and equipment of the plant. This work was carried out so satisfactorily that in 1898 he was made general manager. He was elected president in 1911.

S. D. Conover, a prominent citizen of Dayton, Ohio, and founder of the Miami Valley Machine Tool Co., died February 8, aged sixty-nine years. Mr. Conover was president of the company up to about a year ago when he retired from active business on account of ill-health. He was a director of the Gem City Building and Loan Association, and was interested in a number of enterprises. He leaves a widow, daughter and son, the latter being Mr. P. P H. Conover, the present head of the company.

FRANCIS H. STILLMAN

Francis H. Stillman, president of the Watson-Stillman Co., and a prominent figure in machine tool and engineering industries, died suddenly, February 18, of intestinal hemorrhage at his late residence, 105 Rodney St., Brooklyn, in his sixty-second year. The day before his death he was at his office as usual, and apparently in the best of health. Mr. Stillman was born in New York on February 20, 1850, and was graduated from Yale in the class of 1874 with the degree of B. S. He was a member of Hyatt Lodge, F. and A. M., a member of the thirty-second degree in Aurora Grata Consistory, a Knight Templar, a Noble of Kismet Temple, Mystic Shrine, and a member of the Royal Arcanum. He was a member of the Hanover Club of Brooklyn, the Engineers Club, the American Society of Mechanical Engineers, and continuously since its organization a director of the National Association of Manufacturers. He organized the Machinery Club of New York, and was its first president, and was also first president of the National Metal Trades Association. In addition to being president of the Watson-Stillman Co. at the time of his death, he was also president of the Bridgeport Motor Co., and of the Pequannock Commercial Co., and a director in other manufacturing firms. Aside from his continuous activities in various engineering organizations and projects, Mr. Stillman was one of the recognized pioneers and, perhaps, the most prominent American engineer on hydraulic machine and tool construction. On leaving college, Mr. Stillman first associated himself with the Cottrell Printing Press Co., then with his stepfather, Mr. Lyons. In 1883 he organized and became president of the

Francis H. Stillman

firm of Watson & Stillman, which succeeded Lyons & Co. The firm was incorporated in 1904 as The Watson-Stillman Co., Mr. Stillman remaining its president up to the time of his death. Under Mr. Stillman's direction, his firm early became prominent in the hydraulic engineering field, and it has built upwards of 4000 different types and sizes of hydraulic machines, and now has a large and active plant in Aldene, N. J. Mr. Stillman's kindly disposition, high standard of business integrity and kind personal interest in all those with whom he came in contact, won for him a large circle of friends that will keenly regret their loss in his death. He is survived by his widow, formerly Miss Irene A. Bancroft of Boston, and by two sons, Austin Frank and Edwin Arthur Stillman.

* * *

COMING EVENTS

May 13-15.—Triple convention of the American Supply and Machinery Manufacturers' Association, National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association, at Norfolk, Va., Monticello Hotel, headquarters. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 14-17—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Bldg., Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

June 4-7.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

July 9—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

SOCIETIES AND COLLEGES

American Society of Engineer Draftsmen, 116 Nassau St., New York, held its regular monthly meeting in the Engineering Societies Bldg., 29 West 39th St., New York, on February 15, at 8:15 P. M. The subject of the meeting was "The Training of Draftsmen." by Prof. F. G. Higbee, head of the department of descriptive geometry and drawing, Iowa State University. Mr. Wm. F. Turnbull of the engineering department of the American Locomotive Co., delivered a lecture on "Some Common Faults of Draftsmen."

National Association of Master Steam and Hot Water Fitters, Wool Exchange Bldg., 260 West Broadway, New York. The 1912 U. S. standard schedule of standard weight and extra heavy flanged fittings and flanges which was lately adopted by the joint committee on standardization of the National Association of Master Steam and Hot Water Fitters and the American Society of Mechanical Engineers. The American Society of Heating and Ventilating Engineers' special committee on standards has reported in favor of recommending its use by members of that society. Copies of the schedule will be sent to architects, mechanical engineers, heating and ventilating engineers, manufacturers, dealers, and others interested, without cost, upon receipt of request.

Inventors Guild, Ralph D. Mershon, 60 Wall St., N. Y., president, has addressed a resolution to President Taft regarding inadequate patent protection given to American inventors. The substance of the resolution is that a patent is in effect a contract between the government and the inventor, by which the government in consideration of the right to publish the invention agrees to secure to the inventor for a limited time the exclusive right to use his invention, and that under present conditions these rights are not properly safeguarded. Under existing methods of trying patent causes, an inventor-patentee of average means cannot at his own expense carry to a conclusion a patent litigation against a wealthy opponent, and, therefore, a few wealthy concerns have acquired many important patents in their field, to the great damage of the nation, because of the restraint of competition and because of the resulting tendency of such inventors to seek protection for their inventions by keeping them trade secrets, or by ceasing to develop inventions.

NEW BOOKS AND PAMPHLETS

Year Book of the American Electrical Institute, 1912. F. L. Hutchinson, secretary, 23 West 39th St., New York.

The Vermont Bulletin. Catalogue 1911-1912. 190 pages, 5 by 7½ inches. Published by the University of Vermont and State Agricultural College, Burlington, Vt.

The Kingdom of Dust. By J. Gordon Ogden. 116 pages, 4¼ by 7 inches. Numerous halftone illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price 50 cents.

Comparative Railway Statistics of the United States, United Kingdom, France and Germany. Published as Bulletin No. 24, by the Bureau of Railway Economics, Washington, D. C.

New Hampshire Highways. Report of an Inspecton of Highways in the State of New Hampshire, August, 1911. By Charles H. Hoyt. Published by U. S. Department of Agriculture, Washington, D. C.

Proceedings of the American Electric Railway Engineering Association, 1911, containing a complete report of the ninth annual convention held at Atlantic City, N. J., October 9-13, 1911. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

The Modern Submarine Boat. Chart 14 by 28 inches. Published by Norman W. Henley & Son, New York. Price 25 cents.

This chart is printed on heavy paper, suitable for framing, and contains a cross-section showing clearly and distinctly the interior parts of a modern submarine boat. Two hundred parts are numbered and named in a reference list printed alongside of the illustration. The chart is drawn accurately to scale.

The Essentials of Lettering. By Thomas E. French and Robert Meiklejohn. 94 pages, 9 by 6 inches. 119 illustrations. Published by McGraw-Hill Book Co., New York. Price $1.00.

This is the third edition of a manual on lettering for students and designers. Like the previous editions, it contains an outline on the history of lettering, and then contains chapters on letter construction, composition and titles, selection of styles, letters in design, design and composition, monograms, ciphers and marks, and on drawing for reproduction.

Engineering Directory. 1496 pages, 4 by 6¾ inches. Published by D. Crawford Publishing Co., Chicago, Ill. Price $5.00.

This is the 1912 edition of this well-known directory, now in its nineteenth year of publication. In the classified section, manufacturers' products are found under 3850 classifications. The directory contains the names of more than 6000 manufacturers, producing over 4000 varieties of engineering goods and having more than 50,000 trade or brand names. The book is bound in leather and has thumb indexes to its fifteen sections.

Hand Forging and Wrought-iron Ornamental Work. By Thomas F. Googerty. 197 pages, 5¼ by 8 inches. 122 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price $1.00.

This book has been written in order to meet the demand for an inexpensive text-book on the subject of hand-wrought ornamental iron work. It contains numerous examples of ornamental forging, giving explicit directions for doing the work. It contains twelve chapters headed as follows: Introductory; Equipment; Working at the Forge; Various Forms of Welding; Welding (Concluded); Twisting, etc.; Scrollwork; Box Forging; Embossing; Drawer-pulls and Hinges; Doorplates; Iron Lamps.

An Investigation of the Strength of Rolled Zinc. By Herbert F. Moore. 24 pages, 6 by 9 inches. 14 illustrations. 13 tables. Published by the University of Illinois, Urbana, Ill. Price 15 cents.

This bulletin, No. 52 of the Engineering Experiment Station of the University of Illinois, records the results of tests made in the laboratory of applied mechanics of the University on the tensile, compressive and shearing strength of zinc. Comparison is made with results of tests made in Europe. The resisting power of the zinc to stress is shown to be from 30 to 40 per cent of that of soft steel. While normally sold at a price of 15 cents, copies of the bulletin may be obtained free of charge upon application to Prof. W. F. M. Goss, University of Illinois, Urbana, Ill.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson, 256 pages, 5 by 7½ inches. Published by the *Engineering Magazine*, New York. Price $2.00.

This is the third edition of this work. It has been revised and enlarged, but, of course, the subject matter is in the main the same as in the previous editions. While, as the author says, when the first edition was brought out, it was almost as the voice of one crying in the wilderness. with a new doctrine and an unusual form of teaching it, the subject is now fairly familiar to the engineering world. The main changes in the third edition consist in the revision which has been due to the rapid change of public sentiment, and the enlargement of the text designed principally to emphasize certain points upon which experience has shown added emphasis to be necessary.

Prevention of Railroad Accidents or Safety in Railroading. By George Bradshaw. 173 pages, 4½ by 6½ inches. Numerous illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

The author of this book, a practical railroad man, has for ten years been constantly engaged in the investigation and settlement of claims for personal injuries and death resulting from railroad accidents. This direct experience gives his work especial value. The book is addressed especially to railway employes and is, therefore, confined to that class of accidents that are within the power of the employes to prevent by their own personal efforts. The illustrations in the book show in a graphical manner how dangers may be avoided in railroading, and illustrate also the careless methods which are the cause of many accidents. The book is of considerable interest even to non-railroad men, and some of the general sections would be useful to anyone in the mechanical trades.

Twelve Principles of Efficiency. By Harrington Emerson. 423 pages, 5 by 7½ inches. Published by the *Engineering Magazine*, New York. Price $2.00.

The earlier book—"Efficiency as a Basis for Operation and Wages" —by the same author, was essentially the statement of a philosopher. It contains a new view of the industrial problem and defines the relations and proportions of the factors that enter into it. This latter volume is in a sense a continuation of the earlier work, but it is more specific in its statements and reduces the doctrine of efficiency to a practical basis. The twelve principles of efficiency the author enumerates are as follows: Clearly defined ideals; common sense; competent counsel; discipline; the fair deal; reliable, immediate and adequate records; despatching; standards and schedules; standardized conditions; standardized operations; written standard practice instructions; and efficiency reward. The book contains a great many examples from practice indicating possibilities for improved efficiency and makes altogether interesting reading even if one should not everywhere agree with the conclusions of the author. On many important questions the author, although at odds with the trend of the times, undoubtedly strikes the true keynote of efficiency, as for example when he scores the great terminal stations of railroads as monuments of inefficiency, and shows that they are lacking in the application of true engineering principles.

STREET LIGHTING. By J. M. Bryant and H. G. Hake. 61 pages, 6 by 9 inches. 28 illustrations. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill., as Bulletin No. 51.

Efficient and economical street lighting is a subject on which little information of a definite and tangible character has been published. Bulletin No. 51 is designed to supply such information concerning electric street lighting. The subject has been treated in a simple, direct manner, and while of especial interest and value to the technically trained illuminating engineer, will appeal particularly to city councils and central station managers. The general theory and construction of electric lamps, both incandescent and arc, are discussed together with the standard systems of electric distribution for lighting, and accepted methods for the measurement and study of illumination, with and without shades and reflectors. These principles are then applied to the study of street illumination, curves and calculations being given to show the candle-power distribution for the various lamps used, equipped with their proper glassware and reflectors, and others to show the illumination along the street for representative installations and conditions. Based upon these results, a discussion is given of the proper lighting of business streets, cross streets, boulevards, residence streets and outlying districts. The subject of economy for the several systems and lamps is discussed—the initial cost, up-keep, interest, and depreciation of various lamps and equipment are considered in tables and curves showing their relative economy at standard costs of power. Attention is also called to the economical selection of different lamps for certain classes of illumination.

NEW CATALOGUES AND CIRCULARS

WALTER O. AMSLER, Pittsburg, Pa. Descriptive pamphlet of the Amsler gas producers and accessories.

UNITED NUT LOCK CO., Springfield, Mass. Leaflet advertising the "Hugtite" nut lock manufactured by the company.

EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Catalogue of Emerson fan motors for alternating and direct currents.

ROBBINS CONVEYING BELT CO., New York. Bulletin No. 48 on chains, sprockets and elevators; Bulletin No. 49 on conveyor belts.

HARVEY HUBBELL, INC., Bridgeport, Conn. Folder advertising the Hubbell lamp guard, a wire guard for protecting the bulbs of electric lamps.

CALCULAGRAPH CO., 9 Maiden Lane, New York. Circular on the advantages of the calculagraph for registering actual working time in shops, mills, factories, etc.

NATIONAL TUBE CO., Pittsburg, Pa. Bulletin No. 8 treating of the necessity for protecting pipe with a coating material, and giving suggestions relating to the laying of pipe covered with "National" coating.

SPRAGUE ELECTRIC WORKS OF THE GENERAL ELECTRIC CO., 527 W. 34th St., New York. Catalogue No. 325 of Sprague electric fans, illustrating and describing the various types of fans made by the company.

FAWCUS MACHINE CO., Pittsburg, Pa. Booklet on worm gearing, containing a general outline of the requirements of worm-gearing installations, and tables of standard worm-gearing manufactured by the company.

CHICAGO PNEUMATIC TOOL CO., Chicago, Ill. Bulletin No. E-19 on universal electric drills operating on direct or alternating current; bulletin No. E-20 on a new line of electric drills for heavy duty for direct current.

PAWLING & HARNISCHFEGER, Milwaukee, Wis. Folder illustrating "P. & H." apparatus for steel mills, rolling mills, foundries, etc., comprising grab buckets, charging machines, mono-rail systems, mill type cranes, etc.

NATIONAL TUBE CO., Pittsburg, Pa. N. T. C. bulletin No. 4 on "Corrosion of Boiler Tubes," by Rear Admiral John D. Ford, U. S. N., being an abstract of a paper published in the journal of the American Society of Naval Engineers, May, 1904.

ELECTRO-DYNAMIC CO., Bayonne, N. J. Circular No. 39, entitled "Ratings and Dimensions of Inter-Pole Constant and Adjustable Speed Type 'S' Motors." The circular, which covers 24 pages, is principally devoted to tables giving this information.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Bulletins No. 1017, on automatic controllers; No. 1018, motor field rheostats; No. 1019, protective panels for direct-current motors; No. 1020, automatic float switch; No. 1021, motor starting rheostats.

UEHLING INSTRUMENT CO., Passaic, N. J. Bulletin No. 102 on recording instruments, describing a line of recorders for pressures up to 30 pounds per square inch. These instruments are calibrated either in ounces, pounds, inches of water or mercury.

SEAGER ENGINE WORKS, Lansing, Mich. 1912 catalogue of Olds gasoline and kerosene engines. Various types of engines from the smallest sizes up to 70 H. P., intended for miscellaneous uses—for small power plants as well as for agricultural work—are illustrated and described.

LINK-BELT CO., Philadelphia, Pa. Circular illustrating application of the "Maximum" silent chain to automobile engines. The illustrations show the "Maximum" chain applied to driving the magneto, pump and camshaft, thus eliminating all toothed gearing in mesh and reducing the gear noise.

WESTERN TOOL & MFG. CO., Springfield, Ohio. Catalogue of shop furniture comprising portable vise stands, tool stands, lathe stands, stands for blacksmith and machine shops, assembling stands, driving block stands, steel racks, power hacksaws, bench legs, drill holders, emery wheel dressers, etc.

THOMAS E. BUTTERFIELD, consulting engineer and gas power specialist, 68 William St., New York. Circular indicating the work which Mr. Butterfield is prepared to undertake, such as testing gas and oil engines and producers, designing of gas engines and producers, building, equipping and organizing new shops, etc.

LEXINGTON INSTRUMENT WORKS, Lexington, Ohio. Bulletin No. 1 on the Smith recording gas calorimeter, type A. This instrument is designed to supersede the ordinary type of calorimeter which requires the services of a skilled chemist in order to get satisfactory results. The Smith calorimeter will give reliable results in the hands of the ordinary plant operator.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletins No. 4887, on small turbo-generator sets from 5 K.W. to 300 K.W.; No. 4900, on series incandescent lighting apparatus; No. 4918, on direct-current switchboards; No. 4919, on small plant direct-current switchboards; No. 4920, on GE-203A railway motor; and No. 4924, on Thomson prepayment watthour meters.

SMITH-BOOTH-USHER CO., 228-238 Central Ave., Los Angeles, Cal. Catalogue A of machinery, supplies, pipe and fittings, comprising equipment for pumping and irrigation plants, power plants, distillate engines, steam boilers, steam engines, air compressors, transmission machinery, machine tools, woodworking machinery, mining machines, concrete and brick machinery, etc.

GEORGE J. HENRY, JR., hydraulic and mechanical designing and constructing engineer, Rialto Bldg., San Francisco, Cal. Booklet entitled "Water Power," giving hints as to its economical and efficient development and use for hydro-electric transmission for mining and industrial plants, and containing miscellaneous information relating to hydraulic power plant developments.

B. F. STURTEVANT CO., Hyde Park, Mass. Catalogue No. 190 on Sturtevant steam turbines illustrating and describing the new slow-speed type particularly adapted for direct connection with blowers, ventilating fans, gas exhausters, mechanical draft installations, electric generators, centrifugal pumps, and other apparatus for which efficient turbine speeds have generally been too high.

NATIONAL ELECTRIC WELDER CO., Warren, Ohio. Circular of the National spot welder, which in the 24-inch size will weld to the center of a 48-inch shape and unite two 3/8-inch pieces of boiler plate. The machine has a capacity of thirty spot welds per minute in 1/16-inch sheet steel and twenty per minute in 1/8-inch sheet steel. The company makes both spot and butt welding machines.

LANGELIER MFG. CO., Providence, R. I. Bulletin No. 28-32 on Langelier multiple drilling machines with three interchangeable heads. These heads embody the well-known Langelier design of multiple spindles with cranks driven by a common crank plate on the main spindle. The design of drilling head enables the maker to place spindles in any desired relation and at a minimum distance apart.

FITCHBURG STEAM ENGINE CO., Fitchburg, Mass. Pamphlet on the Fitchburg plan of industrial education by Mr. W. B. Hunter, director of the industrial department of the Fitchburg high school. All who are interested in industrial education should procure copies of this pamphlet which describes the successful Fitchburg plan of educating boys in the high school and the shops simultaneously.

CORK INSERT CO., 16 State St., Boston, Mass. Booklet entitled "Here's the Proof," containing a number of letters from customers of the company, giving the results obtained from cork-insert installations; also folder entitled "Relative Cost per H. P. transmitted by means of Plain and Cork-Insert Pulleys." This folder contains a diagram to illustrate the comparison, and tabulated cost estimates.

SIDNEY C. CARPENTER, Box 191, Plainville, Conn. Binder with sheets of engineering data useful to draftsmen, designers, mechanical engineers, and others concerned with the design, construction and use of machinery. These data sheets comprise weights and measures, steam engines, air brakes, pay-rolls, drafting-room conventions, machine shop work, machine design, etc. Prices given upon application.

HINCKLEY MACHINE WORKS, Hinckley, Ill. Circular of the Davis milling attachment and compound table for drilling machines, consisting of a circular base carrying a saddle on cross-slides which are operated by screws having balanced handles. The circular illustrates the use of the attachment showing how any upright drill press from 14 inches to 42 inches swing can be converted into a vertical milling machine.

WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J. Booklet entitled "Steam Tables for Condenser Work." This is a hand-book of steam tables with pressures below atmosphere expressed in inches of mercury referred to a 30-inch barometer. It also includes a discussion of the use of the mercury column. None of the tables given have ever been published before, but have been calculated especially for this book.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4893, describing automatic time switches; No. 4901, on alternating-current switchboard panels; No. 4904, on small plant alternating-current switchboard; No. 4905, on small plant alternating-current switchboards; No. 4906, on the lighting of textile mills with Edison Mazda lamps; No. 4907, on the lighting of offices, banks and public buildings; No. 4917, on direct-current exciter panels.

FERRO MACHINE & FOUNDRY CO., Hubbard Ave. and E. 66th St., Cleveland, Ohio. Catalogue of "Ferro" gasoline engines, including a practical treatise on the subject. This handsome publication will be found of general interest by all concerned with the use and operation of gasoline engines, being fully illustrated and showing details of construction throughout. The catalogue illustrates the company's line of marine engines for launches and power boats.

JAMES CLARK, JR., ELECTRIC CO., Louisville, Ky. Catalogue of "Willey" electrically driven tools, dynamos and motors, comprising portable drills for alternating or direct current in a variety of styles; lathes, center grinders, suspended surface grinders, buffers and bench grinders, water tool grinders, wet and dry grinders, sensitive bench drills, upright floor drills, two and three spindle drills, radial drills, notching presses, winding machines, etc., all electrically driven.

MORTON MFG. CO., Muskegon Heights, Mich. Catalogue of draw-cut shapers and keyseating machinery, comprising bulletins Nos. 1, 2, 3, 4, 5, 6 and 7 on keyseating machines, portable planers and portable keyseaters, standard pillar draw-cut shapers, 26-inch stroke draw-cut shaper with rod brass and shell planing attachments, 30-inch stroke shaper with rod brass shell planing and parallel shoe and wedge attachments, special railroad draw-cut shaper and traveling head draw-cut cylinder planers with full equipment.

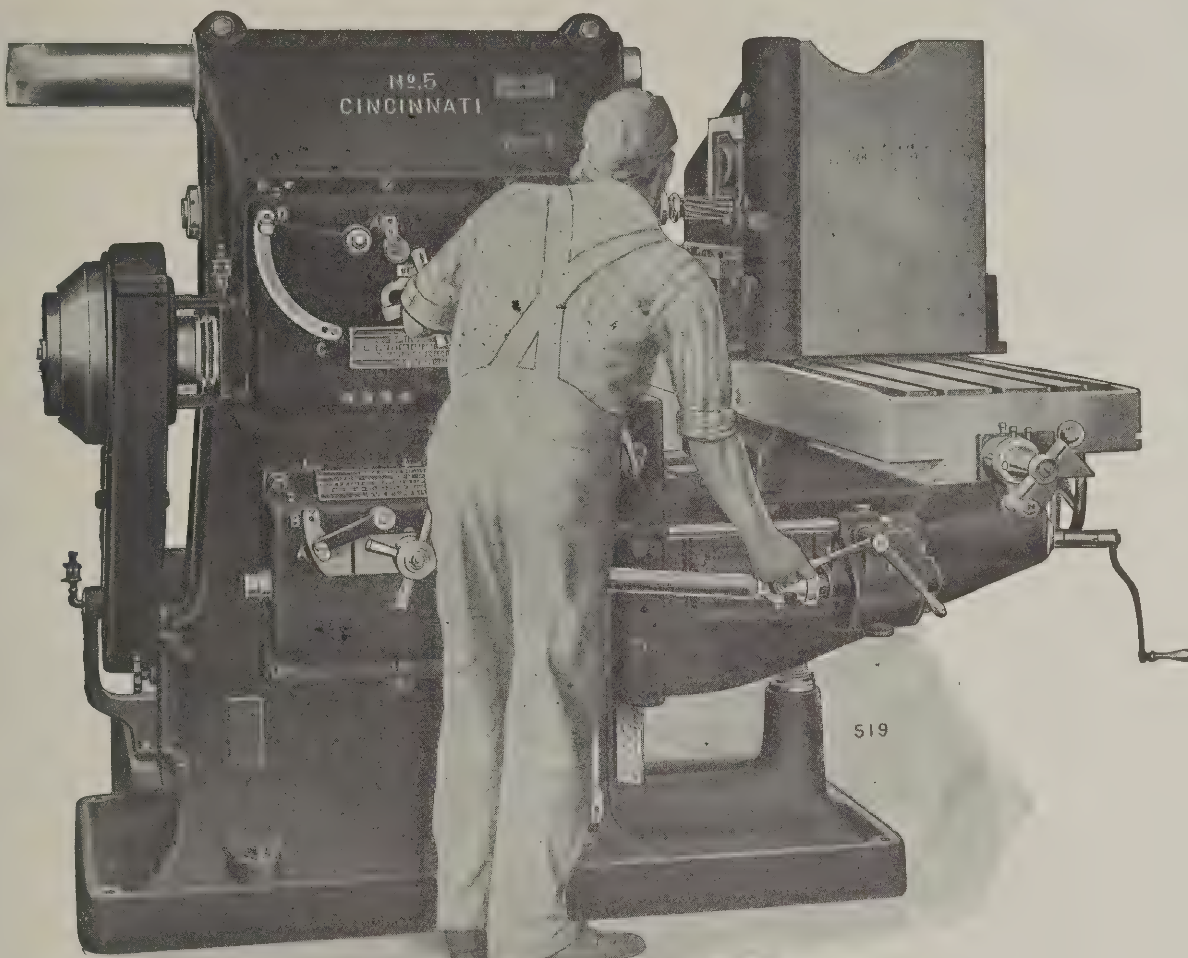
V & O PRESS CO., Glendale, Brooklyn, N. Y. Bulletin No. 6 illustrating and describing automatic attachments for power presses; bulletin No. 1A on inclinable presses; and bulletin No. 200 on sheet metal working machinery. The latter bulletin describes several types of sheet metal working machines which supplement the ordinary press and die equipment of manufacturers of sheet metal articles, such as small automatic screw machines, knurling machines, hand wire ring machines, beading and flanging machines, draw benches, and rolling machines.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Folder No. 4222, on economy coils for tungsten display lighting; descriptive leaflet No. 2299-A, on Westinghouse type HF slip ring induction motors; leaflet No. 2386, on alternating current heavy duty type MW slip ring induction motors; leaflet No. 2387, on type MS alternating current elevator motors; leaflet No. 2390, on type E alternating current generators for engine drive; leaflet No. 2389, on type G alternating current generators for belt drive; and folder 4213, on oil circuit breakers.

ARMSTRONG MFG. CO., 297 Knowlton St., Bridgeport, Conn. Catalogue showing the company's full line of pipe threading machines and parts. The catalogue comprises 45 pages, 6 by 9 inches. An interesting feature of this catalogue is that every detail that enters into the manufacture of this company's machines is illustrated and either lettered or numbered, so that a customer can order duplicate parts directly from the catalogue, and can thus replace broken or worn parts without delay, which is an extremely important feature in the case of a breakdown.

NEW DEPARTURE MFG. CO., Bristol, Conn. Catalogue of ball bearings containing 76, 6 by 9 inch pages, giving information of a technical character relating to ball bearings, well illustrated with high-grade engravings. The book treats of the double row, the single row, and the "radax" type of ball bearings, and describes the accurate methods for testing used in the company's plant. The greater part of the catalogue is given over to concise descriptions of the application of ball bearings and suggestions for their proper use. A number of useful tables are included.

Cincinnati Handiness



WHEN you have a job of end or face milling to do on a Horizontal Miller, don't you find it hard to operate the feed lever and at the same time keep your eye on the cutter? That's because the machines you are using can be operated from only one place. Our new High Power Machines have an additional feed lever at the side of the knee.

The operator can stand close up to his work, with the cutter in full view, and control the machine from this position.

With this one lever he can operate and reverse table, cross or vertical feeds.

The main starting lever is immediately in front of him and the speed and feed changers are at his elbow, so that the entire machine is under complete control from here. *Ask for the catalog.*

The Cincinnati Milling Machine Company

Milling Specialists **CINCINNATI, OHIO, U. S. A.**

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Ayres.

MARVIN & CASLER Co., Canastota, N. Y. Catalogue of the Marvin & Casler offset boring tool for lathes, milling machines, drilling machines, boring machines, etc. The tool is graduated to 0.001 inch and provision is made for holding the adjustment so that the tool stays where it is set. The catalogue is illustrated with examples showing uses of the tool that will suggest other uses to interested persons. The tool is made in five sizes, the small size having offset capacity of 3/16 inch and drill chuck capacity of 1/2 inch, and the large size 5/8 inch and 1 1/2 inch respectively.

T. B. WOOD'S SONS Co., Chambersburg, Pa. Catalogue No. 55 entitled "Modern and Approved Appliances for the Transmission of Power." This catalogue comprises 242 pages, 6 by 9 inches, and is substantially bound. It lists a complete line of power transmission appliances with dimensions and price lists, and includes shafting, shaft collars, flange or plate couplings, double cone compression couplings, Collins compression couplings, clutch couplings, hangers and hanger bearings, pillow blocks, belt shifting appliances, countershafts, pulleys, belt tighteners, friction clutches, rope sheaves, etc.

VEEDER MFG. Co., 39 Sargeant St., Hartford, Conn. Catalogue of the Veeder products, including the Veeder hub odometer or mileage recorder for trucks, automobiles or taxicabs; the Veeder tachodometer, which is a combination of speed indicator and mileage recorder; cyclometers for bicycles and motor cycles; the Veeder counters for different purposes; revolution counters for finding the revolutions per minute made by a shaft or any other revolving part; and printing press counters and tachometers. The catalogue gives complete descriptions of the various instruments and their use and care. It also includes illustrations and descriptions of die castings, which this firm makes for the trade.

NORTON Co., Worcester, Mass. 1912 edition of catalogue of grinding wheels and machinery, listing the Norton products, including alundum grinding wheels, crystolon grinding wheels, alundum grain for polishing, crystolon grain for polishing, India oilstones, crystolon sharpening stones, glass cutting wheels, razor hones, scythe stones, Norton alundum refractories, Norton valve grinding compound, rubbing bricks and stones, grinding wheel dressers, and grinding machinery. The catalogue comprises 142 pages, 6 by 9 inches, and shows excellent illustrations of all the products of the company. It also contains considerable information of a general nature, useful in the grinding department of a machine shop.

MORSE TWIST DRILL & MACHINE Co., New Bedford, Mass. Catalogue of increase and constant angle twist drills, reamers, chucks, milling cutters, taps, dies, machinery and machinists' tools. This catalogue for 1912 is the largest and most comprehensive catalogue issued by the company. The alphabetical index of contents covers nearly seven and one-half pages, and the index by numbers nearly six and one-half pages. The two indexes make the finding of any desired article an easy matter. Tables and data which conclude the catalogue are of general value to users of machine tools, and the catalogue will be of general interest and value to superintendents, foremen, machinists, toolmakers, apprentices, etc.

CARLYLE JOHNSON MACHINE Co., Manchester, Conn. Booklet entitled "The Johnson Friction Clutch as Applied in Machine Building," showing illustrations of well-known machine tools in which the Johnson clutch is being successfully used. The illustrations comprise the Newton horizontal milling machine, Betts vertical boring mill, Gridley multiple spindle automatic screw machine, Beaman & Smith quick operating vertical spindle milling machine, J. E. Snyder & Son's upright drill, Merrell Mfg. Co's pipe threading machine, Fay Machine Tool Co's automatic turning lathe, National-Acme Mfg Co's automatic screw machine, etc. The booklet illustrates the construction of the clutch, showing its compactness and simplicity.

CRESCENT MACHINE Co., 56 Main St., Leetonia, Ohio. Catalogue No. 51 of the Crescent universal wood-worker which comprises a band saw, jointer, shaper, saw table and borer in one machine. It is not, however, a combination in the sense of a single machine that can be adapted for different uses, but is a combination of machines each independent of the other, arranged compactly and self-contained so that all can be driven by one main belt from the lineshaft. It is not necessary to run more than one machine when only one is in use, but four persons may use different machines at the same time without hindrance. The value of a machine of this compact arrangement for pattern shops and other places where space is limited, is obvious.

CHARLES H. BESLY & Co., 118 N. Clinton St., Chicago, Ill. Catalogue of Besly spiral disk grinders, band polishing machines, "Helmet" spiral circles, etc. The growth of the disk grinder business is strikingly shown by this catalogue of 112 pages. It has been necessary to index the different types of grinders, covering their general purposes, the divisions being single spindle, belt-driven machines; single spindle, motor-driven machines; double spindle, belt-driven machines; vertical spindle and special grinders, and patternmakers' disk grinders. It has been the aim to make the catalogue answer any reasonable question, and not only is full information given in connection with each machine, but also detailed dimensions, weights, etc., of disk wheels, ring wheel chucks, various types of floor presses, work tables, countershafts, fixtures, accessories, etc.

HEALD MACHINE Co., 20 New Bond St., Worcester, Mass. Booklet "Oversize Standards for Pistons and Rings," by Mr. James N. Heald, being a reprint of a paper presented at the summer meeting of the Society of Automobile Engineers, June, 1911. The author advocates establishing certain oversize standards for automobile pistons and rings, the object being to enable automobile engines to be refitted with new pistons at low cost. If worn automobile cylinders are bored or ground under present conditions it is necessary to make patterns for new pistons, and to fit the pistons up from the rough castings. The automobile manufacturers should provide oversize pistons as they have the jigs, fixtures and patterns that can be easily adapted to the oversize requirements. The oversizes suggested are 0.010, 0.020 or 0.050 inch more than the standard sizes. With these sizes in stock a repair man could regrind an auto cylinder and fit it with a new piston and rings in short time and at small expense.

TRADE NOTES

MUMFORD MOLDING MACHINE Co., Plainfield, N. J., reports the sale of a large 24-inch jolt rammer, having a capacity of 24,000 pounds, to the Canadian Rand Co., Sherbrooke, Quebec, Canada.

STARK ROLLING MILL Co., Canton, Ohio, has furnished a large amount of formed sheet metal of anti-corrosive "Toncan" metal for the United States coaling station at Pearl Harbor, Hawaii.

WESTINGHOUSE AIR BRAKE & TRACTION BRAKE Co., has removed the office of its southeastern manager, Mr. R. A. Craig, from the general office Wilmerding, Pa., to 308 Westinghouse Bldg., Pittsburg, Pa.

ADAMS-BAGNALL ELECTRIC Co., Cleveland, Ohio, manufacturer of electric light apparatus specializing on electric lighting systems for industrial plants, is now located in its new factory at 7125 Platt Ave., S. E., Cleveland.

RUGGLES-COLES ENGINEERING Co., 50 Church St., New York, reports that the Bayonne Casting Co. has just cast the second propeller for one of the Japanese battleships. These propellers, each of which weighs approximately 12,000 pounds, are to go to the Fore River Ship-Building Co. for finishing and will then be sent to Japan.

H. W. JOHNS-MANVILLE Co., has moved its Pittsburg office from Liberty Ave. above Ninth St. to the eight-story stone, reinforced concrete and steel building at the northeast corner of Wood St. and First Ave. The company has leased the entire building for a term of years and will occupy the whole of it. The building is 31 by 96 feet and contains a gross floor space of approximately 23,800 square feet.

H. W. JOHNS-MANVILLE Co., 100 William St., New York, has acquired the sole selling agency for the Frink reflectors and illuminating specialties. The company is already known in the illuminating field by reason of its J-M linolite system of illumination and will now be in position to design and sell lighting systems for every known form of artificial illumination. An extensive engineering department will be maintained.

STANDARD ELECTRIC TIME Co., a Connecticut corporation formerly located at Waterbury, Conn., and now temporarily located at Foxboro, Mass., will move to its new factory building on Logan St., Springfield, Mass., in April. The general office of the company, which has been in Boston, Mass., will also be transferred to Springfield. Mr. George L. Riggs is president and general manager, and Mr. G. F. Harter, works manager.

BEST MFG. Co., Pittsburg, Pa., has equipped its new plant to expeditiously fill all orders for piping of every description. It is prepared to lay out entire piping systems, furnish material cut and fitted ready for erection, or to take contracts and install complete, ready for operation. Mr. H. W. Evans, formerly with the Crane Co., Chicago, is general manager of sales in charge of the sales, order and engineering departments.

BOYE & EMMES MACHINE TOOL Co., Cincinnati, Ohio, is the successor of Schumacher & Boye and Schumacher, Boye & Emmes. Mr. F. W. Boye, Jr., and W. T. Emmes have purchased the interest of Mr. W. A. Schumacher in both firms. Mr. Emmes has been connected with the firm for a number of years and has a wide reputation in the mechanical line. The firm of Schumacher & Boye has been in existence for about fourteen years.

H. B. BROWN Co., East Hampton, Conn., recently had an important change in personnel of its officers. Prof. Charles S. Brown has acquired a controlling interest, and has been made president; Abner W. Barton is secretary and treasurer; and Henry B. Brown, the late president, after forty-six years of continuous and successful labor, retires from active duty. The company manufactures bolt and nut machinery, and its product is well known throughout the world.

VERMONT MACHINE TOOL Co., Windsor, Vt., has been incorporated to manufacture a multiple-spindle automatic turret drilling machine, designed by Mr. G. O. Gridley of the Windsor Machine Co. In addition to the advantages of the usual type of multiple-spindle drill, this machine is fully automatic in its action, so that its output is not dependent upon the personal element of the operator, and it has in addition certain features in common with the turret machines.

NEIL MACHINERY Co., successors to Geo. E. Neil, machine tool dealer, has opened large display rooms at 711-713 St. Clair Ave., N. E., Cleveland, Ohio, and will handle a line of machine tools. The company will represent, among other concerns, the Springfield Machine Tool Co., Springfield Ohio; Oliver Machinery Co., Grand Rapids, Mich., and the Waterbury, Farrel Foundry & Machine Co., Waterbury, Conn. Mr. Neil was for a long time connected with the W. M. Pattison Supply Co., but has been doing business for himself for the past three years. The company is open for arrangements for agencies in non-competing lines.

LEA EQUIPMENT Co., manufacturer of high-duty centrifugal pumping equipment and the "Lea-Simplex" cold saws, which has heretofore had general offices at 97 West St., New York, has found it necessary to enlarge its manufacturing facilities to accommodate its extensive and growing trade by removal to the works at the corner of Stenton and Wyoming Aves., Philadelphia. The general sales offices will be located at the works under the supervision of Mr. H. R. Williams, the general sales manager. The company will retain quarters in the West St. building, New York, from which point the export and Eastern trade will be served by the president, Mr. Albert G. Lea.

BAUSH MACHINE TOOL Co., 200 Wason Ave., Springfield, Mass., has increased its capital stock to $500,000, 6 per cent accumulative preferred stock and $1,000,000 common stock following the transfer of a controlling interest from Mr. Frank H. Page, president of the National Equipment Co., to Mr. C. K. Lassiter, mechanical superintendent of the American Locomotive Co. The company will take over the manufacture of multiple-spindle and hydro-pneumatic drills, bolt turning machines and stay-bolt threading machines, designed and patented by Mr. Lassiter. The officers of the new company are: C. K. Lassiter, president; Frank E. Bocorselski, vice-president; Walter H. Foster, treasurer; J. A. Eden, general manager; and Charles A. Smith, superintendent.

VAN DORN & DUTTON Co., Cleveland, Ohio, reports that it is receiving many orders from concerns that appreciate the high electrical and mechanical efficiency of its electrical portable tools. The McClintic-Marshall Construction Co., Pittsburg, Pa., several months ago purchased for its Panama Canal work twelve of the Van Dorn & Dutton hard service electric reamers, and later duplicated the order. The same company has recently given another order for twenty-four of the type DC-3 hard service electric reamers. The Hupp Motor Co., Detroit, Mich., recently ordered twenty-five Van Dorn & Dutton electric drills, having found them peculiarly adapted to motor car construction work. The C. R. Wilson Body Co., Detroit, Mich., has twenty-four electric drills in service, and the Haskell & Barker Car Co., Michigan City, Ind., has twenty in its new steel freight car shop.

EAGAN-ROGERS STEEL & IRON Co., has been incorporated under the laws of the state of Pennsylvania with a capitalization of $100,000. The company has acquired a five-acre tract on the Pennsylvania Railroad in the Chester district between Crum Lynne and Eddystone, Pa., and has started the erection of modern steel buildings, the contract for which was let to the McClintic-Marshall Construction Co. The men most actively interested in the company are Messrs. Daniel C. Eagan and John I. Rogers. Mr. Eagan is the son of the late Daniel Eagan and has had wide experience in this line of work, and Mr. Rogers is an engineer who was formerly with the Midvale Steel Co., and has been in consulting practice for the last few years in New York and Philadelphia. The company will specialize on forging plants; hammer, hydraulic press, and drop forging; tire and wheel rolling, etc. The plant is expected to be in active operation about March 1.

PERMANENT MANUFACTURERS EXHIBIT RAILWAY SUPPLIES AND EQUIPMENT, Karpen Bldg., 900 S. Michigan Blvd., Chicago, Ill., has been established on the twelfth floor, having an area of 26,000 square feet. Provisions have been made for additional floors should they be required. The purpose of the exhibition is to display all kinds of railway supplies. In connection with the exhibition there are large assembly and committee rooms for the use of railway associations, free of charge, and also a large club room, which, in furnishings and service, is of the highest class. The booths or display spaces are furnished by the management with all the necessary equipment for doing business, such as rugs, furniture, heat, light, janitor service,

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—I

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	6	......	8	0.8604	10	0.6601	12	0.5310	14	0.4400
	0.040		......		0.8346		0.6351		0.5057		0.4155
	0.060		......		0.8088		0.6101		0.4808		0.3917
	0.080		......		0.7829		0.5851		0.4568		0.3690
	0.100		......		0.7571		0.5601		0.4330		0.3460
	0.120		......		0.7313		0.5351		0.4102		0.3238
55	0.020	6	......	8	0.7640	10	0.5805	12	0.4634	14	0.3820
	0.040		......		0.7403		0.5570		0.4415		0.3603
	0.060		......		0.7167		0.5342		0.4195		0.3385
	0.080		......		0.6928		0.5116		0.3981		0.3141
	0.100		0.9843		0.6691		0.4893		0.3767		0.2900
	0.120		0.9596		0.6454		0.4674		0.3554		0.2785
60	0.020	6	0.9774	8	0.6790	10	0.5102	12	0.4042	14	0.3311
	0.040		0.9543		0.6572		0.4893		0.3830		0.3129
	0.060		0.9312		0.6353		0.4685		0.3630		0.2940
	0.080		0.9081		0.6134		0.4479		0.3438		0.2750
	0.100		0.8849		0.5915		0.4276		0.3252		0.2565
	0.120		0.8616		0.5697		0.4076		0.3072		0.2392
65	0.020	6	0.8824	8	0.6020	10	0.4467	12	0.3504	14	0.2850
	0.040		0.8605		0.5819		0.4283		0.3325		0.2671
	0.060		0.8386		0.5617		0.4090		0.3150		0.2507
	0.080		0.8167		0.5415		0.3906		0.2977		0.2350
	0.100		0.7948		0.5213		0.3720		0.2805		0.2195
	0.120		0.7729		0.5012		0.3538		0.2636		0.2035
70	0.020	6	0.7945	8	0.5311	10	0.3875	12	0.3007	14	0.2420
	0.040		0.7738		0.5125		0.3701		0.2847		0.2271
	0.060		0.7530		0.4938		0.3530		0.2689		0.2122
	0.080		0.7322		0.4751		0.3364		0.2534		0.1980
	0.100		0.7114		0.4564		0.3200		0.2383		0.1842
	0.120		0.6907		0.4378		0.3038		0.2234		0.1708
75	0.020	6	0.7125	8	0.4645	10	0.3332	12	0.2543	14	0.2021
	0.040		0.6928		0.4474		0.3174		0.2400		0.1900
	0.060		0.6731		0.4302		0.3020		0.2262		0.1760
	0.080		0.6534		0.4130		0.2868		0.2125		0.1635
	0.100		0.6337		0.3958		0.2718		0.1990		0.1513
	0.120		0.6141		0.3787		0.2569		0.1857		0.1400
80	0.020	6	0.6339	8	0.4010	10	0.2806	12	0.2099	14	0.1640
	0.040		0.6153		0.3852		0.2770		0.1978		0.1533
	0.060		0.5967		0.3694		0.2533		0.1857		0.1426
	0.080		0.5780		0.3536		0.2396		0.1736		0.1319
	0.100		0.5594		0.3378		0.2259		0.1616		0.1211
	0.120		0.5408		0.3221		0.2123		0.1496		0.1104
85	0.020	6	0.5577	8	0.3394	10	0.2297	12	0.1667	14	0.1271
	0.040		0.5395		0.3248		0.2176		0.1563		0.1180
	0.060		0.5222		0.3098		0.2055		0.1459		0.1090
	0.080		0.5043		0.2953		0.1933		0.1355		0.1000
	0.100		0.4868		0.2811		0.1811		0.1251		0.0910
	0.120		0.4697		0.2673		0.1690		0.1148		0.0820

Contributed by George W. Burley

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—II

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	16	0.3735	18	0.3238	20	0.2847	22	0.2550	24	0.2299
	0.040		0.3505		0.3030		0.2645		0.2347		0.2090
	0.060		0.3281		0.2820		0.2435		0.2132		0.1884
	0.080		0.3054		0.2599		0.2220		0.1920		0.1681
	0.100		0.2840		0.2378		0.2011		0.1724		0.1482
	0.120		0.2635		0.2161		0.1806		0.1526		0.1288
55	0.020	16	0.3250	18	0.2785	20	0.2448	22	0.2191	24	0.1955
	0.040		0.3026		0.2600		0.2264		0.2002		0.1780
	0.060		0.2830		0.2420		0.2090		0.1822		0.1609
	0.080		0.2640		0.2219		0.1906		0.1638		0.1439
	0.100		0.2443		0.2030		0.1721		0.1460		0.1262
	0.120		0.2252		0.1853		0.1540		0.1292		0.1084
60	0.020	16	0.2780	18	0.2395	20	0.2099	22	0.1861	24	0.1672
	0.040		0.2602		0.2230		0.1938		0.1700		0.1520
	0.060		0.2428		0.2062		0.1776		0.1543		0.1371
	0.080		0.2256		0.1891		0.1616		0.1383		0.1220
	0.100		0.2090		0.1732		0.1458		0.1233		0.1071
	0.120		0.1928		0.1578		0.1301		0.1091		0.0925
65	0.020	16	0.2380	18	0.2035	20	0.1780	22	0.1580	24	0.1401
	0.040		0.2222		0.1891		0.1635		0.1435		0.1266
	0.060		0.2066		0.1748		0.1491		0.1293		0.1138
	0.080		0.1915		0.1599		0.1354		0.1161		0.1014
	0.100		0.1770		0.1453		0.1220		0.1031		0.0883
	0.120		0.1630		0.1322		0.1088		0.0908		0.0760
70	0.020	16	0.2010	18	0.1715	20	0.1488	22	0.1312	24	0.1165
	0.040		0.1862		0.1585		0.1363		0.1190		0.1049
	0.060		0.1740		0.1462		0.1240		0.1072		0.0938
	0.080		0.1601		0.1335		0.1123		0.0956		0.0830
	0.100		0.1478		0.1210		0.1010		0.0845		0.0704
	0.120		0.1360		0.1095		0.0890		0.0735		0.0579
75	0.020	16	0.1660	18	0.1400	20	0.1200	22	0.1052	24	0.0933
	0.040		0.1542		0.1289		0.1096		0.0950		0.0836
	0.060		0.1427		0.1180		0.0993		0.0850		0.0741
	0.080		0.1313		0.1072		0.0896		0.0757		0.0650
	0.100		0.1200		0.0970		0.0800		0.0667		0.0562
	0.120		0.1092		0.0870		0.0704		0.0580		0.0480
80	0.020	16	0.1322	18	0.1103	20	0.0950	22	0.0815	24	0.0712
	0.040		0.1228		0.1015		0.0851		0.0735		0.0634
	0.060		0.1130		0.0924		0.0762		0.0654		0.0561
	0.080		0.1035		0.0836		0.0685		0.0577		0.0490
	0.100		0.0942		0.0747		0.0610		0.0503		0.0420
	0.120		0.0848		0.0660		0.0531		0.0430		0.0352
85	0.020	16	0.0991	18	0.0817	20	0.0680	22	0.0580	24	0.0498
	0.040		0.0914		0.0745		0.0615		0.0520		0.0443
	0.060		0.0837		0.0673		0.0550		0.0460		0.0388
	0.080		0.0760		0.0601		0.0485		0.0400		0.0333
	0.100		0.0683		0.0529		0.0421		0.0341		0.0279
	0.120		0.0606		0.0458		0.0357		0.0282		0.0225

Contributed by George W. Burley

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—III

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	26	0.2095	28	0.1912	30	0.1745	32	0.1624	34	0.1508
	0.040		0.1884		0.1705		0.1547		0.1426		0.1314
	0.060		0.1681		0.1508		0.1355		0.1232		0.1126
	0.080		0.1482		0.1314		0.1164		0.1040		0.0935
	0.100		0.1288		0.1126		0.0976		0.0852		0.0749
	0.120		0.1095		0.0935		0.0785		0.0667		0.0567
55	0.020	26	0.1780	28	0.1631	30	0.1490	32	0.1382	34	0.1278
	0.040		0.1609		0.1454		0.1321		0.1219		0.1119
	0.060		0.1439		0.1280		0.1150		0.1044		0.0951
	0.080		0.1262		0.1119		0.0985		0.0880		0.0786
	0.100		0.1084		0.0951		0.0822		0.0718		0.0630
	0.120		0.0930		0.0786		0.0665		0.0566		0.0476
60	0.020	26	0.1520	28	0.1390	30	0.1270	32	0.1176	34	0.1086
	0.040		0.1371		0.1238		0.1126		0.1028		0.0945
	0.060		0.1220		0.1086		0.0984		0.0882		0.0803
	0.080		0.1071		0.0945		0.0832		0.0742		0.0667
	0.100		0.0926		0.0804		0.0694		0.0605		0.0533
	0.120		0.0784		0.0668		0.0562		0.0470		0.0402
65	0.020	26	0.1265	28	0.1156	30	0.1053	32	0.0972	34	0.0899
	0.040		0.1137		0.1025		0.0983		0.0850		0.0780
	0.060		0.1013		0.0897		0.0820		0.0725		0.0660
	0.080		0.0882		0.0779		0.0683		0.0610		0.0544
	0.100		0.0760		0.0660		0.0567		0.0495		0.0432
	0.120		0.0642		0.0544		0.0455		0.0386		0.0325
70	0.020	26	0.1048	28	0.0954	30	0.0865	32	0.0797	34	0.0731
	0.040		0.0937		0.0841		0.0761		0.0692		0.0635
	0.060		0.0830		0.0731		0.0663		0.0589		0.0536
	0.080		0.0703		0.0635		0.0556		0.0490		0.0440
	0.100		0.0578		0.0536		0.0460		0.0396		0.0348
	0.120		0.0520		0.0440		0.0368		0.0313		0.0260
75	0.020	26	0.0835	28	0.0754	30	0.0680	32	0.0623	34	0.0567
	0.040		0.0741		0.0660		0.0594		0.0538		0.0493
	0.060		0.0650		0.0567		0.0509		0.0456		0.0413
	0.080		0.0562		0.0493		0.0430		0.0377		0.0336
	0.100		0.0480		0.0413		0.0353		0.0303		0.0265
	0.120		0.0400		0.0336		0.0278		0.0233		0.0197
80	0.020	26	0.0634	28	0.0568	30	0.0509	32	0.0464	34	0.0421
	0.040		0.0561		0.0493		0.0443		0.0400		0.0360
	0.060		0.0490		0.0427		0.0379		0.0332		0.0301
	0.080		0.0421		0.0360		0.0311		0.0272		0.0245
	0.100		0.0355		0.0301		0.0257		0.0215		0.0191
	0.120		0.0288		0.0245		0.0205		0.0154		0.0141
85	0.020	26	0.0437	28	0.0385	30	0.0341	32	0.0308	34	0.0278
	0.040		0.0385		0.0337		0.0296		0.0265		0.0238
	0.060		0.0334		0.0289		0.0251		0.0222		0.0198
	0.080		0.0283		0.0241		0.0206		0.0179		0.0158
	0.100		0.0232		0.0194		0.0162		0.0137		0.0118
	0.120		0.0181		0.0147		0.0118		0.0095		0.0078

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MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—IV

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	36	0.1404	38	0.1314	40	0.1232	42	0.1164	44	0.1106
	0.040		0.1212		0.1126		0.1045		0.0976		0.0917
	0.060		0.1020		0.0935		0.0858		0.0785		0.0731
	0.080		0.0832		0.0749		0.0676		0.0602		0.0548
	0.100		0.0651		0.0567		0.0484		0.0423		0.0370
	0.120		0.0476		0.0387		0.0297		0.0248		0.0196
55	0.020	36	0.1195	38	0.1119	40	0.1044	42	0.0985	44	0.0937
	0.040		0.1024		0.0951		0.0882		0.0822		0.0773
	0.060		0.0862		0.0786		0.0724		0.0665		0.0614
	0.080		0.0702		0.0630		0.0619		0.0507		0.0460
	0.100		0.0546		0.0476		0.0416		0.0360		0.0311
	0.120		0.0393		0.0326		0.0266		0.0207		0.0163
60	0.020	36	0.1013	38	0.0945	40	0.0882	42	0.0832	44	0.0790
	0.040		0.0867		0.0804		0.0745		0.0694		0.0652
	0.060		0.0728		0.0668		0.0610		0.0562		0.0517
	0.080		0.0590		0.0533		0.0480		0.0432		0.0380
	0.100		0.0459		0.0402		0.0348		0.0303		0.0260
	0.120		0.0329		0.0272		0.0222		0.0172		0.0135
65	0.020	36	0.0835	38	0.0779	40	0.0725	42	0.0683	44	0,0647
	0.040		0.0713		0.0660		0.0611		0.0567		0.0530
	0.060		0.0596		0.0544		0.0498		0.0455		0.0420
	0.080		0.0481		0.0432		0.0388		0.0347		0.0312
	0.100		0.0372		0.0325		0.0282		0.0242		0.0210
	0.120		0.0267		0.0221		0.0180		0.0140		0.0109
70	0.020	36	0.0681	38	0.0635	40	0.0589	42	0.0556	44	0.0525
	0.040		0.0577		0.0536		0.0494		0.0460		0.0429
	0.060		0.0481		0.0440		0.0402		0.0368		0.0338
	0.080		0.0387		0.0348		0.0312		0.0275		0.0249
	0.100		0.0298		0.0260		0.0225		0.0192		0.0166
	0.120		0.0211		0.0174		0.0142		0.0111		0.0085
75	0.020	36	0.0530	38	0.0493	40	0.0456	42	0.0430	44	0.0405
	0.040		0.0444		0.0413		0.0380		0.0353		0.0330
	0.060		0.0370		0.0336		0.0307		0.0279		0.0258
	0.080		0.0296		0.0265		0.0236		0.0205		0.0189
	0.100		0.0225		0.0197		0.0169		0.0141		0.0125
	0.120		0.0160		0.0131		0.0106		0.0083		0.0064
80	0.020	36	0.0390	38	0.0360	40	0.0332	42	0.0311	44	0.0293
	0.040		0.0331		0.0301		0.0280		0.0257		0.0242
	0.060		0.0273		0.0245		0.0225		0.0205		0.0191
	0.080		0.0216		0.0191		0.0172		0.0154		0.0142
	0.100		0.0161		0.0141		0.0122		0.0104		0.0092
	0.120		0.0110		0.0090		0.0073		0.0055		0.0043
85	0.020	36	0.0253	38	0.0231	40	0.0212	42	0.0196	44	0.0183
	0.040		0.0215		0.0195		0.0178		0.0166		0.0151
	0.060		0.0177		0.0159		0.0143		0.0130		0.0119
	0.080		0.0138		0.0122		0.0108		0.0096		0.0087
	0.100		0.0100		0.0086		0.0073		0.0063		0.0055
	0.120		0.0062		0.0050		0.0039		0.0030		0.0023

Contributed by George W. Burley

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

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MACHINING LOCOMOTIVE CYLINDERS*

PRACTICE AT THE JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD

By FRANKLIN D. JONES†

THE cylinders of locomotives vary considerably in their general arrangement, and the exact method of machining them depends altogether on the type, but as the variations in practice are of minor importance, we shall deal with the subject in a general way instead of describing in detail the operations for each particular design. The various operations referred to represent the practice at the Juniata shops of the Pennsylvania Railroad, where all the passenger locomotives and many of the freight class used in this extensive system are built. The style of cylinder now used almost exclusively on the new locomotives built by the Pennsylvania Railroad, is the single-expansion piston-valve type. Figs. 3 and 4 show two designs which differ in that the cylinders illustrated in Fig. 3 are cast integral with the saddle, whereas the cylinders shown in Fig. 4 are bolted to the saddle which forms a separate casting. The advantage of this three-piece construction is that a broken cylinder can be replaced more quickly because the saddle does not need to be detached from the boiler or frames. With the design shown in Fig. 3, considerable time is required to fit and bolt the flange on the saddle of a new cylinder to the boiler.

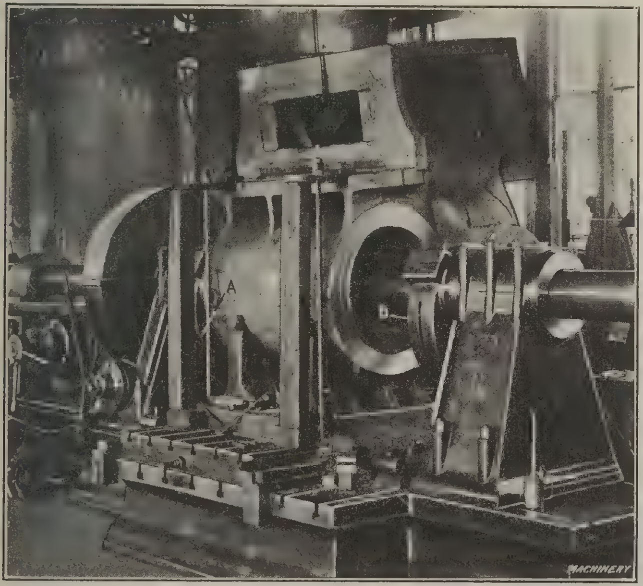


Fig. 1. Boring a Locomotive Cylinder

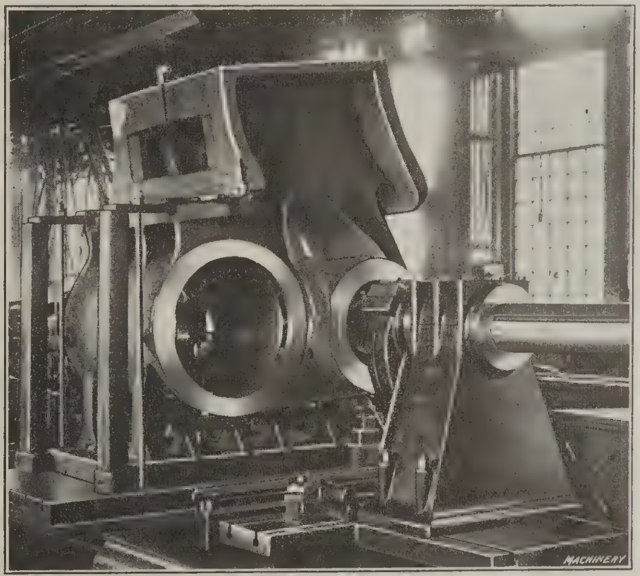


Fig. 2. Cylinder set for Boring Valve Chamber

Boring the Cylinders

The first machining operation on a cylinder casting is that of boring the cylinder proper. The boring is done by the large machine illustrated in Figs. 1 and 2. The cylinder casting is supported at the right height by a fixture, as shown. The flanges are first rough-faced by radial facing arms *A* and *B*, the tools of which are fed by the well-known star feed. The bore is then finished by one roughing and one finishing cut, four tools being used for roughing and two for finishing. Broad-nosed tools are used for the light finishing cut and are given a feed of 3/8 inch per revolution of the boring-bar. As the boring-bar is very rigid, these coarse feeds can be used without chattering. The cylinder is also counterbored as far in as the inner edge of the steam ports, to prevent the piston-rings from wearing shoulders at the ends of the piston stroke.

After the cylinder bore is finished, the table or platen of the boring machine is moved over the right distance for boring the valve chamber, the proper adjustment being determined by graduation lines at the side of the table. In order that the valve chamber will be at the proper vertical height after making this adjustment, the casting is originally set up in the machine so that the centers of the cylinder and valve chamber are in the same horizontal plane. Fig. 2 shows the position of the work when set for boring the valve chamber. The flanges are faced prior to boring, and the offset of the flanges with relation to the cylinder flanges, is tested by a special gage. The valve chambers are not bored to one diameter throughout, but have a shoulder at each end for locating the valve bushings or linings which are afterward forced into the bore. The piston-valve operates inside these bushings, which can readily be renewed when worn. As the steam ports are machined in the bushings, the latter must be accurately located lengthwise to bring the ports in the right position. The proper location for each bushing is secured by the shoulder previously referred to, in conjunction with corresponding shoulders on the bushings; hence this shoulder in the bore must be accurately located by another special gage.

Planing the Cylinders

After the cylinder is bored, the various surfaces on the saddle are planed. By the use of an ingenious set of fixtures, the castings are set up for the planing operations quickly and accurately. Fig. 5 shows the cylinder planer with these fixtures in place, and Figs. 6, 7, and 8 show different views of the work mounted on the fixtures. Three cylinders are placed in a row and planed simultaneously, and the fixtures are so arranged that the bores of the various cylinders are aligned with one another and with the planer platen. These fixtures consist of heavy brackets or standards *B* having flanges as shown. The end brackets have a single flange, whereas the two

* For information on locomotive building, at Altoona, previously published in MACHINERY, see "Machining Locomotive Frames," March, 1912; "Locomotive Building at Altoona—Driving Box Manufacture," July, 1910; "Erection Practice in the Juniata Shops," June, 1910, and articles there referred to.

† Associate Editor of MACHINERY.

which come between the cylinders are double flanged. There is a central pocket A in each flange face, and the distance from these pockets to the base is exactly the same for each bracket.

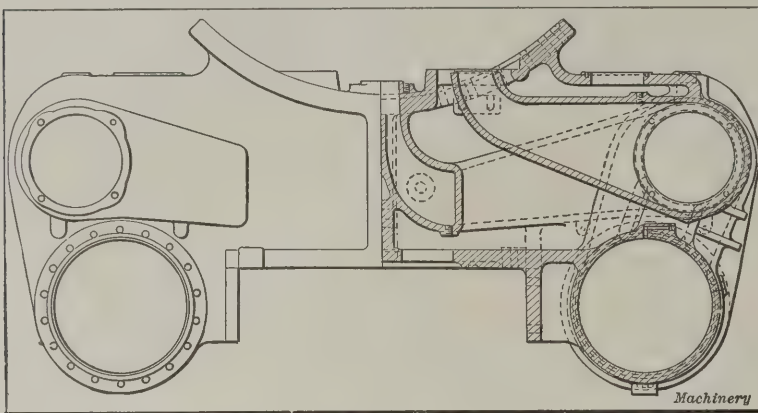


Fig. 3. Front View of Locomotive Cylinders of the Single-expansion Piston Valve Type

Each of the conical disks C which engage the counterbores of the cylinders, has a cylindrical boss D on the rear side which fits into any of the central pockets A. When a cylinder is to be set up for planing, one of these conical disks is clamped in each end of the counterbore by a bolt passing from one disk to the other. The brackets are also bolted to the planer platen in the proper position, as indicated in the illustration. The distance between the brackets is governed by the length between the outer faces of the disks after the latter are bolted in place, and the central pockets A are all brought into alignment, laterally, by tongue-pieces on the base of each bracket. The cylinder is next picked up by a crane and lowered until the disks have entered between the brackets. The temporary holding bolt for the disks is then removed and the work is lowered until the cylindrical bosses D on the disks, which slide through the vertical slots at E, rest in the central pockets A of the fixtures. When three cylinder castings have been set up in this way, the center line or axis of each cylinder bore will be in alignment.

the bore of the valve chamber by using hermaphrodite calipers. The casting is then adjusted vertically by the small supporting jacks seen in Fig. 8, until this center is the required distance below the center of the cylinder, as shown by an ordinary surface gage. The height from the platen to the center of the cylinder bore is accurately ascertained beforehand and remains constant for a given size fixture. After the three castings are set as described, clamping pieces which fit in the slots E, Fig. 5, are tightened against the hubs of the conical disks by clamps H. The cylinders are further secured by a long tie-bolt G, Fig. 6, which extends through the three castings and holds both the work and fixtures rigidly together. The side view, Fig. 7, clearly shows how the conical disks enter the cylinder counterbores and align the three castings. By referring to Figs. 6 and 8, it will be seen that these fixtures make it possible to hold the three cylinders with very few clamps; in fact, the four clamps seen in Fig. 8 are (with the exception of clamps H which are part of the fixture) the only ones required. These fixtures have not only effected a considerable reduction in the time required for setting the cylinders

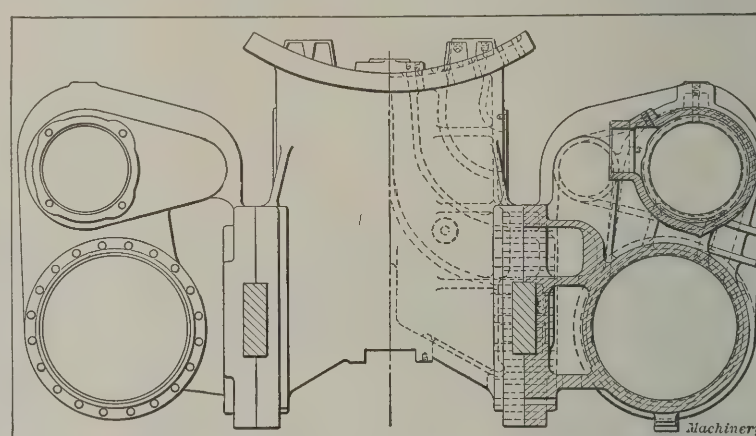


Fig. 4. Locomotive Cylinders having a Detached Saddle

prior to planing, but they also insure accurate and uniform work.

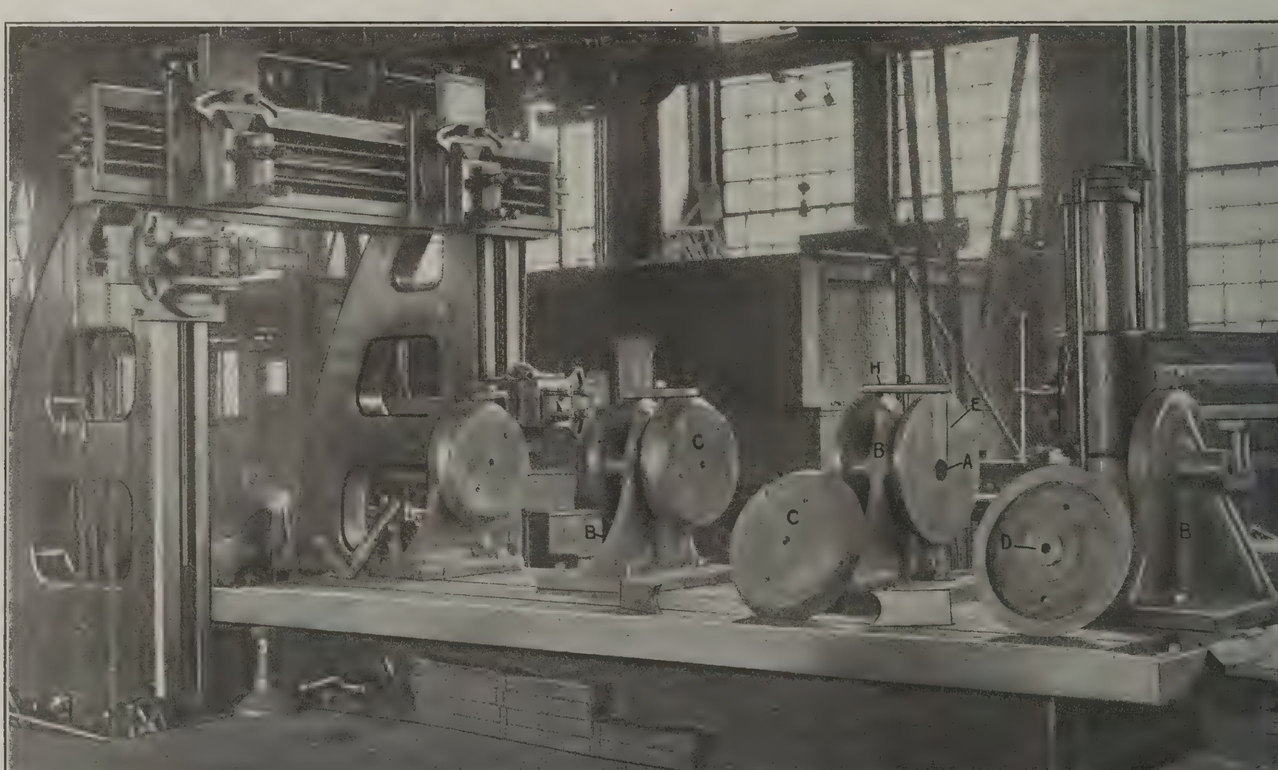


Fig. 5. Fixture for Holding Cylinders while Planing

The valve chamber is next set vertically with relation to the center of the cylinder. To obtain this setting, a spider F, Fig. 6, is placed in the valve chamber and its hub is centered with

After the cylinders are set as described, the top surface I, Fig. 6, which forms the joint between the right- and left-hand cylinders, is rough-planed by using the two tool-heads. This

surface is then finished with a broad tool which is set to the right height for the final cut by a special micrometer gage N. The cutting edge is adjusted to coincide with the top of this gage, which is graduated with reference to the centers of the fixtures so that heights from the center of the cylinder bore can be read directly. The side J is next roughed out and finished by using a side-head, and while this surface is being

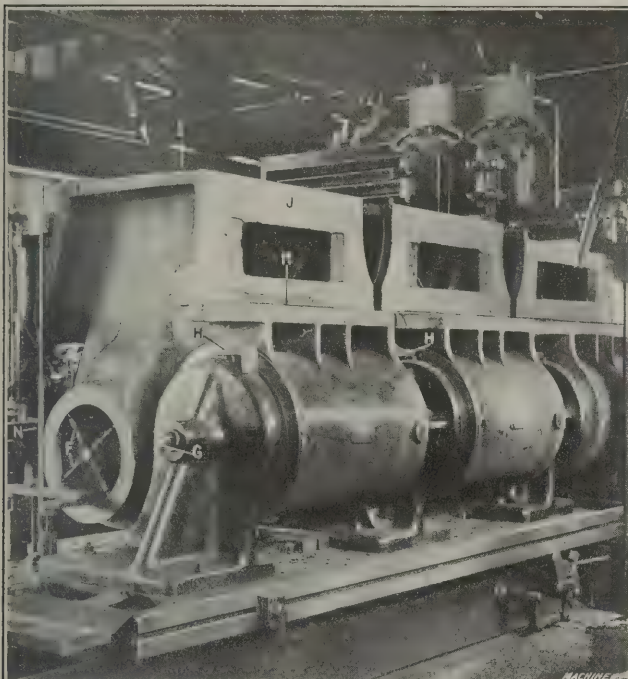


Fig. 6. Three Cylinders being planed simultaneously

planed, the seats K and L (Fig. 8) for the steam and exhaust pipes, are rough-planed with the opposite side-head. Side J is finished to a certain distance from the planer housing, the measurement being taken with a special vernier gage. By measuring directly from the housing, duplicate work is assured and the liability of mistakes is lessened. This method of

exhaust pipe, is gaged from the finished side J and the steam pipe seat L is finished with reference to the exhaust seat. The distance between surfaces I and M is measured by a special height gage. This practically completes the planer work. Of course, the order of the operations is governed entirely by the shape of the cylinder casting, and differs from that described in the foregoing, for other types of cylinders.

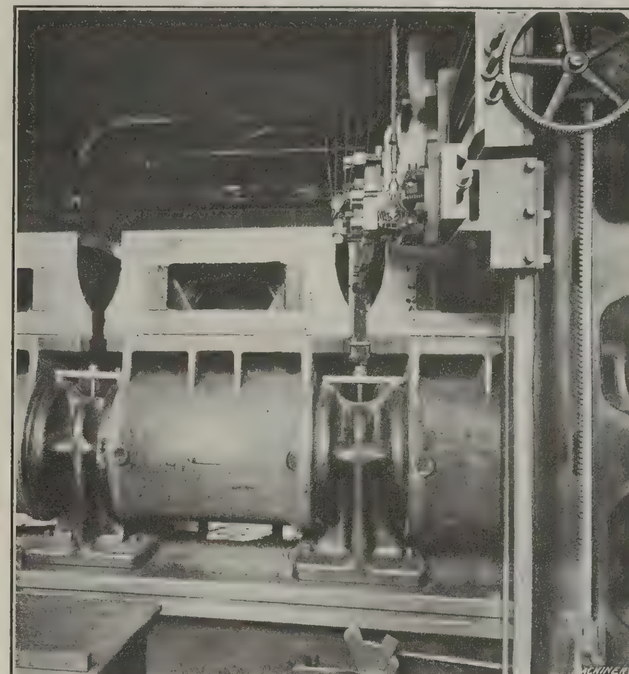


Fig. 7. Side View showing Arrangement of Planing Fixtures

Figs. 9 and 10 indicate the method of planing cylinders of the type illustrated in Fig. 4, which, as will be recalled, are bolted to the saddle. These castings are set up in the same way as described for the style illustrated in Fig. 8. The planer work on the cylinder proper, is more easily done owing to the shape of the casting. The illustrations show the two

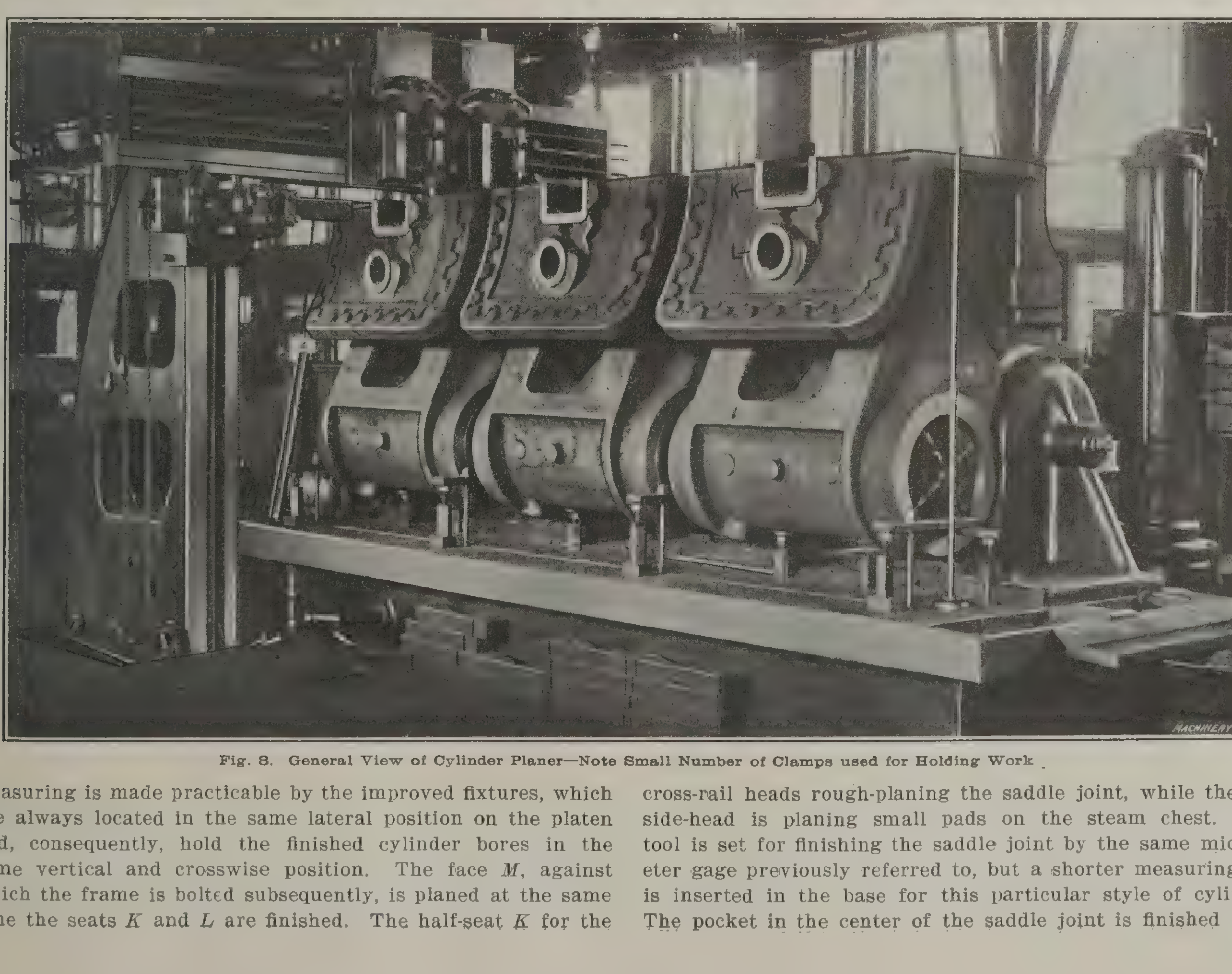


Fig. 8. General View of Cylinder Planer—Note Small Number of Clamps used for Holding Work

measuring is made practicable by the improved fixtures, which are always located in the same lateral position on the platen and, consequently, hold the finished cylinder bores in the same vertical and crosswise position. The face M, against which the frame is bolted subsequently, is planed at the same time the seats K and L are finished. The half-seat K for the

cross-rail heads rough-planing the saddle joint, while the left side-head is planing small pads on the steam chest. The tool is set for finishing the saddle joint by the same micrometer gage previously referred to, but a shorter measuring rod is inserted in the base for this particular style of cylinder. The pocket in the center of the saddle joint is finished to fit

the frame, and in the right relation to the cylinder bore. There are also corresponding pockets in each side of the saddle casting, and the frames pass through the rectangular opening or mortises thus formed, as indicated by the section lines in Fig. 4. The planing of this saddle joint and pocket, is practically all the planer work there is on a cylinder of this type. The nature of the planing operations on the saddle is clearly indicated by the drawing Fig. 4.

Laying Out and Drilling the Cylinders

After the cylinders are planed, the accuracy of the machine work previously done is tested and the casting is laid out for drilling holes that cannot conveniently be jig-drilled. Fig. 11 shows the method of testing the location of the cylinder bore and valve chamber, with relation to each other and to the finished central joint which is resting on the laying-out plate. The centering spiders shown are first accurately set in each bore and the respective heights of the cylinder and valve chamber are determined by using a tall surface gage. These heights are measured by comparing the gage pointer with a long steel scale held in a vertical position. While the use of the planing fixtures previously described, insures accurate work, it has been found advisable to check important dimensions so that the cylinders can be erected without delay due to imperfect work. After the height of each bore has been checked, as described, the distance from the face of the back cylinder flange to the finished projection A is carefully tested, as this projecting flange rests against the frame and determines the cylinder's fore-and-aft location.

Most of the holes in the cylinder are, of course, drilled by the use of jigs. There are, however, a few holes which cannot conveniently be drilled in this way and these are laid out at this time. For example, the small screw holes around the periphery of the flange, for fastening the cylinder jacket, as well as those for lubricator and indicator pipes, dripcocks, etc., are all laid out by hand. A center line L (see Fig. 15) is also drawn across the saddle face for locating the jig used when drilling the bolt holes for the steam and exhaust pipe seats at S and E. This line is exactly central with the front and back flange faces of the cylinder. A central point is first located at L_1, Fig. 12, by measuring from a long straightedge held across the front and back flanges. The cylinder is then turned over and this line is carried across the saddle joint by using a large square.

The drilling operations on the cylinder are of an obvious nature and therefore a detailed description of this work will be unnecessary. Practically all the holes are drilled by the use of jigs, in large radial machines. Fig. 13 shows a plate jig for drilling the frame bolt holes. This jig is located by the finished end A on the cylinder and the jig for drilling the corresponding holes in the frame is set by a shoulder which bears against end A, so that both sets of holes register closely when the cylinder and frame are assembled; consequently,

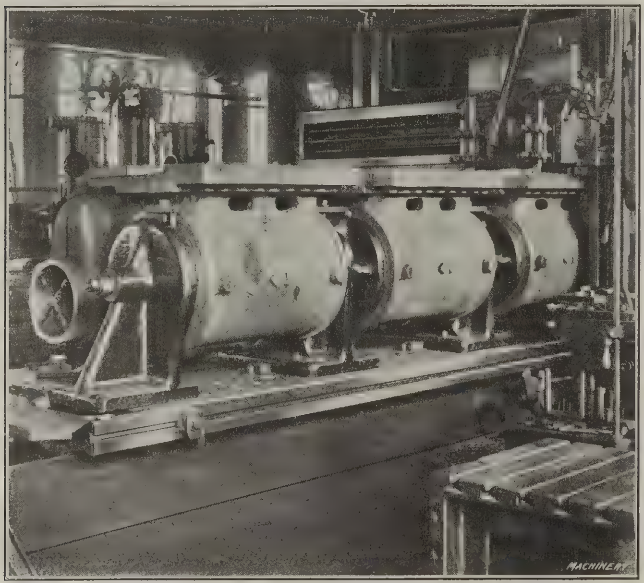


Fig. 9. Planing Cylinders of the "Three-piece" Type

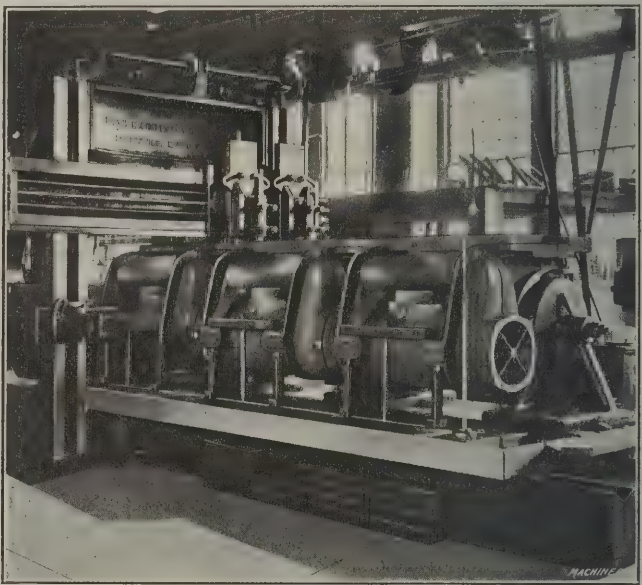


Fig. 10. Another View of the "Three-piece" Cylinders set up for Planing

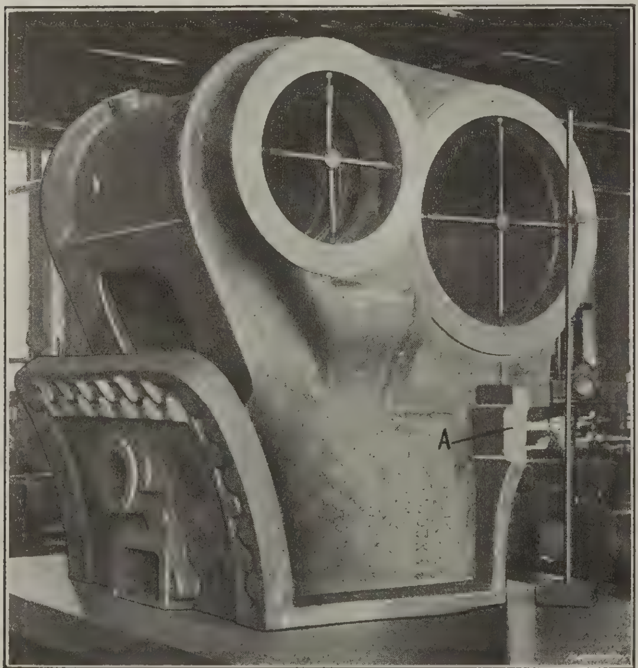


Fig. 11. Testing Height of Cylinder and Valve Chamber

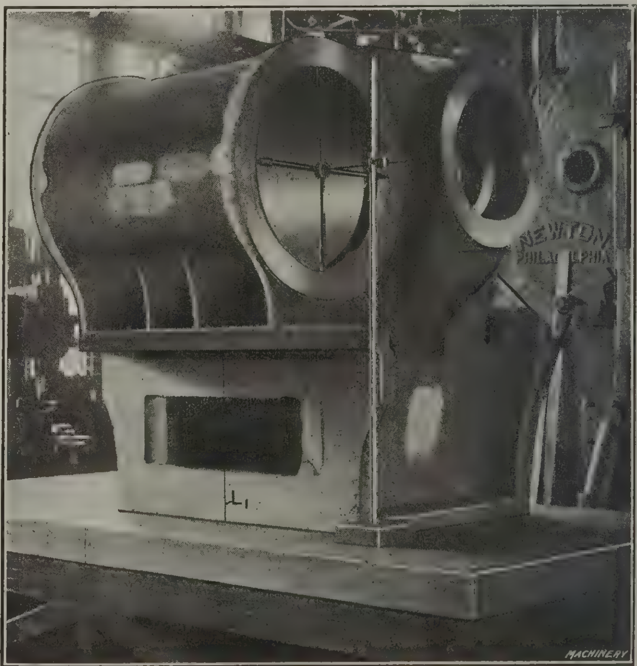


Fig. 12. Another View of Cylinder on Testing and Laying-out Plate

little reaming is necessary. The holes for the stud bolts which hold the cylinder and the steam chest heads in place, are drilled with ordinary ring jigs as indicated in Fig. 14. Fig. 15 shows the method of forming the seat for the steam pipe. This pipe is not clamped directly to the cylinder, but bears against a cast-iron ring having a flat face on one side and a spherical face on the other. The large reamer *R* forms this spherical seat, which is clearly shown in the view to the left, Fig. 16.

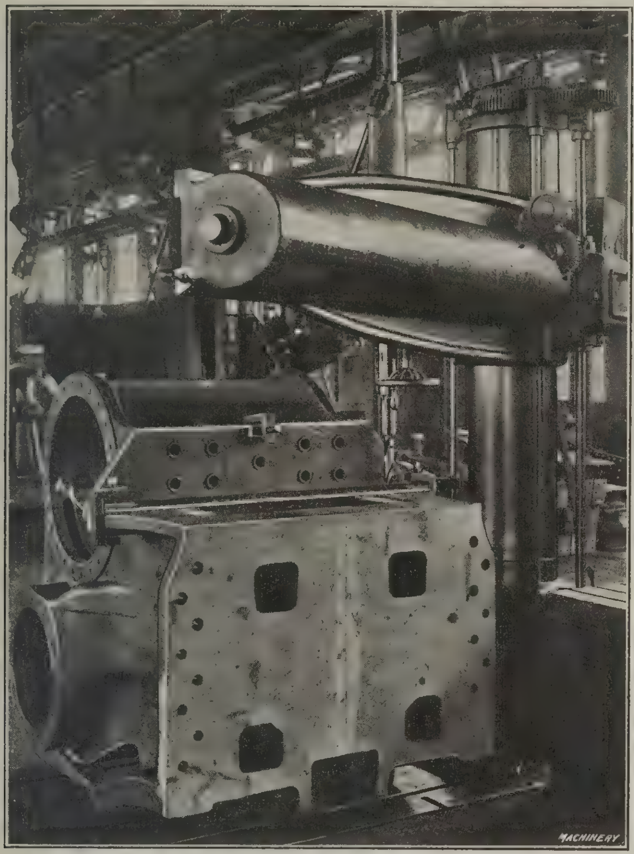


Fig. 13. Drilling Frame Bolt Holes

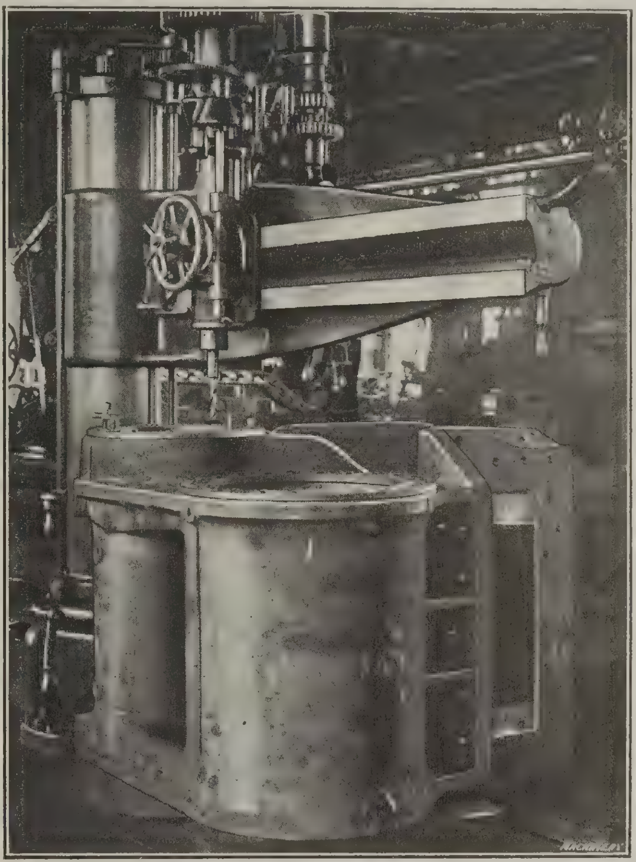


Fig. 14. Drilling Flanges

Erecting Cylinders—Piston-valve Bushings

When the drilling is completed the cylinders are ready for the erecting shop. The right- and left-hand cylinders which are to be mates, are set up and aligned as illustrated in the two views Fig. 16. The saddle bolts through the front and rear flanges *F* are then reamed and the tightly fitting taper bolts are inserted. The cylinders are now ready to be attached to the frames. They are first bolted to the frames temporarily, and their position is carefully tested. The bolt holes are next reamed and the right and left frame sections are bolted to their respective cylinders.

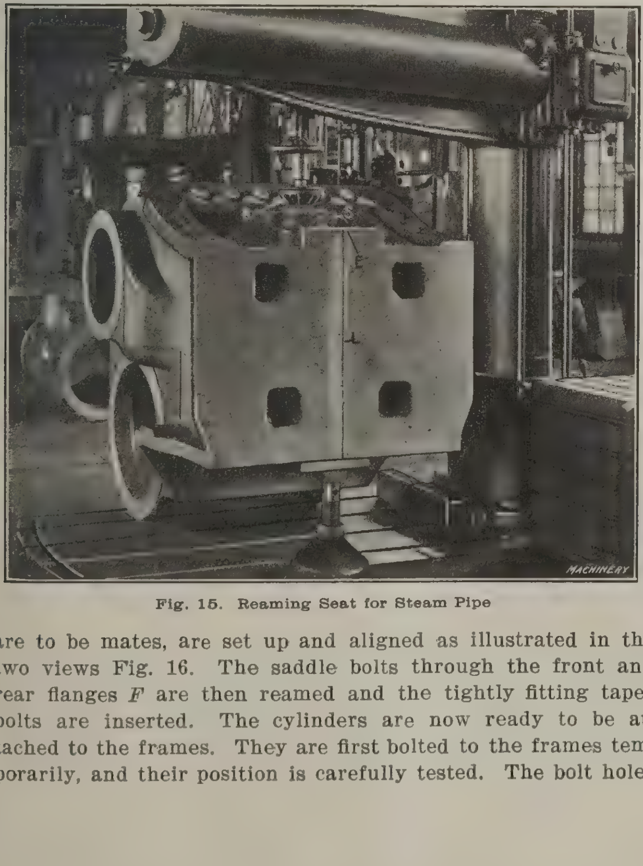


Fig. 15. Reaming Seat for Steam Pipe

Fig. 16. Cylinders aligned for Reaming Flange Bolt Holes

The bushings or linings for the valve chambers are also inserted at this time. There are two of these bushings in each cylinder, which are inserted from opposite ends of the valve chamber bore. The inside of the bushing is bored to fit the piston-valve, and the outside is turned to fit tightly into the cylinder. The boring is done in a vertical boring machine, and the outside is turned in a lathe (as indicated in Fig. 17), after the boring operation. The bushing is mounted on a large expanding mandrel, and it is turned from 0.005 to 0.008 inch larger than the bore of the valve chamber, in order to secure a tight fit. This allowance varies somewhat for bushings of different diameter. After the bushing is turned, the steam and exhaust ports, which are cored in the casting, are finished by milling. Two finished bushings are shown to the right in Fig. 17. The large ports *E* are for the exhaust and the smaller ports *S* register with the cylinder steam ports when

the bushings are in place. These ports are milled to a standard width by the use of gages. They are also located with reference to the shoulders L which, as previously stated, come against corresponding shoulders in the valve chamber, and determine the respective positions of the bushings. The distance between the steam ports is checked before the bushings are inserted in the cylinder. This preliminary test is made by placing the two bushings in line, with the shoulders L the same distance apart as the shoulders in the valve chamber. The distance between the inner edges of the steam ports is then measured with a large vernier scale V. A variation of only 0.004 inch is allowed for this dimension. As the distance

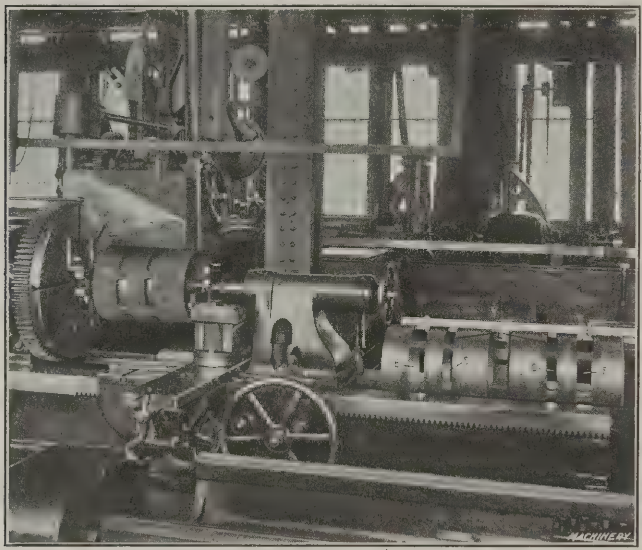


Fig. 17. Method of Turning Valve Bushings and Preliminary Test to determine Location of Steam Ports

between the packing rings of the piston-valves, and also the width of the rings, is accurately gaged, the proper relation between the valve and the steam ports is secured within close limits.

The finished bushings are drawn into the valve chamber by a screw and air motor as shown in Fig. 18. This particular illustration shows the motor arranged for drawing in the rear bushing. The screw, which is rotated by the motor, is prevented from moving longitudinally, by a heavy strap which

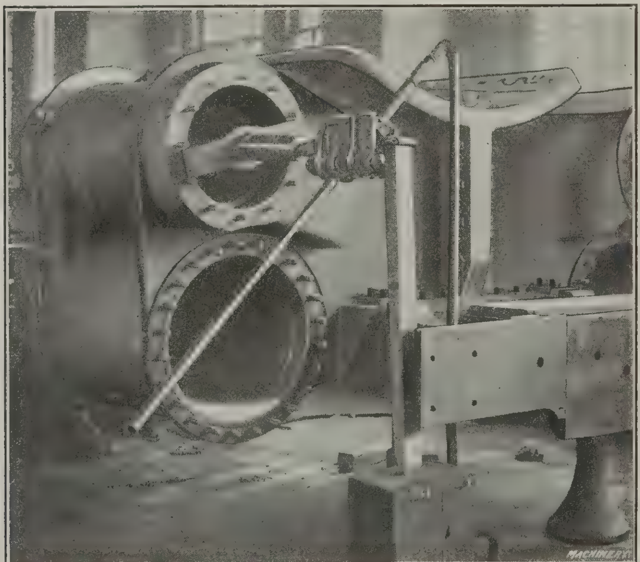


Fig. 18. Drawing in Valve Bushing with Air Motor

is placed across the flange as shown. After both bushings are drawn in against the shoulders, the distance between the steam ports is again tested with the vernier scale. This second measurement is taken to make sure that the bushings are not held away from their seats by small chips or dirt which may have been overlooked when the bore was cleaned.

Before the boiler can be erected, the curved seat or saddle formed by the two cylinders, must be fitted to the front of the smokebox. As the steel sheet which forms the smokebox, may not be exactly circular, the saddle is always fitted to the particular boiler for which it is intended. In order to obtain the required outline, the boiler is lowered by a crane onto the frames and cylinders. The boiler is then set level, both lengthwise and laterally, and it is also centered with the frames. The outline of the smokebox is then transferred to the saddle flanges, by using a scratch gage. This line represents the finished surface of the saddle, and it should be drawn just far enough from the top surface, to permit truing the entire saddle flange. When this line is scribed, the boiler is removed and a gang of men chip the flange down to the required outline. This chipping is done by pneumatic hammers. There are raised pads on the saddle flange as shown in the view to the left, Fig. 16, so that a comparatively small surface requires chipping. When the flange is finished, the boiler is permanently bolted to the cylinders, and when this stage is reached the erection of the locomotive proceeds rapidly. A detailed description of locomotive erection was published in MACHINERY, railway edition, June, 1910.

* * *

HIGHEST VOLTAGE DIRECT-CURRENT LOCOMOTIVE IN THE UNITED STATES

Recently the East Pittsburg Works of the Westinghouse Electric & Mfg. Co. completed equipping the locomotive illustrated, for the Piedmont Traction Co., which will operate an extensive railroad system in the Piedmont section in North Carolina and South Carolina. This locomotive is one of six to operate at a pressure of 1500 volts direct-current.

Baldwin-Westinghouse 55-ton 1500 Volt, Direct-current Locomotive for Piedmont Traction Co., equipped with four No. 308-B—5, 180 H. P. 700 Volt Railway Motors and Westinghouse HL Control

This voltage is the highest direct-current voltage used by any electric railway in the United States. The mechanical parts were built by the Baldwin Works, Philadelphia, Pa. The locomotives weigh 55 tons each and are equipped with four Westinghouse motors which have a rating of 180 horsepower. Each locomotive is able to haul 40 freight cars weighing 45 tons each with load, at 20.5 miles per hour on a straight level track, or nine cars at the same speed on a 1 per cent grade. The motor equipment is controlled by the Westinghouse electro-pneumatic, unit switch type of control. Steel construction is used throughout. The under-framing is built of steel channels and the cab-sheets are mounted on a steel angle-iron frame. Electric power for operating the Piedmont properties will be supplied by the Southern Power Co., Charlotte, N. C.

* * *

A well-constructed locomotive leaf spring is made with the ends of the leaves tapered in thickness to a comparatively thin edge, the object being to make the outline approximate the parabolic curve of the theoretical spring. The tapering of the ends entails considerable labor, and in some railway repair shops the theoretical consideration in spring-making is being sacrificed by leaving the ends of the leaves square. The extra stock required for a spring end is lost, but this is more than balanced by the saving of labor. Springs made in this way are not as efficient, however, as when the leaves are tapered.

REPAIRING PLANERS AND SHAPERS*

By EDWARD K. HAMMOND†

The wearing of parts of a machine, through use or misuse, necessarily disturbs its alignment and makes accurate work impossible. In such cases, the wear in each individual member need not be great, because the errors produced are cumulative in their effect, and negligible amounts of error in the different members combine to result in a serious inaccuracy in the work produced by the machine. The average mechanic, experienced in the operation of machinery, is familiar with these facts, but when he attempts to adjust a machine to compensate for wear, he is more than likely to fail. This failure is generally due to the use of improper methods of doing the work.

The firm of A. O. Walworth & Co., 30 S. Clinton St., Chicago, Ill., makes a specialty of rebuilding machinery, and,

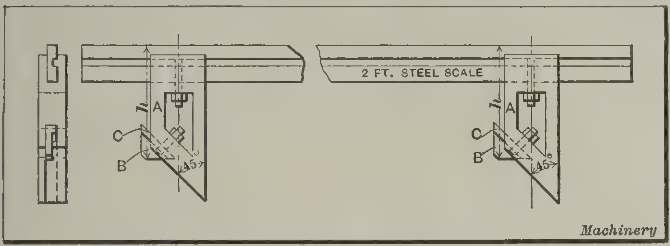


Fig. 1. Special Gage used for Testing Planer Beds and Tables

as the result of a wide experience in this work, special methods have been developed to compensate for the wear in used machine tools. These methods enable a badly worn machine to be adjusted to practically the same degree of accuracy that it possessed when new, and in this article, the practice of this company in the adjustment of planers and shapers will be described. While these methods are all of a special character, they will be readily understood by any mechanic, and their use will make it possible to put machines back into such a condition as to fit them for the production of accurate work.

Method of Adjusting a Worn Planer

In starting upon the adjustment of a planer, the first step is to completely dismantle the machine, in order that the

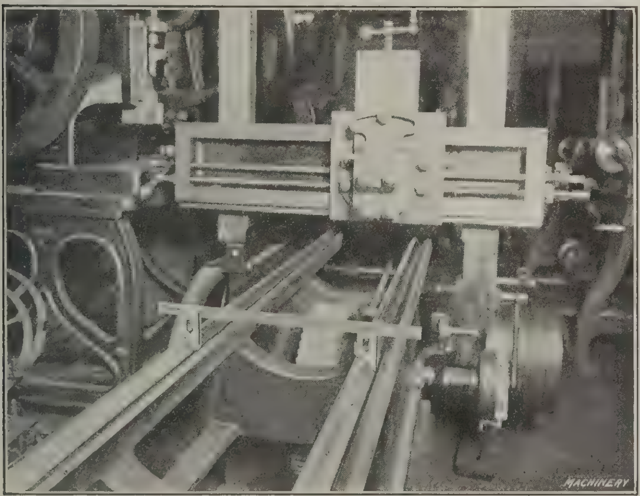


Fig. 2. Testing the Distance between Corresponding Surfaces of the Vees

condition of each part may be determined by tests and inspection. The class of service for which the planer has been used necessarily determines the amount of wear and the points where it will have been produced. In general, however, it may be stated that the table and its bearings in the bed, the crossrail, the saddle bearing on the crossrail, and the shaft bearings, are the points where the most serious inaccuracy is likely to be found.

Planer tables are frequently sprung out of shape as the result of poor judgment on the part of the operators in clamping down the work. When the clamping bolts are tightened to such an extent that the table is drawn out of shape, and the work and table are then allowed to stand in this way for a number of hours, a permanent set is more than likely to be produced. This is especially true if tools or other heavy objects are dropped on the table while it is in this strained condition. In such a case a vibration is set up which causes the metal to readjust itself to the new shape. Where inaccuracy of this kind occurs, it will usually be found that the middle of the table has become high, the amount of the deformation being easily determined with a straightedge. The error in planer tables from this cause is often a very serious matter, an instance having been brought to the writer's attention where an 8-foot planer table was ½ inch higher at the middle than at either end.

In adjusting a table that has been sprung out of shape in this way, it must be remembered that the thickness has originally been properly proportioned to the length and width. Consequently, if any considerable amount of metal is removed by planing, the table will be too thin. This difficulty has been overcome by reversing the process which caused the deformation of the table, in bringing it back into proper alignment. A heavy iron floor-plate is used for this purpose, provided with bolt holes for clamping down the work. The planer table is laid on this plate, face down, and is then clamped tightly against the surface of the plate. After remaining in this position for two or three days, it will be found that most of the inaccuracy has been removed. During the time that

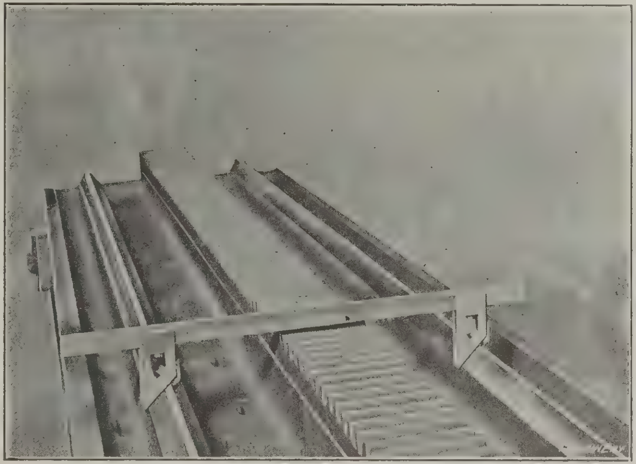


Fig. 3. Testing the Distance between the Planer Table Bearings

the table is clamped to the floor-plate, work can be progressing on other parts of the planer.

Improper methods of oiling often cause serious wear in the vees in the bed and on the table bearings which run in them. Where the bearings have worn quite smooth, there is little chance for proper lubrication, as the oil cannot be held between them. This cause of wear can be easily overcome by taking off the table about once a year, and scraping the vees and bearings. The scraper marks form small pockets which hold the oil and allow it to be distributed over the bearings as required. The bed is tested for inaccuracy of this kind with a straightedge, and if there is found to be any serious amount of wear in the vees, it must be placed on a planer and planed down to approximate accuracy, before scraping to a final finish.

The special gage shown in Fig. 1 is used to maintain the proper distance between the vees during the re-finishing operations. The blade of this gage is a 2-foot steel scale of the kind used on the Brown & Sharpe combination square. The position of the blocks *A*, at either end of the gage, can be adjusted to meet the requirements on different sizes of planer beds and tables; these blocks are secured in any desired position by means of the binding nuts shown. The angle at the bottom is 45 degrees, to fit the standard form of vee. The small triangular plates *B* slide in grooves cut in the inclined edges of the gage blocks, and can be secured in any desired position by means of the binding nuts provided for this purpose. These nuts are carried by bolts which have a slot milled in their sides to fit over the flanges *C* on the plates *B*. In adjusting this gage for use on a given planer bed, blocks *A* are set so that their inclined edges are at the same distance apart as the corresponding sides of the vees, the graduations on the

* See also MACHINERY, July, 1911, "Repairing Lathes and Milling Machines."
† Address: 9620 Hoyne Ave., Chicago, Ill.

blade of the gage being used for this purpose. The plates *B* are then adjusted with a micrometer caliper so that the distance *h*, from the top of the blade to the bottom of the plates, is the same at each end of the gage. It will be seen in Fig. 2 that plates *B* rest on the top of the bed, the purpose being to steady the gage and bring the blocks *A* into proper alignment with the sides of the vees.

In starting to re-finish the bed, the first step is to plane and scrape the horizontal surfaces at the top of the vees. Accuracy in two directions is necessary; each surface must be finished so that it tests up to a straightedge, and all four surfaces must be in transverse alignment. After each of these surfaces has been accurately finished, their transverse alignment is tested with the dial test indicator, which is mounted

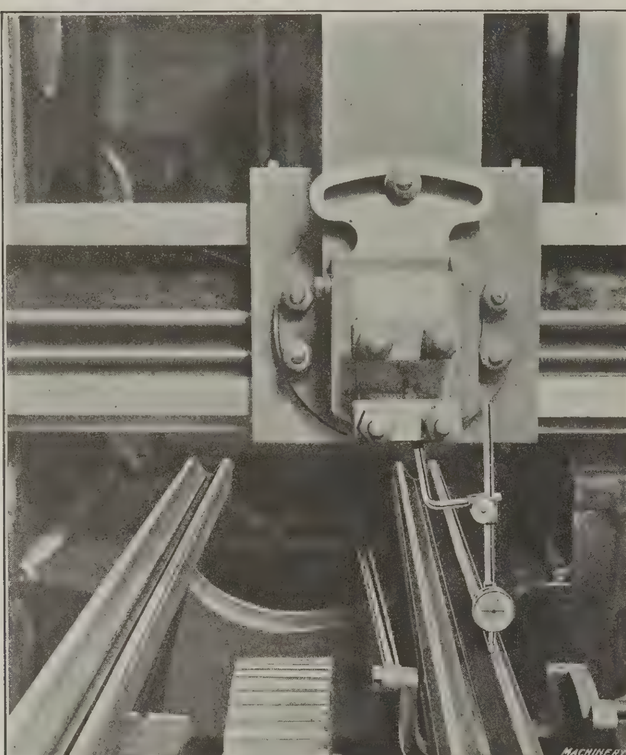


Fig. 4. Method of Aligning the Crossrail with the Planer Bed

in the planer head. The indicator is traversed over each of the four surfaces, and if the proper alignment has been secured, its reading will be the same for each surface; if either surface is found to be too high, however, it must be scraped down until the test gives satisfactory results. The accuracy obtained in this operation is important, because these surfaces of the bed are used in adjusting the housings and to bring the crossrail into proper alignment with the table.

It is only in extreme cases that it is necessary to resort to planing the vees in the bed; the wear at this point is usually so slight that it can be removed by scraping. In performing this operation, the outside surface of one vee is scraped down and tested with a straightedge, and this surface is then used as a standard of reference for the gage in re-finishing the corresponding surface of the other vee. The method of using the gage for this purpose is shown in Fig. 2, the gage being moved along the bed to determine the amount of metal which must be removed at different points. The surface is then scraped down to an accurate finish, as determined with the straightedge, the gage being used at frequent intervals to make sure that too much metal is not removed. The opposite sides of the vees are then re-finishd in exactly the same manner—the surface of one vee is first scraped down to a straightedge and is then used as a standard for the gage in re-finishing the remaining side of the other vee. It is evident that the gage need only be turned end for end to make it available for this operation.

The same general method of procedure is followed in re-finishing the table bearings, the use of the gage providing a method of obtaining exactly the same distance between them as that between the vees; this insures having the table fit properly on the bed. The table is removed from the floor-plate and mounted on the table of a planer, where the bearings are lined up with the dial test indicator to determine the amount of inaccuracy which still exists. If this inaccuracy is great enough to require planing, care must be taken not to remove any more metal than is absolutely necessary. The outside surface of one of the bearings is then scraped and tested with a straightedge, and this surface is then used as the standard of reference for the gage in re-finishing the corresponding surface of the other bearing, as shown in Fig. 3. This latter surface is scraped down to a straightedge, the distance between the bearings being maintained constant with the gage, as previously described for the vees in the bed. The opposite sides of the bearings are then re-finished in exactly the same way.

It is evident that the use of this special gage for both the table bearings ana the vees in the bed, assures that they will fit together with absolute accuracy. Far greater precision is attainable in this way than when male and female templets are used on these operations. If any considerable amount of metal has to be removed from the table bearings, it will bring the rack too low to mesh properly with the driving pinion. In such cases, the rack must be removed from the table and have a corresponding amount of metal planed from its bearing.

The crossrail and the bearing of the saddle upon it are subject to uneven wear, owing to the fact that most planer work is done with the head near the center of the rail. To remove the error produced in this way, the crossrail is planed on its face and sides, and then scraped until the re-finished surfaces line up properly when tested by the dial test indicator. The saddle bearing is then scraped to an accurate fit on the re-finished crossrail.

The planer housings are not often subject to any appreciable amount of wear, but their adjustment is sometimes inaccurate, thus throwing the crossrail out of alignment with the table.

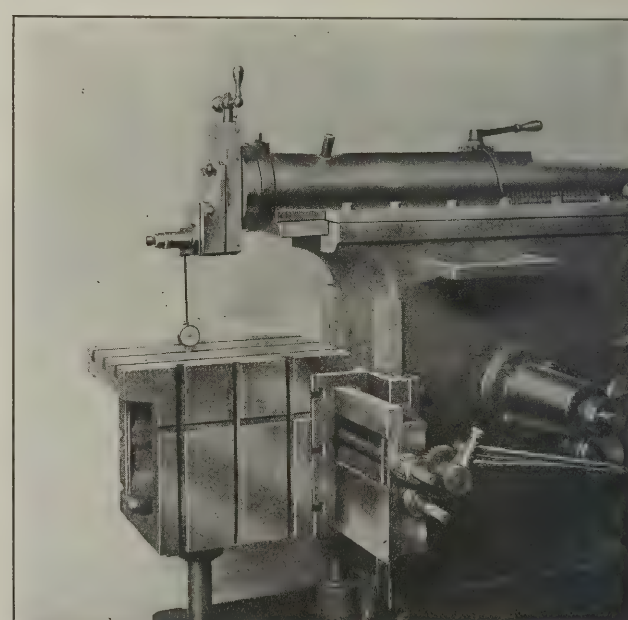


Fig. 5. Proving the Accuracy of a Re-finished Shaper Table

In re-assembling the planer, the re-finished surfaces at the top of the vees in the bed are used as a standard of reference in adjusting the housings, a millwright's steel square being used to bring them into a perpendicular position. After making these adjustments, the bearings of the crossrail are scraped to an accurate fit on the housings; the crossrail is then mounted in position and lined up with the bed. The dial test indicator is used for this purpose, as shown in Fig. 4, the indicator being brought into contact with the surfaces at the top of the vees, first at one side of the bed and then at the other. Corresponding readings of the indicator show the rail to be in proper alignment, but if this test cannot be made with satisfactory results, it is necessary to readjust the housings. The test is then repeated and further adjustments are made on the housings, if necessary, until the proper alignment of the

crossrail has been secured. It is, of course, understood that this alignment of the crossrail with the bed provides for having the table and the crossrail in proper alignment with each other.

Any inaccuracy in the bearings which carry the driving shafts will set up a vibration which manifests itself in an uneven finish on the work. Where such inaccuracy has been caused by wear in the bearings, it must be removed—by scraping, if possible, or by re-bushing the bearings, if they have been too badly worn to be adjusted by scraping.

A small amount of wear on either the rack or driving pinion is not a serious matter, as it does not impair the smooth running properties of the drive. Owing to the greater speed of the pinion, however, it will frequently be worn to a point where the smoothness of the drive is impaired, and in such cases, a new pinion must be provided. Where individual teeth of either the rack or pinion have been damaged, they can be economically repaired by adding metal with an autogenous welding torch and then recutting the teeth. This plan can be followed by sending the work out to a shop which makes a specialty of welding operations, if a torch is not included in the equipment of the plant in which the planer is being rebuilt.

After all of these operations have been completed, the planer is ready to be re-assembled. The machine is then placed in operation to plane down the face of its own table for removing any inaccuracy which exists. The lightest possible cut is taken, and when the operation is completed, the accuracy of the finish is tested by means of the dial test indicator held in the planer head. When these methods are carefully followed, a machine which is so badly worn that it is practically worthless, can be put into condition to produce accurate work.

Method of Adjusting a Worn Shaper

In starting to adjust a shaper for the inaccuracies which have been produced from the wear of its parts, the same general steps are followed that were outlined for a planer. After dismantling the machine, all of the bearings which take part in transmitting power to the ram are examined for wear, and they are either scraped or re-bushed to meet the requirements of individual cases. Where a shaper has been subjected to severe service for a considerable length of time, it will usually be found that the pinion which drives the bull-wheel is badly worn. If this is the case, this pinion must be replaced by a new one.

The ram and its bearings in the frame of the machine are the points where the greatest wear is likely to occur. In compensating for the inaccuracy which is found in these parts, the bearings in the frame are first scraped to a straightedge. The ram is then planed down just enough to remove the wear which has developed, the dial test indicator being used to insure proper alignment of the re-finished surfaces. The ram is then scraped to fit accurately in the bearings in the frame of the shaper.

The crossrail is next mounted on the planer, where it is first planed and then scraped to an accurate finish, as determined by means of the dial test indicator. After this operation has been completed, the saddle bearing is scraped to an accurate fit on the crossrail.

The completion of these operations provides for the smooth operation of the machine. After re-assembling, a light cut is taken over the surface of the table, to provide for having it in proper alignment with the ram, any inaccuracy in the alignment of the crossrail being compensated for in this way. The precision of the finish obtained on the table is proved with the dial test indicator, as shown in Fig. 5; the table is then scraped, if necessary, until an accurate finish has been secured.

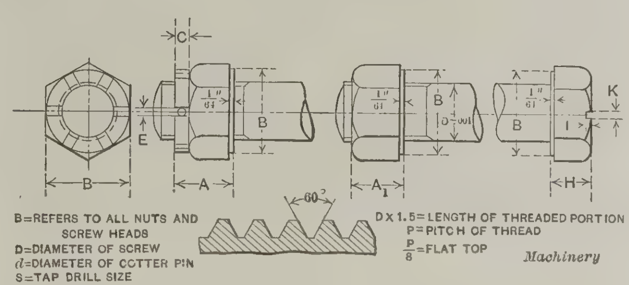
It cannot be too strongly emphasized that the greater part of the wear which develops in machinery is due to improper operating conditions. This is particularly true when machine tools are operated by men who are not trained mechanics, and in such cases, careful inspection should be made at frequent intervals to see that every machine is properly oiled, and that it is not exposed to unnecessary strains. The methods described for proving the accuracy of different planer and shaper parts, can also be used to advantage in detecting wear in the different members of the machines, and when this is discovered before it has assumed serious proportions, it can easily be remedied by a little scraping. Such a course will add greatly to the life of all classes of machinery.

* * *

A. L. A. M. SCREW STANDARD AS REVISED BY THE S. A. E.

The Society of Automobile Engineers has announced the details of the S. A. E. screw standard, which supplants the A. L. A. M. screw standard adopted by the Association of Licensed Automobile Manufacturers in April, 1906. (See MACHINERY'S Data Sheet, No. 63, November, 1906.) The revised list is given in the accompanying table. The only changes which have been made are the distances across the flats of 1/4-, 7/16-, and 3/4-inch screws and nuts, the changes being from 3/8 to 7/16 inch, from 11/16 to 5/8 inch, and from 1 1/8 to 1 1/16 inch, respectively. The A.L.A.M. screw standard did not go beyond 1 inch in diameter for standard screws, but the S. A. E. standard proceeds by eighths of an inch for screws over 1 inch up to and including 1½ inch in diameter.

S. A. E. STANDARD SCREWS AND NUT



	Number of Threads Per Inch														
Sizes	28	24	24	20	20	18	18	16	16	14	14	12	12	12	12
	Dimensions in Inches														
D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
A	9/32	21/64	13/32	29/64	9/16	39/64	23/32	49/64	13/16	29/32	1	1 5/32	1 1/4	1 13/32	1 1/2
A_1	7/32	17/64	21/64	3/8	7/16	31/64	35/64	19/32	21/32	49/64	7/8	63/64	1 3/32	1 13/64	1 5/16
B	7/16	1/2	9/16	5/8	3/4	7/8	15/16	1	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16
C	3/32	3/32	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4	5/16	5/16	3/8	3/8
E	5/64	5/64	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32	7/32	7/32	1/4	1/4
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	21/32	3/4	27/32	15/16	1 1/32	1 1/8
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	7/32	7/32	1/4	1/4
K	1/16	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	5/32	5/32	3/16	3/16
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8	11/64	11/64	13/64	13/64
S	7/32	17/64	21/64	3/8	7/16	1/2	35/64	39/64	43/64	25/32	29/32	1 1/64	1 9/64	1 17/64	1 25/64

The material from which the screws and nuts are made is steel having a tensile strength not less than 100,000 pounds per square inch, and an elastic limit of not less than 60,000 pounds per square inch. The screws as well as the screw-heads are to be left soft, and the plain nuts are to be left soft, but the castle nuts are to be casehardened. It is assumed that when screws are to be used in soft materials, such as cast iron, bronze or aluminum, U. S. standard pitches will be used.

* * *

ERICSSON'S MEMORY HONORED

The American Society of Swedish Engineers celebrated the near fiftieth anniversary of the battle between the *Monitor* and the *Merrimac* in connection with its annual dinner at the society's house in Brooklyn, N. Y., February 17. The celebration commemorated Capt. John Ericsson, the famous Swedish-American engineer who invented and designed the *Monitor*. Mr. Erik Oberg, associate editor of MACHINERY, spoke on "John Ericsson the Man," and W. L. Axel Warn, Albany correspondent of the New York *Times*, briefly described the famous engagement between the two vessels which took place in Hampton Roads, Va., March 9, 1862.

THE MANUFACTURE OF STEEL BALLS

INSPECTING, GAGING AND TESTING

By ROBERT H. GRANT*

In the previous articles on the making of steel balls in the February and March numbers, the making of the blanks, the rough-grinding, the hardening and the finish-grinding of steel balls has been taken up. In the present article it is proposed

Fig. 1. Inspecting the Balls

to treat of the inspection, grading, gaging, and testing of the balls, and also to review the various uses of steel balls, as well as to give some advice to purchasers and users regarding the quality of balls.

The Burnishing and Tumbling Processes

When the balls come from the oil grinders, they have a dull finish and must be burnished or tumbled. The burnishing can be done in the oil grinder with a set of rings having grooves in them the exact size of the balls. A light oil is used, and after a very short run of the machines, a finely polished surface will be produced. This process, however, is expensive, and the ordinary tumbling method is most generally used. The tumbling barrel universally adopted is of is most generally used. The tumbling barrel universally adopted is of the regular iron tilting type. The balls are placed in the barrel in sufficient quantities so that, when they roll over and over, their weight will cause enough friction between them to polish them. A polishing material is placed in the barrel, and the latter is allowed to run at least ten hours to produce a good surface. The balls are then cleaned off by tumbling them in sawdust, and are later placed in another barrel with finely cut kid leather. This final tumbling brings out the high polish.

Inspection

The balls are now ready to be inspected, which is done almost exclusively by girls. The skill and rapidity which can be obtained in doing this work is certainly most remarkable. One girl can inspect fifty thousand ¼-inch balls, picking out seven or eight different grades, in ten hours. This inspection, as indicated in Fig. 1, is done on glass plates which are about ten inches square and inserted in a frame so that the balls cannot roll off. The under side of the glass is painted so as to reflect the light. The plate is about half filled with balls and is placed upon a box which is tilted slightly towards the inspector. This causes the balls to always roll to the front. The inspector holds in her hand a magnet resembling in shape a knitting needle. The end is sufficiently magnetized to raise one ball of the size being inspected from the glass. In the other hand the inspector holds a piece of heavy white paper 4 inches wide by 8 inches long, which she slides under the balls. This makes the balls revolve, and with the magnet defective balls are picked out. The defects consist of pits, bands, dents, scale, rough grinding marks, etc.

The different grades are separated in boxes, placed to the right of the inspector, and they are used for different purposes according to the requirements placed on the balls. It is evident that different grades of balls may be used when it is remembered that ball bearings are employed in so many different kinds of devices, such as bicycles, clothes-wringers, hand trucks, sash pulleys, hinges, etc.

After the balls have been inspected for defects they are rolled back and forth on the glass plate in order that those that are out of round may be picked out. As the balls which are not perfectly spherical will take a zigzag motion when rolling down the plate, and the true balls will run straight, it is comparatively easy for the inspector to pick out the imperfect ones. An expert inspector does not stop each time she picks up a ball to place it in the boxes, but will usually toss it into the palm of her hand, which will generally hold all of one grade that she will pick out from the batch of balls on the plate. Balls larger than ¾ inch in diameter are generally taken up by hand and looked over. Those that are out of round in the larger sizes are taken out while measuring the balls.

Grades of Balls

Balls are generally graded into four main classes, known as alloy, and A, B, and C grades. The steel for the alloy balls contains chromium, and these balls have the greatest crushing strength. They must be absolutely free from defects as regards material and finish, and must not vary in size more than 0.0001 inch. Balls classified as A-grade are made from

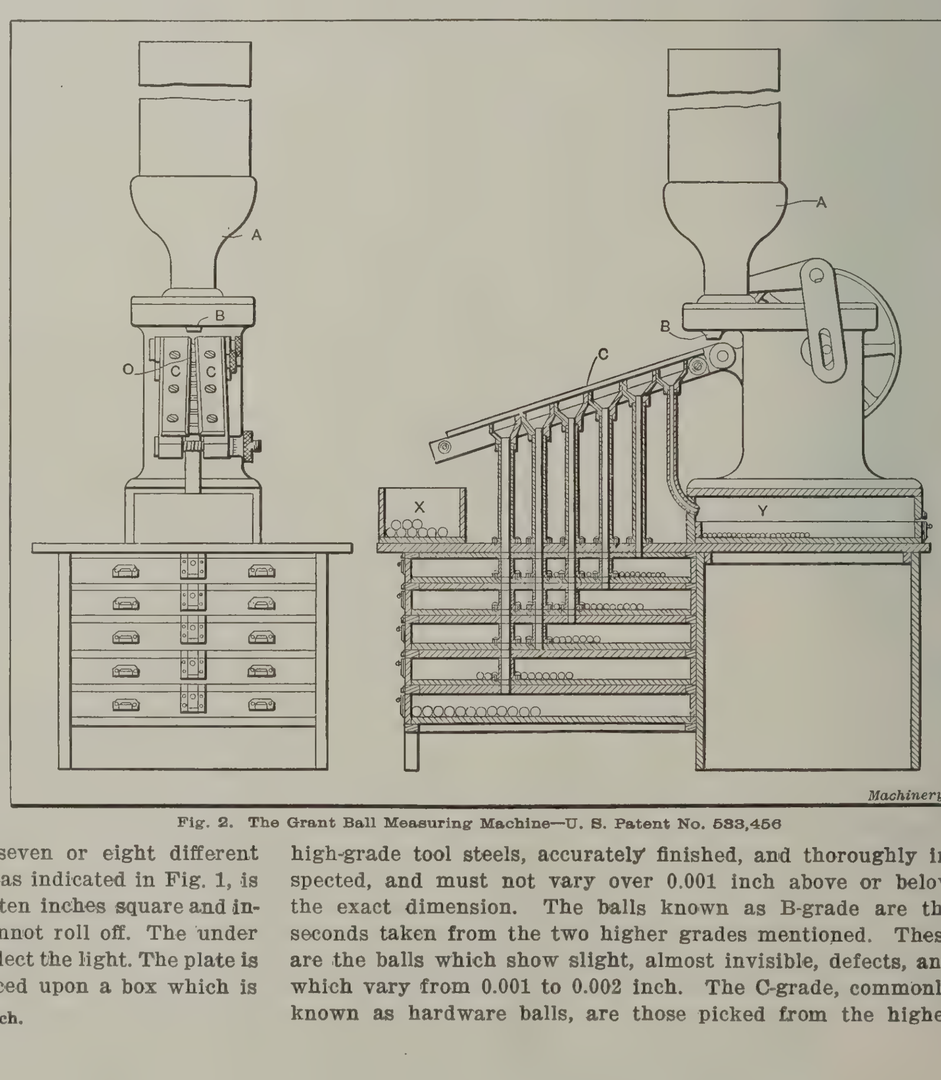


Fig. 2. The Grant Ball Measuring Machine—U. S. Patent No. 533,456

high-grade tool steels, accurately finished, and thoroughly inspected, and must not vary over 0.001 inch above or below the exact dimension. The balls known as B-grade are the seconds taken from the two higher grades mentioned. These are the balls which show slight, almost invisible, defects, and which vary from 0.001 to 0.002 inch. The C-grade, commonly known as hardware balls, are those picked from the higher

* Address: 912 Oakland Ave., Ann Arbor, Mich.

grades when these show a defective surface. Whether these balls are gaged or not depends upon the use to which they are to be put.

The Gaging of the Balls

After the inspection, the balls are automatically gaged, the gaging being done in a gaging machine in which the balls are fed from a hopper and allowed to roll down between two hardened straightedges and to fall into tubes which carry them to the proper drawer, as indicated in Fig. 2. This illustration shows the Grant ball measuring machine. At *A* is shown the automatic dropping machine, and at *B* the delivery spout through which the balls drop into the measuring slides *C*, provided with a longitudinal slot or opening *O* between them. The sides of the slot may be accurately separated any desired amount by the micrometer adjusting screws provided at both ends. Consequently, the flare of the slot may be adjusted so that it is possible to determine exactly what the diameter is of the balls that will drop into each of the tubes and drawers beneath the measuring slide as the balls roll down along it.

Fig. 3. A Battery of Grant Gaging Machines

As is clearly shown in the illustration, pockets are arranged successively beneath the inclined slot, and are connected by pipes with the drawers of the cabinet underneath. It is evident that in this way balls of the same size will go into the same drawer each time, the balls that go into the middle drawer being those of correct size, those that go into the upper drawers being those that are too small, while the large balls will go into the lower drawers. The balls that are entirely too large will run down the full length of the measuring slide and will be deposited in the box *X*. Those that are deposited in the drawers of the cabinet will be from 0.0025 to 0.005 inch too large or too small, according to the setting of the slides.

The exact arrangement of these measuring devices varies somewhat. In Fig. 3 is shown a group of the type of machines just described. A rack is run through the center of the machine. In this rack, directly under the hopper, there is a hole having a bushing in it of the size of the ball to be gaged. The ball drops from the hopper into this bushing and is carried forward until it comes to an opening which is connected with a tube for carrying the ball to the measuring slides. The rack is operated by a sector of a gear mounted on a shaft having an eccentric pin on one end and a pulley on the other. Inside of the hopper there is a small tube which is operated up and down by two levers, one being attached to the eccentric pin and the other to the tube. This arrangement prevents the balls from clogging so that the bushing in the rack is always ready with a ball to carry forward, thereby constantly feeding balls to the measuring slides.

In Fig. 4 is shown the writer's machine with the measuring slides removed. This particular machine is worked by a worm and worm-wheel instead of by a rack. There are two disks, beneath the balls in the hopper, the upper one of which is keyed to the shaft fastened to the worm-wheel and hence revolves. This disk has a series of holes drilled near the periphery, these holes being 0.005 inch larger than the ball to be gaged. The lower plate has a hole in it directly above the measuring slide, so that when the upper disk carrying the balls presents a hole directly above the hole in the lower disk, the ball will drop through the hole and tube onto the measuring slide. As the hopper is full of balls there is a liability of clogging, because two balls may have a tendency to drop through the hole at once when the opening is presented. The clogging tendency is overcome by a cut-off made of a thin piece of tool steel with beveled edges, which covers two holes in the revolving disk, the holes covered being the one directly over the lower disk and the one next to follow. This prevents jamming of the balls. The remainder of the machine and cabinet is substantially the same as the machine shown in Fig. 2.

In the Putnam gaging machine the hopper is worked practically the same as in a machine for slotting screws. Fingers raise the ball, allowing it to fall into a trough, and then through a tube onto the measuring slides.

This mechanical gaging and sorting of balls is applied to all sizes up to and including ⅝ inch. The large sizes are measured by hand by micrometers. The girls employed for this work pick them up one by one and measure each ball separately over several diameters, throwing them into small boxes placed before them, each of the boxes containing a certain size of balls between the limits of measurements adopted. This work is very rapidly done, as the operators become very skillful.

Counting the Balls

The next operation is the counting and boxing of the balls which at first sight might be assumed to be a tedious and very slow operation. So it would be were it not for the mechanical means adopted for doing this work. Balls up to ⅜ inch in diameter are counted by means of a counting board, as indicated in Fig. 5, which has holes sunk in it 0.010 inch larger than the ball. Around the board is tacked a narrow strip of wood to prevent the balls from rolling off.

Fig. 4. A Modified Type of Grant Measuring Machine, with Gaging Slides removed

The balls are then poured upon the board and all balls which do not find a hole to enter are allowed to run off. As there is an exact known number of holes in the board, the counter immediately knows how many balls she has, and she transfers them immediately from the counting board into a pasteboard box in which the balls are packed. In this way one girl can easily count a million balls a day and do other work besides.

The pasteboard boxes are made of a telescoping form and lined with paper which is free from acid and which has previously been soaked in an anti-rust compound. The balls, which have a very high polish, would otherwise easily rust on account of sweating, which is caused by the difference in temperature of extreme heat and cold. It is very essential that steel balls should be kept in a room properly heated.

The Testing of Balls

The testing of a steel ball for crushing strength should be done between hardened plates by placing three balls in a

tube into which they nearly fit. The center ball is the one that will be tested. The upper and lower balls will, of course, sink into the plates, and this will give them more of a surface bearing than the middle ball, which bears only in two points upon the upper and lower balls; hence the middle ball will ordinarily give way first. As the pressure is applied, a double pressure cone will be formed inside of the ball, this cone having its apexes where the outside balls bear on the middle ball. If properly hardened, a ball will break into several pieces. This method is the proper way to test a ball, but there seldom are two balls that will stand exactly the same load when tested. This is caused largely by the methods in which the ball blank is made. As will be remembered from the description of the making of the blanks in the February number of MACHINERY, the balls in the forging process are much more dense at what might be called the "poles," that is, where they join the next ball forged, than at the "equator." Therefore, if the center ball being tested has the point of contact on the "equator," it will not stand within ten or twenty per cent of the load that it would stand if the points of contact were at the "poles." The same method of reasoning may be applied to stamped and turned balls.

Through the means of this testing operation and the appearance of the fracture, it can be determined whether the balls have been properly hardened. Every batch of steel, no matter how carefully made, usually requires a slightly different

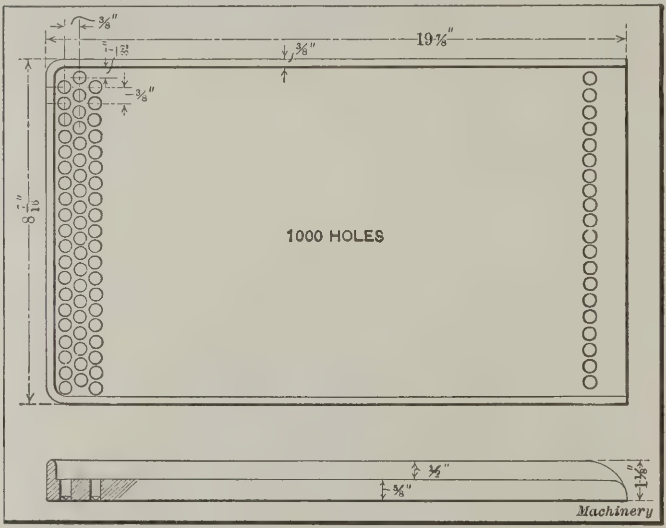


Fig. 5. Counting Board for 5/16-inch Balls

treatment in hardening, and what this treatment is must be determined by the man responsible for the hardening work. The accompanying table shows the crushing load ordinarily required by ball manufacturers for regular tool-steel balls.

Size of Ball in Inches	Ultimate Strength of Ball in Pounds	Size of Ball in Inches	Ultimate Strength of Ball in Pounds
1/16	390	5/8	39,000
3/32	875	3/4	56,250
7/64	1,562	13/16	66,000
1/8	2,450	7/8	76,000
3/16	3,496	15/16	88,000
7/32	4,780	1	100,000
1/4	6,215	1 1/8	125,000
5/16	9,940	1 1/4	156,000
3/8	14,000	1 1/2	225,000
7/16	19,100	1 5/8	263,000
1/2	25,000	1 3/4	306,000
9/16	31,500	2	400,000

The figures above have been adopted after a great many years of testing and are considered by the manufacturers safe figures with which to calculate. Of course, in selecting a ball for a bearing, a factor of safety of ten should always be adopted unless the bearing is used in an extremely narrow space. The grooves in which the balls run when heavy loads are imposed should be round instead of V-form. No figures can be given relating to tests of balls made from alloy steel, because these steels give such irregular results that the manufacturers have been unable to compile any data that would be in any way satisfactory. It is, however, safe to state that the alloy-steel balls will stand from 25 to 50 per cent more than the regular tool-steel balls.

Balls of Other Materials than Steel

Balls are made of a great many other materials, brass and bronze, for instance, being used extensively for oil-well devices where acid is found in the crude oil. Such balls are also used in valves where the material to be pumped will rust steel balls and cause corrosion, and also in electrical work. German silver balls are used in Yale locks to prevent corrosion when used on shipboard or in other places where they would be subjected to the damp sea air. Casehardened machine steel balls are used extensively in agricultural implements and similar apparatus on account of being inexpensive. Chilled cast-iron balls are used in turntables, trucks, and for similar requirements.

The Uses of Steel Balls

It may be said without exaggeration that balls are used in nearly every kind of article that it is possible to name provided it revolves. They are used in the cheapest kind of hardware and in the finest mechanisms and surveyors' instruments. Balls 1/16 inch in diameter are used in electric meters and typewriters. The number of balls being used for these purposes alone is from fifty to seventy-five millions per year. German silver balls 3/32 inch in diameter are used under the tumblers of a Yale lock to prevent the tumblers from becoming worn by the constant sliding of the key into the lock. Steel balls 1/8 inch in diameter are most extensively used in bicycle pedals. Some people think that the bicycle industry is no longer of the importance that it once was. This is a mistake. More bicycles are made at the present time than ever before, and about fifty million steel balls are used yearly in the pedals alone.

Sewing machines are now being provided with ball bearings. Millions of 3/16-inch balls are used for this purpose yearly. Some fifty million 1/4-inch balls are used every year in clothes-wringers; 1/4- and 5/16-inch balls are used exclusively for bicycle bearings, and the quantity used runs into hundreds of millions per year. Balls of the same size are used in thrust bearings in motor boats. Balls from 3/8-inch to 3/4-inch diameter are used extensively in automobiles. The quantity of balls so used is estimated at not less than five hundred millions a year. Larger balls of, say, 1 1/8 inch in diameter are used in oil-well pumps, road rollers and traction engines. The quantity being used for these purposes is not less than five hundred thousand a year. One of the most important uses for 1 1/4-inch balls is that in the side bearings on trucks for steam and electric cars. Still larger balls are used for a great many other purposes, including water-wheels, step bearings, locomotive cranes, drawbridges, etc.

Balls are made up to six inches in diameter, and some are used in very peculiar places. Balls of from 4 to 6 inches in diameter are now used by a Canadian concern in a whistling buoy. This buoy has a large tube in which the ball is placed, evenly balanced on the top. The end of the tube has a whistle. The ball, as the tube dips on account of the waves, rolls to the lower end, compressing the air by its weight, and thus blows the whistle. Then it rolls to the opposite end and causes the whistle to blow again.

As already mentioned, brass and bronze balls are used extensively in valves, electrical meters, and bearings where dampness or acid is liable to come in contact with the balls. The number of balls made from these materials is not less than fifty millions per year.

Points for the User and Purchaser of Steel Balls

In the following the essential points relating to the manufacture of balls which should be kept in mind by a purchasing agent or consumer are given. Nothing but a tool-steel ball should be used for high-grade work, and it is very important that it be properly heat-treated. Do not be deceived by a finely polished ball, as high polish and deep scratches (which show only under a magnifying glass) do not necessarily indicate a good ball. In fact, the outside appearance has little or nothing to do with the wear of a ball, for a dull looking ball may be just as good as one with the highest polish. The polish is merely the result of the tumbling process.

The first requirement is that the right material has gone into the balls. It costs but little to have the steel analyzed so that the purchaser may know whether he is getting a tool-

steel ball or a machine-steel ball. The fact that the ball has only a point bearing makes it the more important that it be made from good material in order to stand the pressure to which it may be subjected. Casehardened machine-steel balls ought not to be used when heavy duty is required. Naturally there is some difference in the quality of the steel that costs thirty-five dollars per ton from that which costs one-hundred-fifty dollars per ton.

It is true that a ball can be casehardened very deeply, in fact, almost through to the center, but it should be remembered that casehardening implies adding carbon to the steel under a high heat, which causes the pores in the steel to open so that the carbon can enter. The process, however, does not remove the injurious elements, such as phosphorus, sulphur and silicon, of which the cheaper steel contains a large percentage. It is, of course, perfectly satisfactory to use casehardened balls for many purposes, but when it comes to a really high-grade article, the highest class of steel is to be preferred.

In order to determine whether a ball has been properly heat-treated, place the finished ball in a piece of waste on an anvil and break it open with a heavy blow. The waste prevents the pieces from flying around. If the ball is properly heat-treated, the break will show a soft silky-appearing surface—the grain of the steel being fine. If it has not been heat-treated, it will look coarse and granular, having more the appearance of cast iron. As a further illustration of why the ball should be heat-treated, the following tests made by the writer when with the New Departure Mfg. Co., may be of interest. The balls tested were made of tool steel; they were ¼ inch in diameter and drawn to 420 degrees F.

Ground; not Annealed before Hardening	Headed and not Ground; Annealed before Hardening
4800	7500
5700	8150
6300	8200
6150	7200
5800	6880
5600	7300

It will be found that the average crushing load of the balls that were not annealed before hardening is 5725 pounds, while the average crushing load of the balls that had been annealed before hardening is 7538 pounds; hence the heat-treated ball is some 1800 pounds or nearly 30 per cent stronger than the balls which were not heat-treated. The heat-treatment not only strengthens the balls, but prevents them from flaking off, crumbling, etc. It distributes the molecules so that the steel is at rest.

If during the test the ball should break in half, it would indicate that it had not been properly drawn after hardening, but was still subjected to internal stresses. If such a ball is placed in a bearing, it would easily break if subjected to a severe shock or strain. If a ball has been properly drawn it can be touched with a fine Swiss file, and under the blows of a heavy hammer it will dent slightly and break into several pieces.

Balls over 5/16 inch in diameter that have been turned or headed should not be used for heavy duty, as they are not as good as balls for which the blanks have been forged. The headed ball, on account of the severe shock to which the metal is subjected when cold, cannot be treated so as to stand the strain that the forged ball will stand. A turned ball is cut from a rod which is rolled, so that the grain of the steel is in a lengthwise direction; hence when a ball is turned from this bar the surface of the ball consists of a mass of exposed fibers. When put under a heavy strain, as in a thrust bearing, it will pit and flake off. The surface of the ball should be smooth, that is, all the marks from the rough-grinding process should have been removed in the finish-grinding. If this has been done it can be readily determined by a magnifying glass.

A ball made from a forged blank cannot be hardened properly unless the decarbonized surface has been wholly removed. Some manufacturers attempt to keep the forgings as small as possible in order to save material and time in grinding, and in many cases it is then impossible to remove all of the decarbonized surface. Hence when the ball is hardened, rough marks and soft spots can be detected. The soft spots are much brighter than the properly hardened surface.

If balls are to be used for special purposes, this should be designated in the order sent to the ball manufacturer. In order to be able to supply a ball that will give satisfaction, it is necessary that he be furnished with information as to what the ball is to be used for, the speed and load at which it will be used, and the kind of bearing employed. Then the balls can be drawn to a degree of temper adapted to the particular purpose in view, and thus satisfaction can be guaranteed to the purchaser. It is also very important to see that the balls that are furnished are not out of round, as this would cause the bearings to "catch" and "jump." The resulting bearing will run unsatisfactorily, and will rattle on account of the fact that the balls are loose at one point and tight at another. The actual size of the ball does not make a great deal of difference, provided the balls are all of the same size. In other words, in a lot of one-hundred-thousand balls, if they are found to be 0.0005 or 0.001 inch under size they will give satisfaction if they are all used before the next shipment can get mixed up with them.

It has already been mentioned that the temperature of the room in which the balls are stored must not be too low. The temperature of the stock-room should be kept the same at all times, and on Sundays and holidays, when the factory is closed, it should be especially heated, for a ball which becomes very cold and then is brought back to a warm temperature will soon begin to rust and cause a great deal of trouble.

Summary of Ball-making Processes

In order to fix in the reader's mind the various processes that a ball passes through, from the time that the blank is produced from the rough stock until the finished ball enters the stock-room, a general summary of the processes described in the three articles comprising the present treatise on the manufacture of steel balls will be given.

There are several methods for producing the ball blank. One is that of turning the ball blanks in a special automatic machine. This method is rapid and makes it possible to produce a blank which requires less grinding than the blanks produced by other methods, but on account of the fact that the fibers of the stock from which the blank is turned are cut and exposed at the surface, a ball so made is of inferior strength after hardening as compared with balls the blanks of which are made by other methods.

Another method commonly used for producing ball blanks is to form the blank in a heading machine. A bar is fed into the machine and pieces of the required length are cut off and headed between dies to a ball shape. This is a very rapid method, and balls up to, say, 5/16 or 3/8 inch in diameter can be made advantageously by this process. As there is no waste, this process for smaller sizes of balls must be deemed the best as well as the cheapest of the methods used at the present time.

The best method of making ball blanks from 3/8 inch to 2 inches in diameter is known as string forging. This method is very extensively used and the balls so produced, when properly heat-treated, are strong and tough in their structure. The balls which have been produced by the heading or forging process must have the fin or flash ground off before they pass to the grinding machines. The process by means of which the fin is removed is called "flashing," and the machine in which it is done is ordinarily termed a "rotary" file. Large balls are flashed separately in a special fixture by an ordinary emery wheel.

The balls are now ready for the dry-grinding process, the grinding being done by an emery wheel acting upon the balls which are held and rotated by suitable means. After being dry-ground, the balls are annealed and then hardened, the smaller balls being quenched in cotton-seed oil, while the larger ones are immersed in brine. After hardening, the balls are washed in boiling soda and then tempered in oil.

After the tempering the balls are ready to return to the finish dry-grinding department, and are finish dry-ground in machines of the kind that performed the rough dry-grinding, but a finer grade of emery wheel is used. From the finishing dry-grinders the balls pass to the oil grinders, where the final grinding operation is performed and where the balls

are brought to exact size. The oil grinding operation is practically a lapping process, no grinding wheel being used. The machine has merely two plates, one of which is grooved, between which the balls roll. The grinding medium is fine emery and oil.

When the balls have been brought to size in the oil grinders, they are given their final finish either by burnishing them in machines similar to the oil grinders, or by being tumbled in a tumbling barrel with a polishing medium. Next they are tumbled in sawdust, and finally in a barrel with cut-up kid leather to obtain the high polish. The balls are then inspected, graded and gaged. The smaller balls are gaged in gaging machines, while the larger are measured by micrometers. Next the balls are counted and packed into boxes and sent to the store-room, which finishes the operations.

* * *

DOURTE VALVELESS PUMP

The pump which is illustrated in Fig. 1 has no suction or discharge valves and is designed especially to handle very trashy matter. Weeds, pieces of rope and other foreign material which may be drawn into the pump are sheared off by the edges of the ports which are located in the piston. This type is being used to pump trashy water out of irrigation ditches and to handle slimes in reduction works. It is also planned to use this pump for handling syrup and heavy oils. The sectional view, Fig. 2, of one of the cylinders of a horizontal type, shows the general arrangement of the piston and ports. A miter gear keyed on the end of the crankpin meshes with the mating gear keyed to the end of the connecting-rod, and the latter is attached to the piston by means of a universal coupling. This mechanism imparts a constant rotary movement to the piston in addition to the reciprocating action. The piston is of the trunk type with an opening at both ends and a partition in the middle. The head end at the left of the partition has a port, as the illustration shows, which alternately registers with the suction and delivery ports. When

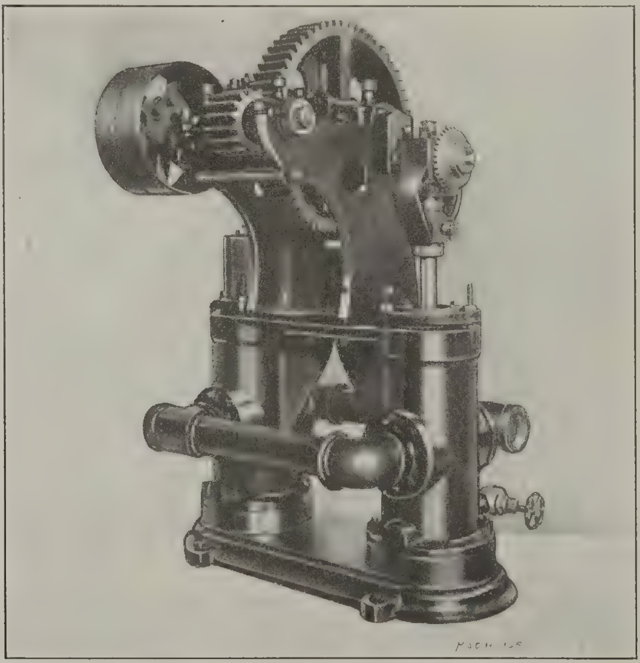


Fig. 1. Duplex Pump without Suction or Discharge Valves

the piston is in the position shown, both ports are closed, but as soon as the pump rotates in the direction indicated by the arrow, the suction port begins to open. When the crank has moved 90 degrees and is on the "top quarter," the piston port will be exactly over the suction port, and when the opposite "dead center" is reached, both ports will again be closed. When the crank is on the bottom quarter, the piston port will be exactly under the delivery port. It will thus be seen that the piston by its rotary movement regulates the suction and discharge openings. If the pump is reversed or one miter gear is turned through 180 degrees, the pump will operate from the delivery to the suction side or, in other words, the flow will be reversed. The delivery port is formed in a separate saddle which rides on the piston and is held down by adjustable spiral springs, as shown. The suction port is cut

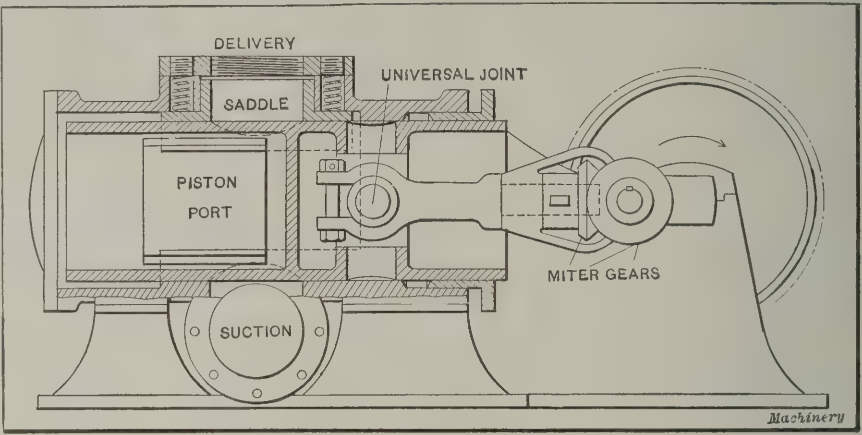


Fig. 2. Sectional View of Valveless Pump of Horizontal Type

out of the solid cylinder. This pump is made at Longmont, Col., and was designed by George L. Sullivan, Bozeman, Mont.

* * *

ENERGY THE MOVING FORCE

Many business concerns that have been organized with ample capital and to outward appearance well equipped to succeed, in the course of a few years have gone into the hands of receivers. Other concerns have started with very small capital, under adverse conditions and have prospered. What was the difference in the organization of these typical concerns which meant success for one and failure for the other? Largely brains and energy.

An incident from the career of a well-known machine tool manufacturer in the Middle West is an illustration of the point. Thirty years ago this manufacturer started in business with a small capital, and his hostages to fortune were "a wife and two kiddies on the hill." His money was soon tied up in the business, and no immediate cash returns were in sight. In the emergency he solicited some job work from a large concern and was "turned down," but being insistent and forceful finally secured an order for two hundred flask-pins at ten cents each. They had to be tapered at one end, turned down, shouldered and threaded at the other end, and provided with a hexagon nut. This was before the days of automatics, and after the order was taken the job hunter realized that he was in for a loss if he followed the regular method of production, so he set his brain to work. He went to a dealer in bar iron, got two hundred pieces cut off while he waited, took them in a box on his shoulder to his shop and then rigged up an engine lathe for the job. A boy hired at fifty cents a day, who had never worked in a shop, with the aid of simple tools and the expert assistance of the boss, turned out the job complete in a day at a cost of $2 for stock, 50 cents for nuts and 50 cents for labor, making the total cost $3, not including a small overhead expense.

The brains and energy used in this case were characteristic of the man and the concern he organized. Starting out in this small way it showed $7000 in assets at the end of the first year, and $32,000 the second year, increasing until the investment now represents over a million dollars, and its product is known and used all over the world.

* * *

A user of high-speed drills complained to the maker that he could not get results. The production was not much higher than with carbon steel drills, and much time was lost in grinding. Examination showed that the cutting speed was high, but the feed very fine. The speed was reduced and the feed doubled, the result being that the output of drilled holes was doubled and the squealing and heating of the drills disappeared entirely.

VARIATION IN MACHINE TOOL POWERS

By T. BARTON*

The wide divergence in the power put into machine tools by different makers is a fact not often commented upon, but a walk through any average shop will reveal many instances of it. The writer recently noticed an 18-inch turret lathe on chuck work, with a single-pulley drive, having a pulley 12 inches in diameter for a 5-inch belt, running at 200 R.P.M. Close by was a 2-inch bar lathe, having exactly the same size pulley, but running at 500 R.P.M. It will be seen at a glance that the bar lathe has two and one-half times the power of the turret lathe. Is not this somewhat of an anomaly? The bar lathe operates on work of small diameter, has only one tool cutting at a time, and that tool has a very keen cutting edge. The turret lathe handles work of large diameter, has frequently several tools in action simultaneously, and the cutting edge of the tools is not as keen. Either one machine is under-powered, or the other has a surplus of power which it can never hope to convert into useful work. Both these machines are of standard make, are good sellers, and do good work.

If the power of a machine is in reasonable proportion to the work to be done, then if anything goes wrong, the belt will slip or be thrown off, but if it is very much over-powered, this safeguard is lost. If a machine has twice the power that it needs, it means that, as the driving gears have to be strong enough for the belt, they must be made twice the width otherwise required. This increases the distance between the bearings, and consequently the diameter of the shafts must be increased to retain stiffness. In short, the whole machine must be made larger and heavier, and the belt up-keep cost is increased. The contrast between these two machines led the writer to investigate more thoroughly. Some of the results of this investigation are given in the following: A 3½-inch bar lathe was driven by a 10 H. P. motor; a 3-inch bar lathe was satisfied with a 3 H.P. motor. A 2-inch bar lathe had an 8 H.P. motor; another make of 2-inch bar lathe was content with a 2½ H.P. motor. It will be seen that here is a difference of over 3 to 1 on two machines made for doing identically the same size and class of work.

The increase in belt speed, and use of wider belts, which a geared drive allows, permits a great increase of power, compared with the old cone pulley drives, and in some cases it would appear to be the practice, when cone-driven machines are converted into single pulley drives, to put on a pulley as large in diameter, and as wide as the machine will stand, and run it at the highest permissible speed, without comparing the power thus obtained with that given by the old cone drive, which has probably stood up well to its work.

Below are given particulars of a few single-pulley machines. The first three figures have been multiplied together, giving a result which facilitates comparison:

	Diam. of Pulley, A	Width of Belt, B	R.P.M., C	$A \times B \times C$
2 -inch Bar lathe	12	5	500	30,000
18 -inch Turret lathe	12	5	200	12,000
3 -inch Bar lathe	10	3	800	24,000
3½-inch Bar lathe	14	5½	500	38,500
3½-inch Bar lathe	10½	4½	300	14,175
18 -inch High speed lathe	13	4½	300	17,550
21 -inch High speed lathe	16	5	300	24,000
22 -inch Combination turret lathe	10	4½	450	20,250
30 -inch Boring and turning mill	12	3½	400	16,800
4 -foot Boring and turning mill	12	4	575	27,600
4-foot 6-inch Boring and turning mill	13	5	400	26,000

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From this it will be seen that 50 per cent more power is put into a 3½-inch bar lathe than into a 4-foot 6-inch boring and turning mill. The weight of the work and table of a boring and turning mill is considerable, and the machine itself is less efficient, the power being taken through one, and often through two pairs of bevel gears.

To obtain the same tool pressure, or take the same cuts, at the same surface speed, would, neglecting the increased friction of the larger machines, require the same horsepower on any diameter; but as larger machines take heavier cuts, and the weight of the moving parts is greatly increased, they, of course, require more power. From the figures given in the foregoing, however, the reverse would appear to be the case in some instances.

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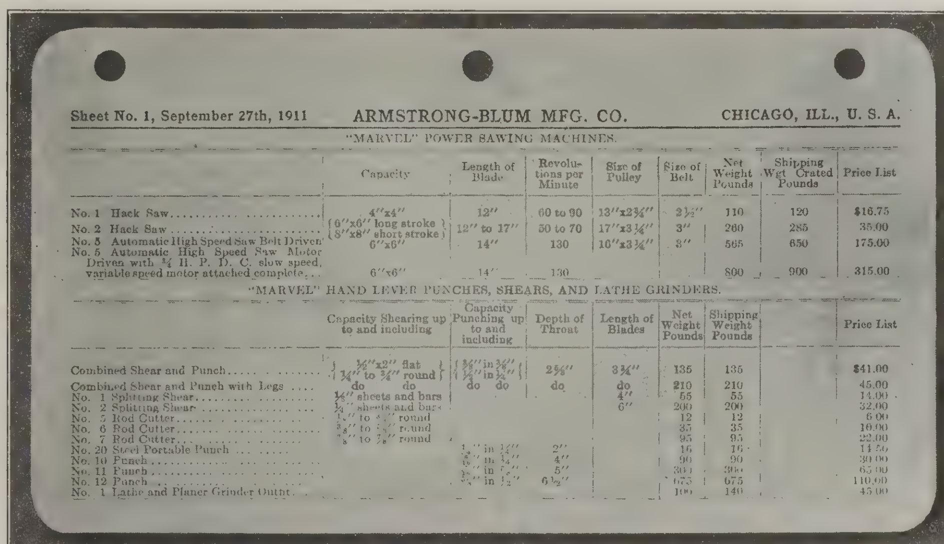
PRICE SHEET FOR SALESMEN

Manufacturers of light machinery sold by jobbers and dealers find it advantageous to issue price sheets printed on thin paper with rounded corners, 4 by 7½ inches perforated, as



Sheet No. 1, September 27th, 1911 ARMSTRONG-BLUM MFG. CO. CHICAGO, ILL., U. S. A.

"MARVEL" POWER SAWING MACHINES.

	Capacity	Length of Blade	Revolutions per Minute	Size of Pulley	Size of Belt	Net Weight Pounds	Shipping Wgt Crated Pounds	Price List
No. 1 Hack Saw	4″x4″	12″	60 to 90	13″x2¾″	2½″	110	120	$16.75
No. 2 Hack Saw	6″x6″ long stroke; 8″x8″ short stroke	12″ to 17″	50 to 70	17″x3¼″	3″	260	285	35.00
No. 5 Automatic High Speed Saw Belt Driven	6″x6″	14″	130	16″x3¼″	3″	565	650	175.00
No. 5 Automatic High Speed Saw Motor Driven with ¾ H. P. D. C. slow speed, variable speed motor attached complete	6″x6″	14″	130			800	900	315.00

"MARVEL" HAND LEVER PUNCHES, SHEARS, AND LATHE GRINDERS.

	Capacity Shearing up to and including	Capacity Punching up to and including	Depth of Throat	Length of Blades	Net Weight Pounds	Shipping Weight Pounds	Price List
Combined Shear and Punch	½″x2″ flat; ¼″ to ¾″ round	⅜″ in ⅜″; ½″ in ¼″	2⅝″	3¾″	135	135	$41.00
Combined Shear and Punch with Legs	do do	do do	do	do	210	210	45.00
No. 1 Splitting Shear	⅛″ sheets and bars			4″	55	55	14.00
No. 2 Splitting Shear	¼″ sheets and bars			6″	200	200	32.00
No. 5 Rod Cutter	[illegible] to [illegible] round				12	12	6.00
No. 6 Rod Cutter	⅜″ to [illegible] round				35	35	10.00
No. 7 Rod Cutter	[illegible] to ⅞″ round				95	95	22.00
No. 20 Steel Portable Punch		¼″ in ¼″	2″		16	16	14.50
No. 10 Punch		[illegible] in ¼″	4″		90	90	30.00
No. 11 Punch		[illegible] in [illegible]	5″		300	300	65.00
No. 12 Punch		[illegible] in ½″	6½″		675	675	110.00
No. 1 Lathe and Planer Grinder Outfit					100	140	45.00

Price Sheet for Salesmen

shown in the reproduction of the sheet issued by the Armstrong-Blum Mfg. Co., Chicago. These sheets fit the loose-leaf price sheet books commonly carried by salesmen, and most of them are glad to add it to their regular lists though they would not think of carrying an extra circular or catalogue.

* * *

STANDARD HEADS FOR SMALL SCREWS

The Engineering Standards Committee (Great Britain) has issued report No. 57, dealing with standard heads for small screws. The report standardizes the heads for small screws in five classes—countersunk, instrument, round, cheese, and fillister. For all classes of screws, the diameter of the head has been fixed at 1.75 times the full diameter of the thread. The committee recommends the adoption of a standard angle of 90 degrees for both countersunk and instrument heads. The depth of the coned portion has been determined at 0.375 times the full diameter of the thread. For instrument-head screws the committee recommends that the radius forming the curved surface of the upper portion of the head be equal to twice the full diameter of the thread. It follows from this that the depth of the curved portion of the head will be approximately equal to 0.2 times the full diameter of the thread. In the case of screws with round, cheese or fillister heads the committee recommends that a plain cylindrical portion having a length not exceeding twice the pitch, be left on the shank immediately underneath the heads of the screws. When determining the depths of the saw cuts or screw-driver slots the committee has endeavored to follow existing practice as far as possible, and has grouped them together in convenient sizes according to the gage of the metal from which the saws used are manufactured. The committee recommends a standard depth of saw cut equal to half the total depth of the head in all cases, this depth to be measured at the center of the head.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

APRIL, 1912

PAID CIRCULATION FOR MARCH, 1912, 24,986 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE UNIT SYSTEM OF MACHINE CONSTRUCTION

A feature of machine construction that has been widely adopted during the past decade, especially in machine tools, is the so-called "unit system." The principle of the system is simply that of dividing a machine into groups of closely related mechanisms and constructing them with independent frames or boxes in which the shafts, studs, clutches, gears, etc., are assembled. These units of mechanisms are assembled on the main frame to form the complete machine. The natural divisions of the engine lathe, for example, are the headstock, tailstock, carriage, apron, feed-box, change-gear box, etc. These, mounted on the bed, require only the lead-screw, feed-rod and legs to complete the lathe. This admirable system has several marked advantages.

In the first place it is the logical development of the interchangeable system of manufacture which has so greatly reduced the cost and improved the quality of manufactured products. The units are made independently in departments suited to the character of the work, by men who, specializing on each particular unit, become experts. Refinements of design and construction are developed that could hardly come into existence in a building shop.

In the second place the units being interchangeable can be replaced by the user in case of accident with a minimum of trouble; they can be removed, returned to the factory for repairs at small expense for freight and handling.

A third advantage to the machine tool builder is the ease with which units can be incorporated in various designs. The builder, say of milling machines, can use the same feed-box in several sizes and styles, thus enabling him to produce a variety of designs at a minimum cost for jigs and fixtures, all in harmony with the general design.

These advantages, particularly the last, are slowly being grasped by the builders of special machine tools. This business, as everyone knows who has ever been in it, is conducted on a close margin of profit, and its returns, when compared to straight manufacturing, are hardly commensurate with the thought and energy required for success. More of the manufacturing element can be introduced by the development of unit designs of speed- and feed-boxes, tool-slides, elevating mechanism, etc., which can be worked into special designs with little trouble. These units can be made in lots of fifty or a hundred, using jigs and labor-saving appliances that are out of the question when making up parts specially for each machine. The reduction in cost and the more even distribution of labor over a given period incident to the unit system should make the conditions of special machinery building easier than they are now.

* * *

CLEAR THINKING AND WRITING

Given good ability, the one faculty that an ambitious man should cultivate is that of expressing his thoughts clearly in speaking and writing. Compared with one of equal ability who cannot express his ideas clearly, the possessor of a good vocabulary has a great advantage. This fact has been recognized in all times, and yet it is not as fully appreciated by many who are striving to rise in the world as it should be. The successful salesman sells goods because of his ability to secure an audience with buyers and to hold their attention. He holds attention because his story is interesting. He talks of the quality of his goods, how they are made, when they can be delivered, the terms of sale, meets arguments in a kindly spirit, and overcomes opposition by attractive manner and expression. That ability is certainly a great asset to any man. Not all of us can be salesmen in the sense of selling goods, but most of us have to market our abilities in some form of service. The man who can make his service appear to the best advantage usually gets the highest wages, other things being equal.

The machinist who can turn out a perfect piece of work in the average time or less, is a man whose ability will be recognized in most shops in the highest wages paid to journeymen. If he possesses the ability to plan a job and to tell how to perform it he will stand still higher and will, in fact, be rated as having executive ability, simply because he can tell someone else what to do.

With the foreman the telling of what to do and how to do it is the principal part of the day's work. The journeyman who aspires to fill higher positions must cultivate the faculty of imparting knowledge to others. If he practices writing out the plan of procedure for all the jobs that come under his observation, he will be surprised to find that the simplest piece of work is generally made up of several elements, each of which must be clearly known before the work can be carried to a successful conclusion. Describing a piece of machinery either orally or in writing develops logical thinking and leads to investigations of the principles of elements which are the fundamentals of all machines.

With understanding comes the joy of mastery and the common desire of broad-minded men to impart their knowledge to others. That imparting knowledge is profitable to the giver is common experience. It is proved by the rapid advancement of many contributors of MACHINERY who have started in a humble way to tell the readers about some interesting piece of machinery and how it was made. Their mental horizons expanded rapidly, and with expansion of mind came better appreciation of the meaning of what they read and the ability to assimilate ideas and use them. Soon, to our regret, they have ceased to write, because their time and energies have become absorbed in the duties of the executive positions to which they have been promoted.

* * *

One of the fascinating subjects to the theoretical engineer is the Schiele curve as applied to step bearings. The curve is a beautiful design in theory to equalize the wear on all parts of a thrust bearing. In practice, however, it is another story. The cost of producing it compared with an approximate form is so high that its advantages are *nil*. A well-known builder of boring mills formerly made the spindle bearings of his mill tables with the Schiele curve, and fitted up at heavy expense to produce them accurately. But after using the Schiele curve bearing for a few years it was abandoned for a conical bearing and plain step, the two approximating the shape of the Schiele curve spindle. The result has been entirely satisfactory and the cost is much reduced.

TARIFF REFORM

Although many American industries have attained their present strength under protection, this result has been accompanied by abuses from which consumers have suffered, and the majority of voters want a reform. They will have their way; but business men who favor a reduction want it brought about in a businesslike way, by a competent tariff commission not composed of politicians. Our machine tool builders in 1908 not only consented to, but favored, a reduction in the tariff on machine tools, and if a similar policy had been adopted by manufacturers generally the present disturbance to business might have been avoided.

There is a marked difference between the position occupied by machinery manufacturers and almost any other American industry, in that a machine usually represents years of thought, labor, experiment and outlay before a single one is sold. Yet this is hardly on the market before its vital points are imitated by foreign manufacturers who, except for the tariff, would be able to undersell the originator in his own market on account of the difference in the labor cost. Freights also favor the foreign manufacturer as the rates to New York City from almost any of the English or German industrial centers are less than from Cincinnati.

Our tariffs should be reduced; but the changes should extend over a period of years so as to enable our manufacturers to readjust their prices and methods to the new conditions. Any radical change in the tariff on machine tools, such as the proposed one to place them on the free list, would result in disaster to the entire machinery and allied industries; and the losses would fall as heavily on the workman as on the employers. Immediate free trade in this industry would mean destruction, not reform.

* * *

TURNING SHAFTS IN TURRET LATHES

Some manufacturers of machinery who have put turret lathes to all possible uses have occasionally met with serious difficulties when trying to turn shafts, say, 1 inch diameter and 30 inches long. The shape of the shaft at the chuck end where the cut is started will be turned round and true; but as the tool travels away from the chuck a quasi-hexagon, octagon or other polygonal shape may be developed under certain conditions, which gradually grows worse, until it is so pronounced at the finish end that ordinary allowances for grinding may not be sufficient to remove the tool marks. Although this is an old trouble, and the causes, and means for eliminating them, were discovered long ago, a knowledge of the facts is not as common as it should be in view of the widespread use of the turret lathe.

Where roller back-rests are in use, the first surmise of course is that one of the rollers is eccentric or worn flat, but other elements more obscure may cause the trouble. A well-known turret lathe builder states that the trouble is wholly overcome by using a back-rest of the old style, which embraces about half the cylinder and is of a dimension fairly close to the size to be turned. But these back-rests are not adjustable, and are subject to roughing up, which becomes a serious trouble. The V back-rests and roller back-rests seem to be superior, notwithstanding the possibility of the work's becoming slightly polygonal at times.

One of the principal elements in establishing the tendency to turn polygonal is produced by the varying depth of cut, which of course is the result of eccentricity of the stock. The effect of varying the depth of chip can be almost wholly neutralized by setting the cutting face of the tool perfectly square to the travel or a trifle "under," so that the variation in radial thrust is reduced to a minimum. The surface of the back-rest should make contact very close to the front edge, and the cutting tool should be set slightly in advance of the back-rest. If the back-rest does not touch the stock at the front, because of being a trifle bell-mouthed, or if the tool stands too far ahead of the back-rest, or again, if the tool is beveled so that the outer edge is in advance of the point, then the stock will spring away from the tool under the heaviest part of the cut. A round-nose tool, or a tool in which the point is behind the cutting edge, of course gives the greatest variation in radial resistance when the depth of the cut varies. This applies to turning cylindrical work in either direction, but the action is especially pronounced in turning away from the chuck when the outer end of the stock runs free.

Attention to these details of setting the tools and back-rests will generally eliminate the tendency to turn polygonal shapes entirely. The case is but another of many in machine shop practice in which apparently minor adjustments play an all-important part in producing satisfactory work.

* * *

THE DISAPPEARING TOOL-CHEST

By A. P. PRESS

Those of us whose heads are white well remember what was the first thing to be done after we had got a new job. That was to hunt up an express man to move the tool-chest. The machinist who did not possess a good set of tools and a good looking chest, even if it did not contain a "mike" or a vernier caliper, was considered a "poor stick."

One of the first requisites for the tool-chest was a pair of good stout handles for each end—handles that would stand a strain of 100 pounds or more. Inside of the chest you would find a 2-pound chipping hammer, a 1-pound or a 1½-pound light hammer, three or four smaller riveting hammers, most of which were homemade; three or four cape chisels, and an equal number of broad-faced chisels for straight chipping; a 12-inch and a 6-inch monkey-wrench; a 24-inch straightedge about ¼ inch thick with one edge beveled down to 1/16 inch or less; and a 12-inch scale usually round at one end and square at the other. These scales were imported from England. A 24-inch scale was beyond the machinist's wildest dreams. Besides there would be in the tool-chest six or eight pairs of calipers; a surface gage with a 4-inch base that weighed about 2 pounds or more, and a standard not less than ⅜ inch in diameter; a hacksaw on which the teeth had to be filed every time it was to be used; and a box level (not a protractor).

If the man claimed to be a millwright as well, as many of the oldtimers were then, there would be an 18-inch level and a plumb-bob with a line around it. Under all circumstances there would be a box of drills or "flats," and one or two choice twist drills, besides an indescribable amount of scrap that invariably accumulated.

Now what does the new man that comes in to-day bring along? He has a little hand-bag, about the size my lady uses when she goes downtown shopping, and inside there will be one or two sets of "mikes" and possibly a full assortment of scales from 9 inches down. There will also be a bevel protractor and a pair of spring calipers, and possibly a chipping hammer about 1½ pound in weight. Of a dozen men to-day, not more than two will bring a tool-chest, and the foreman does not view them with approval. When you have only 3½ or 4 feet of bench room for each man, the space is too valuable to be taken up with a big tool-chest. There are several shops with which I am personally acquainted where the tool-chest is not tolerated unless it is kept under the bench, but it is preferred, by those in charge, to have it left at home.

* * *

STRENGTH OF THICK HOLLOW CYLINDERS

A formula for calculating the bursting pressure of thick hollow cylinders, which agrees closely with the results of experiments undertaken by Messrs. Cook and Robinson, is given in *Engineering*, issue of January 5, by F. van Iterson.

Let P = bursting pressure, in pounds per square inch,
F = ultimate strength of material, in pounds per square inch,
R = ratio of external to internal diameter.

Then

$$P = F \text{ hyp. log } R$$

This formula, of course, is not applicable for values of R which make hyp. log R greater than 1, as in that case the bursting pressure P would be greater than the ultimate strength of the material F.

NOTES AND COMMENT

One discriminating dealer in second-hand machinery pays more for Eastern tools, claiming that the harder iron used in the East gives appreciably longer life to lathe shears and other sliding parts. This dealer, however, handles only second-hand tools that are in prime condition—those that have been well used and employed on a variety of work which has given nearly uniform wear to the shears, etc.

Milling carbon steel at a peripheral speed of 500 feet a minute and producing a surface like polished silver is what the National Twist Drill & Tool Co., Detroit, Mich., is doing on small drills. A high-speed cutter about 3 inches in diameter, having teeth of 3/16-inch pitch and cut at an angle of 15 degrees, is run at the given speed to mill the drill clearances. The drill is supported directly beneath the cutter by a V-rest and the cutter rotates against the cut. Lard oil of the best quality is used for lubricating.

An international exhibition will be held at Liverpool, England, from May to October. The textile, electrical, machine building, general manufacturing, and shipping industries, as well as arts and crafts, will be represented. The exhibition, it is claimed, will be of international importance and similar to the successful exhibition at Glasgow, where the number of people attending exceeded 11,000,000. Copies of the prospectus and application forms for exhibit space may be secured from the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C.

A change in the equipment of modern drop-forging plants that is being made in the interests of greater efficiency and better product, is the substitution of steam drop-hammers for board or other free falling hammers. The steam hammers work quicker, are under better control and deliver a harder blow for the same weight of drop. They are not as efficient, however, in the use of power as the mechanically-operated hammers. The steam is not as effectively expanded as in an efficient engine cylinder and there are large wastes in steam lines due to condensation. The power cost is, however, a small item compared to the labor cost and general overhead charges.

Few mechanics have an adequate idea of the great cost of some experimental aeroplane engines that have been built to develop great power with low weight. One came to our notice lately that has cost over $12,000 and is not yet completed. The cylinders are made from solid chrome-nickel steel bars, and are marvels of fine and accurate machine work. The weight of the engine, complete, is about 180 pounds and it develops 65 horsepower when all the seven cylinders are chugging. The cost is in inverse ratio to the weight. To illustrate, take one part made of alloy steel which in the rough weighed 115 pounds; when finished, the weight was 6 pounds and the labor cost was over $250.

It is reported that the White Star Line has commissioned Harland & Wolff, Belfast, to build a transatlantic liner which will be 990 feet long, with a beam of approximately 110 feet, a displacement of 70,000 tons, and a gross tonnage of over 50,000 tons. The liner is to be named the *Gigantic*. It will have twelve or thirteen levels or decks, the highest of which will be 75 feet above the water line. The vessel is to be designed with accommodations for over 4000 passengers, 1000 of which can be carried in the first cabin. The new vessel will be a seven-day boat, provided with a combination of reciprocating and turbine engines. It is stated that a cricket field, tennis court, golf links (?), and ball-room will be included. The cost of the vessel will be nearly $10,000,000.

Pensions are granted by the American Steel & Wire Co. to employes who have reached the age of seventy, and who have been in the service of the company or any of its predecessors for ten years. A pension is also paid to employes who have reached the age of sixty and are physically disqualified for further service, provided they have been employed during the preceding ten successive years. The pensioners are allowed to seek employment elsewhere, should they so desire, and can live wherever they please. Some of the retired pensioners, it is said, are living in England, Ireland, and Sweden, besides in various parts of the United States. The pension fund is maintained entirely by the company without any form of contribution from the employes.

A correspondent of the *Frankfort Gazette* draws attention to what seems to be a rather common practice of some German steel-making concerns. It appears that machine tool builders are practically compelled to accept deliveries of steel, instead of cash payment, in return for orders of machine tools. The great iron and steel works thus place the machine tool makers in a difficult position, as the latter have often to choose between losing a contract or laying up a stock of material which they may not be able to use for a long time to come. Sometimes they are forced to use material which they perhaps otherwise would not employ.

The wonderful effect of harvesting and other farm machinery, on the world's food supply is but dimly appreciated by those who have given it only casual thought. A pamphlet called "The Story of Bread," published by the International Harvester Co., is authority for the following statement that almost staggers belief: "A modern farmer, with the practice of scientific knowledge, and the use of modern machines, can, with three months' labor, raise as much wheat as could an old Roman had he worked ten hours a day, six days a week, for all the weeks of his three score and ten years. In the time of Nero it took four and a half days' labor to raise a bushel of wheat; when the reaper was invented it took three hours; and in the time of Roosevelt it takes ten minutes."

For many years past there has been a tendency to mark cutlery and other goods similar to those produced in Sheffield, England, with the word "Sheffield," in order to convey to the purchaser the idea that they have actually been manufactured in or near Sheffield, and that they carry with them the traditional high quality of Sheffield goods. A fund of $55,000 has been raised, and has been placed at the disposal of prominent citizens of Sheffield to prosecute in all cases where the name "Sheffield" is being fraudulently used as a trademark. It is proposed to increase this fund as occasion may arise. The results of the prosecution will be widely advertised, especially in the localities where the firms using the fraudulent marks are located.

Specialization in industries effects innumerable economies and cheapens production. Centralization of some of the functions of a community increases their efficiency. An exception is electric lighting in the case of large buildings. Many of the office buildings, hotels and other large buildings of New York and other cities have their own lighting plants. The exhaust steam is used for heating in winter and carries nearly as many heat units as the same weight of steam used direct from the boilers. If the lighting is charged at the lowest rate that the central lighting plants will quote, the heat costs nothing; if the heating is charged at the cost of live steam as furnished by the boiler, the cost of the current for lighting and power drops to less than a cent a kilowatt in New York City.

A type of machine construction that is much used in Germany is that employing steel plates and structural shapes for the frames. Castings of simple form are placed between the plates to act as separators and give stiffness and strength where most needed. The advantage of this construction is greatest on special machines of rough character, such as boiler shop tools. The cost of large and complicated patterns is avoided, as is the delay incident to making them and getting the castings. A variety of castings that experience has shown can be largely used are kept in stock, and these are modified by machining where needed. Sometimes a large machine for shearing and punching structural shapes will be built up in this manner in a few days, using plates, angles and gussets principally, that would require weeks if built with cast-iron frames in the usual manner.

THE DIESEL ENGINE*

By S. M. HOWELL†

To save the first cost of the igniting devices used on internal combustion engines and to avoid the additional expense and trouble incident to their employment, is an attainment of great practical value; an engine that is self-igniting and which also embodies other important advantages, is certainly a very desirable form of construction. The fact that the heat of compression is capable of firing the charge in a gas engine cylinder is, of course, a self-evident proposition in the science of thermodynamics, as well as a matter of common experience, and the idea of its utilization for this purpose no doubt occurred to some early designers; but the first prominent example of a self-igniting gas engine was that of Rudolf Diesel, of Germany, and it is probable that his was the first engine in which ignition was thus effected. The Diesel system, however, is not the only method of operation which is capable of self-ignition. Several patents have been secured by other inventors since the date of the first Diesel patent, in which the heat of compression generated by means of an auxiliary high-pressure air pump is used to fire the charge in engines of the impulse or explosion type. In the original Diesel patent, No. 542,846, of July 16, 1895, the inventor does not claim this feature of his motor, but he afterward claimed it in combination with other elements in his patent, No. 736,944, of August 25, 1903. The self-ignition, however, in the Diesel engine, is merely an incident in the operation of the cycle. The motor as a whole differs in its operative principle from all other gas engines, belonging to that general class known as the continuous combustion type. This type was first exploited many years ago by a number

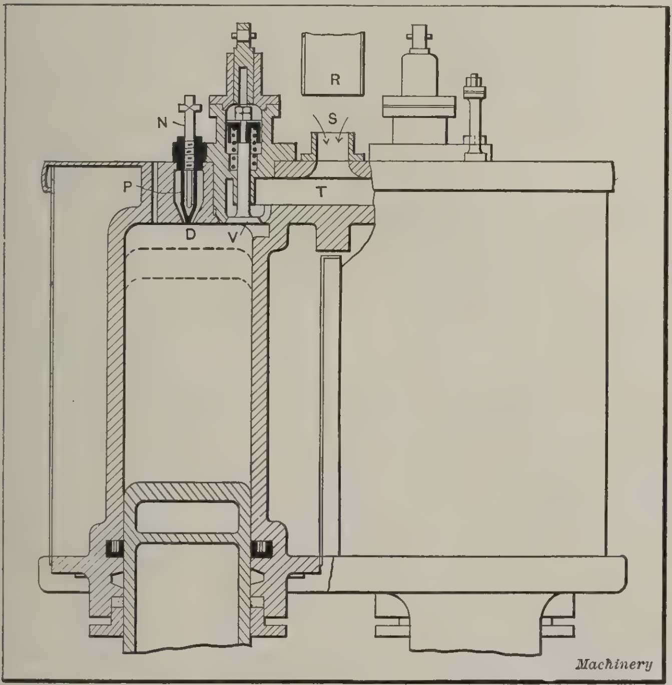


Fig. 1. Diesel Engine using Oil Fuel—U. S. Patent No. 542,846

of inventors whose productions never came into general use, and it was for a time displaced almost entirely by the impulse form of gas motor.

The primary idea of the Diesel system is to compress a charge of air by the in-stroke of the piston, to such a degree that the resulting heat will equal the highest temperature subsequently attained by the burning charge. The fuel is injected during a first fractional part of the power stroke, and is self-ignited and burned in a volume of air considerably in excess of the quantity actually required to consume it. By this means the mean working temperature of the cylinder is so reduced that the use of a water jacket is unnecessary. Thus the loss due to the abstraction of heat by water cooling, is avoided, and the highest degree of efficiency is secured from the thoroughly consumed fuel.

In considering the theory of this system of operation it would seem at first thought that to produce by means of compression alone a temperature equivalent to that of normal combustion, would require an excessive degree of pressure, so high indeed as to be altogether impracticable; and it may also seem that the heat generated by the combustion of the fuel would simply be added to that already existing in the body of compressed air, and that the resulting temperature would be still higher. Ordinarily this would be the case—that is, if the charge of fuel could be instantly introduced, but this action is not contemplated by the theory and does not occur in practice. Nor is the degree of initial compression as high as would be required to produce a temperature equal to that of combustion under ordinary conditions. The reasons for this are, first, that the burning charge is diluted,

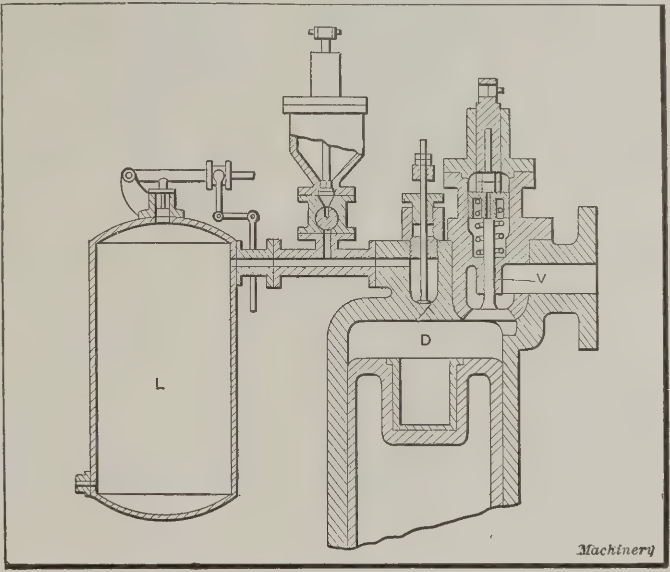


Fig. 2. Section of Diesel Engine having Compressed Air Tank for Starting

and the heat greatly modified by the superabundance of air, and second, that the fuel is forced into the cylinder while the charge is expanding on the power stroke, and is so regulated that the heat added by combustion is only sufficient to counterbalance that lost by expansion as the piston moves forward. Thus both the temperature and the pressure of the initial air charge are maintained, without material change, to the point of cut-off. This point is determined by the governor or control lever, and from thence to the end of the power stroke the pressure falls in an adiabatic curve, and the burnt gases are finally exhausted at the temperature of the atmosphere. The heat is absorbed and transformed into work by the expansion of the charge from the point of cut-off to the termination of the stroke.

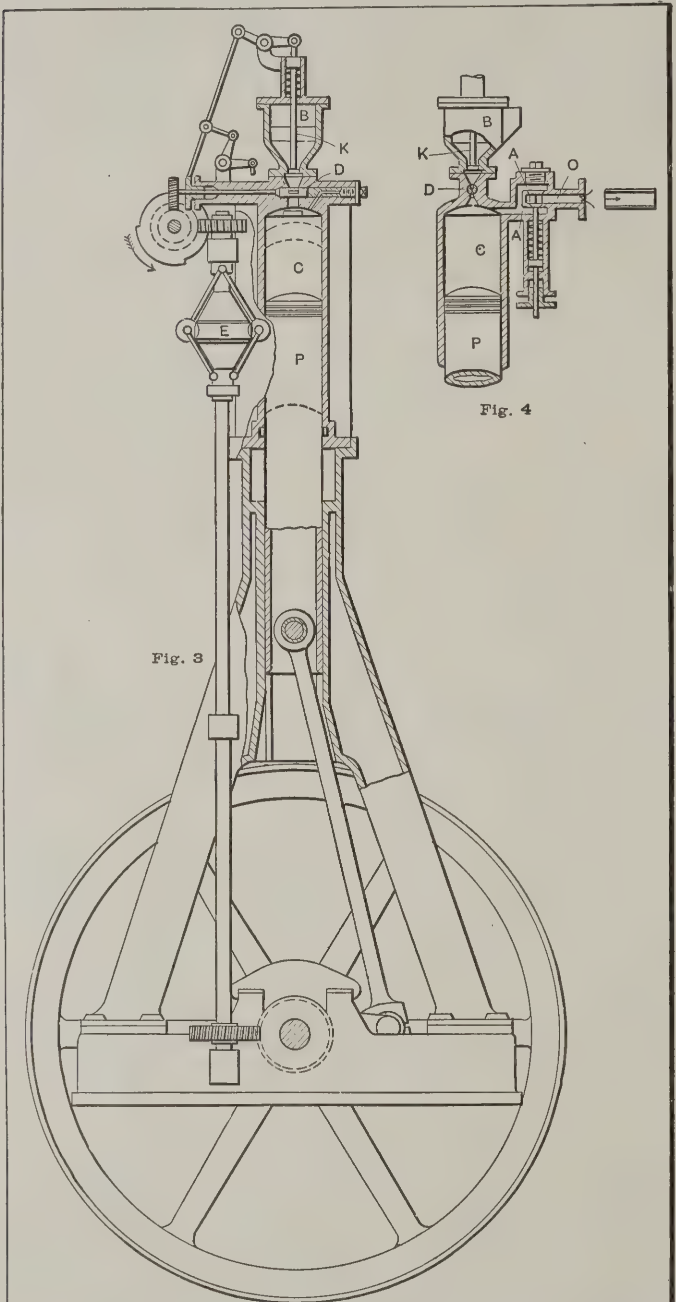
The object of the system is to promote a more perfect combustion, and to secure a working fluid of comparatively low temperature, expanded to the full limit of its useful effect. It should be observed, however, that while this is the theory of this celebrated motor, it is not fully carried out in the prevailing practice of the present day. A theory can seldom be accurately followed, and must always be subject to the requirements of practice. In the models originally demonstrated by the inventor, the initial air charge was compressed to 1500 pounds per square inch, with a resulting temperature of 1500 degrees F., and the fuel admission was accurately adjusted to maintain the theoretical conditions; but in many cases the Diesel engines now built depart somewhat from the first standard in this respect, and operate partly upon the system of the impulse or explosive cycle. The water jacket discarded by Diesel is now generally restored, and a pressure of 500 pounds per square inch is considered the proper degree of initial compression to secure the best all-around results in practical service. The thermal efficiency may be slightly reduced by this practice, but durability and ease of lubrication are improved by it, and commercial efficiency is secured to a more satisfactory extent than would be the case if the

* For further information on this and kindred subjects, see MACHINERY, February, 1912, engineering edition: "Points in the Design of Two-Stroke Cycle Engines," and also the previously published articles there referred to.

† Address: Oroville, Cal.

exact conditions demanded by theory were made the governing motive of the design.

For the purpose of automatic ignition, the extent to which the initial compression of the air charge should be carried depends upon the character of the fuel—that is the temperature at which it ignites; but as the fuel is usually crude oil or one of its heavy constituents, such as distillate or kerosene, there is but slight difference in the igniting points of these liquids. It is, of course, absolutely essential that the injection fuel be instantly and unfailingly ignited, and for obvious reasons it is certain that the compression of an engine in continuous use will not always be as high as when first



Figs. 3 and 4. Diesel Engine using Solid Fuel

installed. It is, therefore, good policy in designing a Diesel engine to take the safe side in this matter, by providing a degree of compression which is sufficiently high to include a margin of safety, in anticipation of the probable effect of wear and use under unfavorable conditions.

The manner in which this cycle differs from that of the more familiar impulse or explosion type of motor, and the chief reasons of its greater efficiency, may be seen at once by comparison. In the impulse motor the volume of the clearance space usually equals about one-third of the piston displacement. The in-stroke compresses the charge of mixed air and gas to, say, 75 pounds per square inch. At the moment this action is completed the charge is fired, and the pressure instantly rises to perhaps 300 pounds per square inch and a temperature as high as 3000 degrees F.; the gases are exhausted at the termination of the stroke at a temperature of at least 500 degrees. This makes the mean working temperature quite high, and a considerable portion of this heat must be absorbed by the water of the jacket in order to moderate the temperature of the cylinder and piston.

In a Diesel engine, however, the clearance does not exceed 7 per cent of the piston displacement, and the in-stroke forces the entire body of the air drawn in on the previous out-stroke into this space, at a pressure of 500 pounds and a temperature of about 1000 degrees. The injection of fuel begins with the power stroke and continues (if the engine is running under full load) until the piston has completed about one-fourth of its outward movement. The quantity of fuel is just sufficient to maintain the original pressure during the combustion interval, that is, from the beginning of the stroke to the point of cut-off. The volume of air is about double the amount required to consume the fuel, and the resulting temperature is correspondingly low. From the point of cut-off the charge expands to the end of the stroke, where it is exhausted at low temperature and pressure. As a result of this method of operation, the mean working temperature of the charge is lower than that of any other gas engine cycle. Consequently less heat is taken up by the jacket or lost by radiation, and a larger proportion of the heat energy of the fuel is utilized for the production of power.

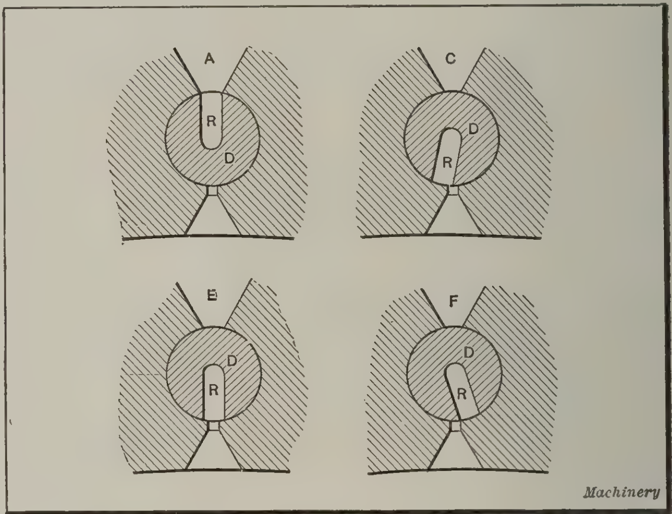


Fig. 5. Section showing Action of Valve D, Figs. 3 and 4

The means of introducing the fuel into the cylinder of a Diesel engine in a suitable physical condition and in a regulated amount is one of the most important features in the design and operation of the motor, and has received a large share of the attention given to the construction of these engines by engineers and inventors. Several methods have been devised by the original inventor of the engine, as well as by others, and two or three of these are now in use. In most cases the engine comprises an auxiliary air or injection pump, capable of producing a degree of pressure considerably in excess of the cylinder compression; this higher pressure is used to force in the liquid fuel through a minute opening controlled by a needle valve in the cylinder head. In one arrangement the fuel opening is located at the bottom of a cup-shaped chamber in the head of the cylinder, the stem of the needle valve standing in a vertical position. This chamber is in communication with the injection pump, the suction stroke of which draws a charge of oil fuel into the chamber. The lift of the needle valve is effected by a device operated by a cam on the main shaft of the engine, and the extent and duration of this lift, and also the quantity of fuel drawn into the chamber, is controlled by the governor. At the proper moment the needle valve opens and the high-pressure air drives the oil, in a finely divided spray, into the hot-air charge within the cylinder.

In the first American patent of Diesel, No. 542,846, the mechanism used for delivering the oil fuel is practically the same as that just described, and is shown in Fig. 1. This

illustration shows an engine with two cylinders just alike, and designed to be connected to the same shaft. The crankpins are in the same line, and the movements of the reciprocating parts are parallel. One cylinder is shown in section and the other in elevation. The spring closed valve *V* is used for both admission and exhaust; *R* is the exhaust pipe, and just below the open end of this pipe is the nozzle *S*, communicating with the passage *T* which leads to the valves *V* in both cylinders. Combustion takes place alternately in the cylinders, producing a working stroke at each revolution, and since the exhaust follows immediately after the drawing in of the air charge, the valve *V* remains open during a full revolution and is then closed during a full revolution. At *D* is shown the fuel nozzle; at *N* the needle valve; and at *P* the fuel cavity into which the charge of oil fuel and a small body of highly compressed air are first delivered by the injection pump and then passed through the nozzle *D* by the needle valve and sprayed into the heated air of the cylinder charge in the manner already described. The exhaust is nearly cold and of nearly even tension with the atmosphere, and the return of the piston drives out the products through the nozzle *S* into the open end of the exhaust pipe. The fresh air for the next stroke enters the same nozzle from the open space around it.

The claims of the American patent of July 16, 1895, were previously granted in England, April 14, 1892, and expired by limitation April 14, 1904. The three claims broadly covered the principles involved in the operation of the cycle as above described, and as the field is now open to all who wish to use the Diesel cycle in combination with their own designs, this patent is the key to the situation as far as general principles of operation are concerned. The specifications of this patent were largely devoted, however, to a description of certain methods of using solid fuel (coal dust), as then contemplated by the inventor, and we will consider this feature further on.

The second American patent of Diesel, Reissue No. 11,900, dated April 2, 1901, contemplated the employment of solid fuel injected with a mixture of gas and air in order to insure instantaneous ignition and more complete combustion. It also described a method of starting the engine with compressed air stored in tank *L* in Fig. 2, the compression having been effected by the engine on a previous run. In this arrangement, a lever-operated clutch controls a system of shifting cams, by which, when the engine is first started, the valve *V* is made to admit the compressed air from tank *L* to the cylinder at each out-stroke of the piston, and to exhaust the same upon the in-stroke. After a few revolutions the flywheel acquires sufficient momentum to effect the compression of the charge, and by a movement of the clutch-lever, the action of the cams is so altered that the valves are operated in the usual manner, and the regular cycle is taken up. This patent specification further provides for a method of automatic ignition without the use of the extra high-pressure air pump. In this modification ignition is effected as follows: The opening of the fuel valve is delayed until the piston has receded slightly from the dead point, and the pressure first produced by the initial compression of the air charge has fallen somewhat. The fuel valve then opens and the air previously compressed in tank *L* forces in the fuel charge as usual. The remainder of this patent specification is devoted to descriptions of burners, fuel spraying devices, etc., evidently designed in anticipation of their possible adoption by others, but probably never constructed.

The next Diesel patent is No. 708,029, dated September 2, 1902. The object of this specification is to reduce the usual size of the auxiliary air or fuel injection pump. For this purpose the pump receives its air from the compression space of the engine cylinder at a high pressure, and thus a pump of much smaller size may be employed than would otherwise be necessary. The next patent, No. 736,944, dated August 25, 1903, relates to the construction of a two-cycle engine and certain means of scavenging the cylinder of the burnt gases before the admission of the fresh air for the succeeding charge.

The last patent of this inventor, No. 890,620, dated June 16, 1908, deals with the introduction of the liquid fuel, the leading idea of this specification being to heat the oil fuel and to saturate it as far as possible with highly compressed air, prior to its admission to the cylinder of the engine, in order to facilitate atomization and promote a more thorough admixture of the fuel with the air of the charge. The oil fuel is continuously pumped into a receiver where it is submitted to the action of air at the working pressure of the engine, and then delivered to the cylinder by the means already described.

Figs. 3, 4 and 5 of patent No. 542,845 show the construction of the original Diesel engine designed for the use of solid fuel. The stroke is long in comparison with the bore, and the compression of the charge is very high. The air is drawn in on the suction stroke at valve *O* (as in the engine shown in Fig. 1), and this valve serves also for the exhaust. The powdered fuel is supplied to the hopper *B*, and is fed by valve *K*. The lift of this valve is controlled by the governor, and the consumption of fuel is thereby proportioned to the demand for power. The delivery of the fuel to the combustion chamber is effected by the rotating plug valve *D*, shown in Figs. 3 and 4, and in transverse section in Fig. 5. This valve has a slot *R*, on one side, and is revolved by the worm-gear shown in Fig. 3. When in position shown at *A*, in Fig. 5, the slot *R* receives a charge of fuel from valve *K*, and while in positions, *C*, *E*, and *F*, delivers the same to the cylinder during the combustion interval.

The inventor states in regard to the use of coal dust fuel that, "the residues of combustion being suspended in a finely divided state in the whirling gases are blown out with the same." If such an engine was ever successfully operated, however, it was probably run at a slow speed.

The Diesel cycle is easily adapted to the use of gas fuel of almost any description. The injection pump receives and compresses the gas to about 750 pounds per square inch, and the injection valve operated under control of the governor, delivers this compressed fuel to the cylinder.

* * *

AN ANALYSIS OF LATHE ACCIDENTS

The gathering of statistics by labor inspectors and inspectors of factories is accumulating a vast store of interesting information. In England, for example, a very complete report has been published covering facts elicited on inspection and in reports, in the Northeastern division of the work of factory inspection.

The total number of accidents reported with lathes in the year 1910 was 670. The classification of the sources of these accidents and the numbers in each group are given in the following table:

From the driving belt of the lathe	24
From the cone-pulley, or belt of the lathe proper	46
From spindle-gear and back-gear	17
From the change gears at the headstock	17
From other gears in apron and feed mechanism	8
From the driving dog	71
From the faceplate or chuck	23
From projecting set-screws about the lathe or work	8
From the tool point or article being turned	297
From the flying chips, or articles being turned flying out	127
From other causes, including falls upon the workmen	32
	670

It is interesting to notice that nearly one-third of these accidents occurred in connection with the work being turned; next to these are the accidents incident to the dog or driver catching the arm or clothing of the workman, and doubtless the chuck or faceplate accidents might be taken together, making up nearly 15 per cent of the entire list.—*The Journal of Industrial Safety.*

* * *

To illustrate the progress of the introduction of machinery in different manufacturing industries, a notable example is cited in a factory in Waterville, Me., where paper pie-plates such as are used by bakers are made in automatic machines that cut, form and emboss plates, turning them out at the rate of 840,000 per day.

PREVENTION OF INDUSTRIAL ACCIDENTS*

By FREDERICK REMSEN HUTTON†

Prof. Frederick Remsen Hutton‡

It should require no argument to prove that an accident in a shop or factory is an economic blunder. It costs the owner, the victim, and the community more to produce the staple article in that establishment than if accidents were prevented. The owner or manufacturer pays at least four costs.

1. The proper compensation of the victim who for a longer or shorter period is unable to earn wages.

2. The cost of litigation where questions arise respecting the responsibility for the accident; or the cost of liability insurance, if the owner follows this method of protecting himself from more costly attack.

3. The cost of the diminished rate of production which follows the nervous shock to everyone who witnessed the accident or ran to the help of the sufferer.

4. The cost of the time to train a new operative to the speed and skill of the disabled one, and such loss as there may be from defective work in that process.

If the seller properly charges these costs to the prime costs of production, he is unable to meet the competition of a rival who has no accidents. In the second place, the community as a whole wastes its resources in the care of the disabled one in the hospital and the charity doled out to any dependents he may have. The community suffers indirectly also, because the victim's children are held back from their full schooling in order to go to work. In the third place, the victim himself spends his savings, laid aside for old age, to say nothing of the pain, the sorrow, the disappointment, the broken spirit, and the quenched ambitions, which the victim has to bear.

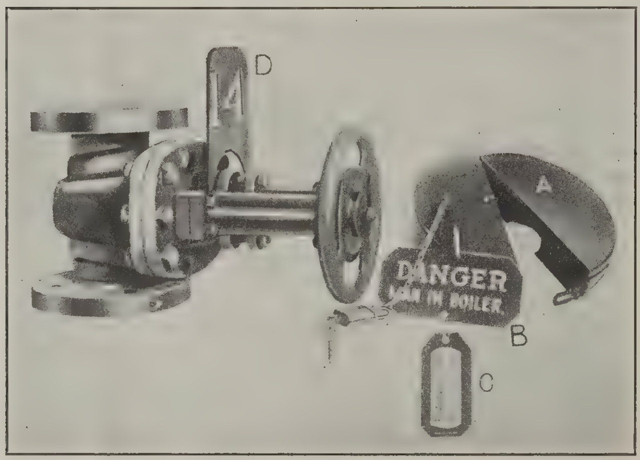


Fig. 1. Safety Lock for Steam Valves

Are industrial accidents preventable? The answer must be conditioned upon the definition given to an accident. An industrial accident may be defined as something which happens to a man, or to a machine, which incapacitates either for the process of production. The accident to the machine may involve an accident to its operator, or he may escape. So far as the operator is concerned, an industrial accident is one by which a mechanical force acts upon the non-resisting tissues or structure of the human body and wounds, bruises, lacerates, or crushes such parts of the body as are in the path of that force. It is the mechanical forces which are responsible for the injuries in industrial accidents. The accident to the machine may be the result of a poor design or of a failure in the material of a properly designed part, from an excessive stress. Prevention of accidents would therefore seem to be a matter which concerned the designer, the inspector, and the works-manager, foreman or superintendent.

The accidents outlined above are in the nature of a sudden disablement. It is no less the duty of the designer and manager to take steps to prevent a gradual disablement, or a premature wearing out of the wage-earning capacity, by slow physiological causes incident to the character of the work; or, to put this in other words, the producing interests need as an economic proposition, to have their human factors in the "pink" of physical condition. They should take care that no conditions in the works itself are responsible for lowered vitality.

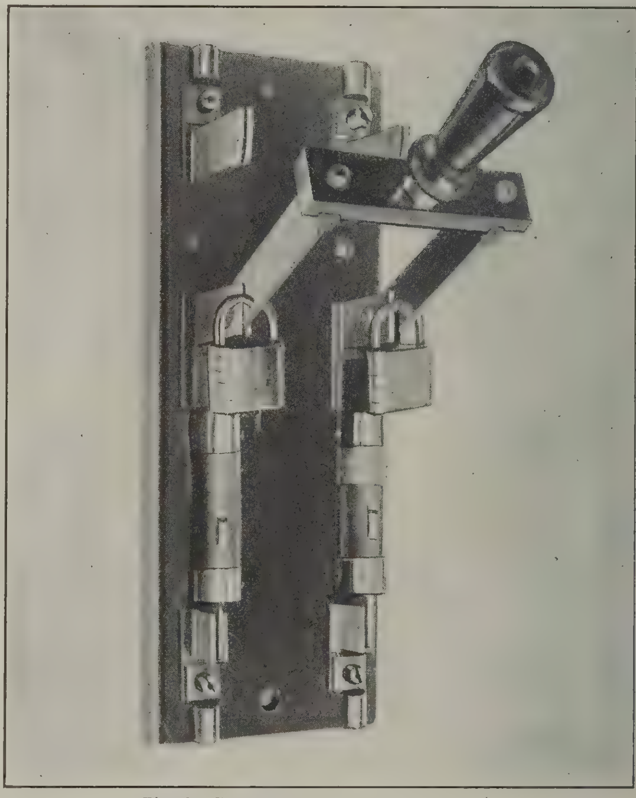


Fig. 2. Safety Lock for Electric Switch

Preventing Accidents in Boilers, and around Engines and Motors

If the foregoing contentions are sound, the motor energy on which all modern production is based, is the prime cause of industrial accidents. Accidents do not happen when the works are shut down. It is so common to surround the moving parts of the power plant by railings, that it seems scarcely necessary to illustrate safeguards in this class. A disaster, however, hangs over the workman around a boiler, which the safety device shown in Fig. 1 seeks to prevent, and against which it has been found entirely effective. This device for preventing a steam valve from being opened upon a line where

The illustrations used in this article have been furnished by the American Museum of Safety, 29 West 39th St., New York City.

* For previous articles on safety devices and accident prevention published in MACHINERY see November, 1911, number and the articles there referred to.

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‡ Prof. Frederick Remsen Hutton graduated from Columbia University in 1876. From 1877 until 1907 he was professor of mechanical engineering in Columbia University. In that year, he was made professor emeritus and entered consulting engineering practice. From 1883 to 1906, he was secretary of the American Society of Mechanical Engineers and was president for the society year 1906-1907. He was then made honorary secretary of the society in recognition of his efforts and success in building up the society from its early beginnings until it moved to the great engineering building on 39th St., New York. He is the author of "The Mechanical Engineering of Power Plants" and "The Gas Engine." In 1911 he served the city of New York as consulting engineer, and is consulting engineer and chairman of the technical committee of the Automobile Club of America. He was one of the persons who early realized the significance of the protection of the workman from the accidents of his occupation in factory and shop. He is vice-president of the American Museum of Safety, chairman of its committee on exhibits and of its board of award of medals. He was for some time also president of the Industrial Safety Association, organized with a special view to the promotion of safety devices in the design of tools and machinery. He is much in demand as a lecturer on this special subject, particularly among the student branches of the American Society of Mechanical Engineers. He is also greatly interested in the problem of good roads and the philosophy of national highways.

people are at work, consists of a sheet-steel casing which fits around the handwheel. It is locked in place, and the key given to the man most interested. The engine down the line on which men are working cannot be started; steam cannot be turned into a boiler within which a man is working; acid cannot be turned into a tank or vat within which repairs are in progress; and a wide group of most distressing accidents are precluded where this safeguard is used.

Fig. 2 shows a safeguard identical in principle and operation where the danger may come from an unauthorized closing of an electrical switch which the repair-man opened when he went to work. The key of the padlock is, as before, in the pocket of the man most interested, and the current cannot be turned on the line until he unlocks the lock.

The next great avenue of disaster is to be found in the belts or gears through which power is passing. The main belt is usually massive enough to act as its own warning sign. The smaller transmissions, however, are those with which the workman is usually more intimate, and from which his greatest danger arises.

In Fig. 3 is illustrated a form of safeguarding against belt accidents, and, of course, the same principle can be extended

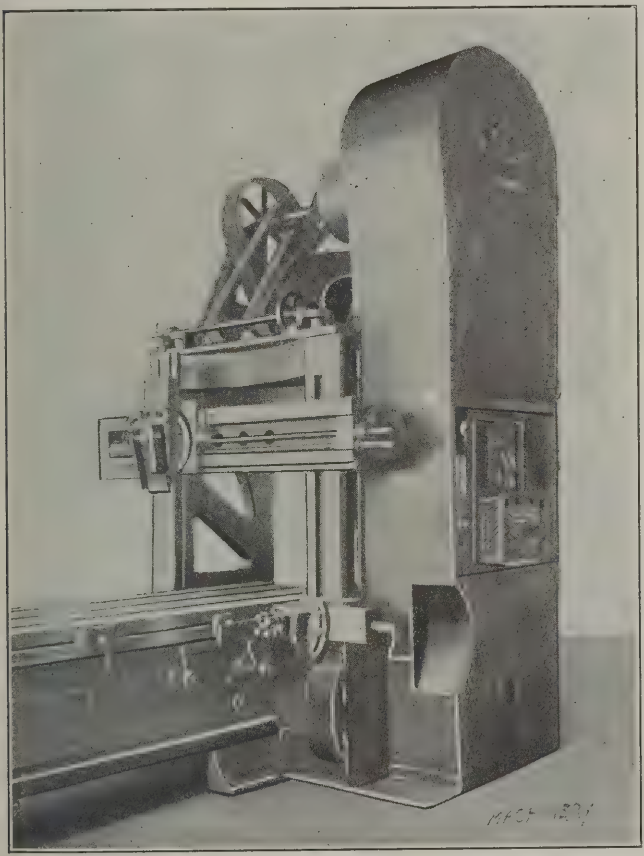

Fig. 3. Guard over Belting and Gears

to gears. A slippery floor or a loose end of a garment may be the cause of throwing a man into the path of the belt, and he may be maimed or killed before the motion can be stopped.

The wood-working or pattern shop is a place where dangerous cutting edges are moving at high speed. These conditions make the circular saw, the jointer or buzz-planer, the molder or sticker, and the band-saw, sources of most distressing accidents, which seem almost worse by reason of their suddenness of attack without warning. Fig. 4 illustrates the trend of modern prevention of accidents of this kind. The lower part of the band-saw is completely encased, and the upper wheel covered with a guard. The accident from the breakage of the saw, and the danger to the forehead of the workman are practically eliminated. He can still, however, lose a finger in the danger zone of the tool. Improved designs of cutter-heads for planers have greatly reduced the dangerous character of the accidents which happen about it, and many forms of guards for the villainous circular saw have been widely installed.

Preventing Accidents in Punch Presses

The punch for boiler and bridge plate is not in itself so very dangerous a tool, but Fig. 5 illustrates a principle of actuating such tools which will make them still safer. Without going into the detail of mechanical construction, it will be plain that by using the electrical wire to put the punch into commission, the fingers of the workman can be kept entirely outside of the danger zone, and he is much less liable to accident than when the design compels that the clutch be thrown in by a second man who may not know just exactly where

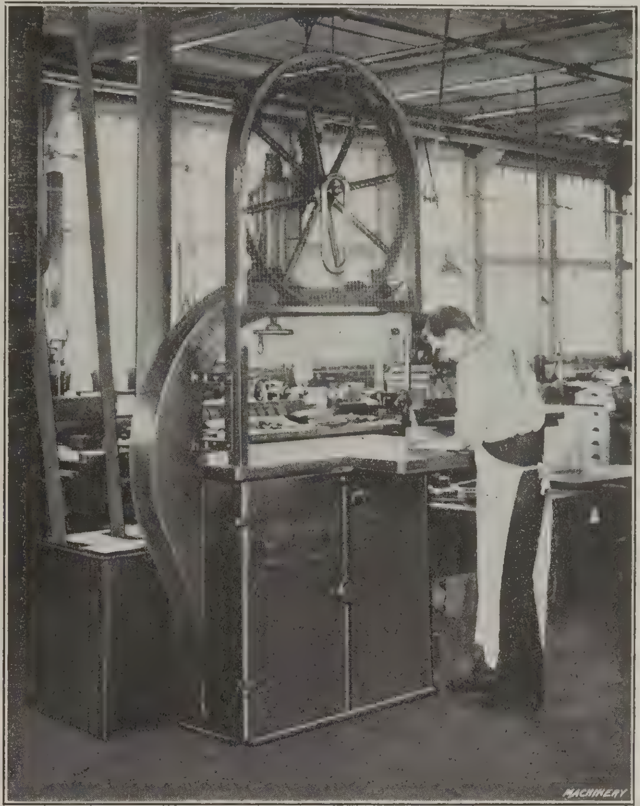

Fig. 4. Guards for a Band-saw

his comrade's fingers are. Probably, however, the most dangerous of the tools in the punching class are the ordinary punch presses used in stamping and drawing sheet metals and similar work. If the ram reciprocates continuously, and the workman feeds the stock by hand, there is always the danger that something will distract his attention, resulting in his leaving a finger where the stroke of the ram can catch it. The designs in Figs. 6 and 7 show a collapsible guard forming a safety device, the intention being that the fingers of the operator

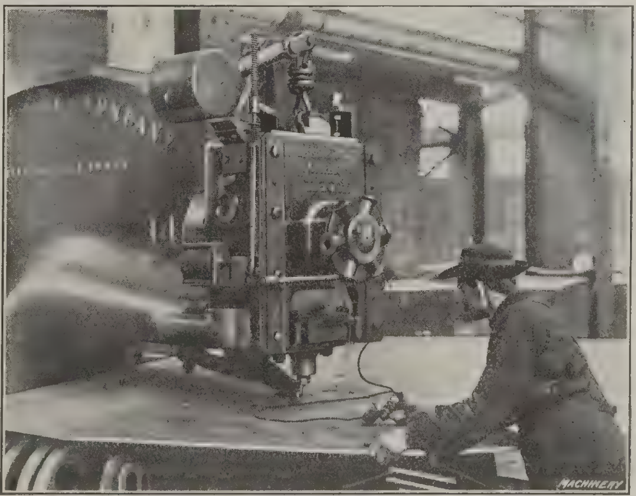

Fig. 5. Operating a Boiler-plate Punch by means of an Electric Hand-switch

shall never get within the guard, while it gives freedom for presenting the stock to the press. Other forms of safeguards cause a steel finger to sweep over the die of such a press, just as the ram descends, forcing the careless finger out of the danger area. A recent clever inventor has proposed to electrify the die as the punch starts to descend, so that any man whose fingers rest on it will get a sharp shock, and automatically draw the fingers away, due to the involuntary contraction of the muscles.

Guarding Emery-wheels

The emery-wheel is a dangerous center of possible accidents. The danger is first from a bursting of the wheel, either by the pressure of the work at the periphery of the wheel, or, more rarely, simply from the action of the centrifugal force. A two-fold safeguard against these accidents can be secured by the use of large disks or washers which grip the wheel at a considerable distance from the revolving axis. If, further, the wheel is thicker at the center than where the washers bear, the danger of a centrifugal flinging of the parts of a broken wheel is materially lessened. Furthermore, the wheel can be covered, except just at the working sector, by a steel guard strong enough to keep in any fragments of the wheel if it should burst.

Fig. 9 shows a safeguarded emery-wheel with the belt protected within a steel shield, and the eyes of the workman shielded by screens either of glass or of fine wire mesh. If

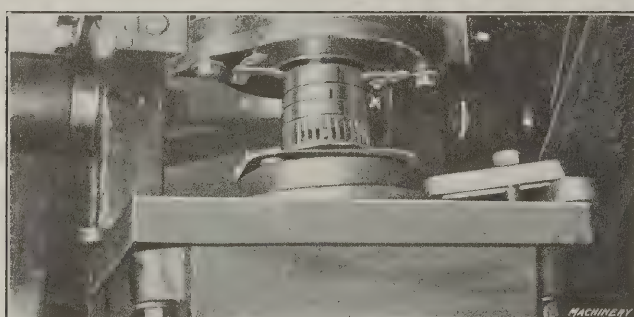

Fig. 6. Punch Press with Telescoping Guard

exhaust currents of sufficient strength to overcome the centrifugal tendency of abraded particles are led away from the wheel, the respiratory tract of the workman is saved from the slow deterioration which it would otherwise suffer.

Miscellaneous Safeguards

The lathe, working on small diameters, or with work in its chuck or on its faceplate, is particularly liable to entangle the sleeve of the workman and break or lacerate his arm. In Figs. 8 and 10 are shown two suggestions for safeguarding the man. The drum *A* in Fig. 8 should keep his clothing from the projecting points of the chuck or faceplate, while

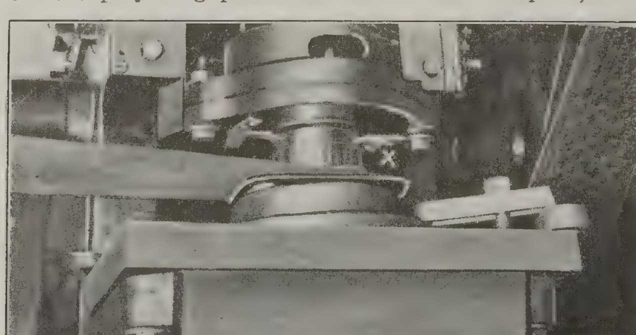

Fig. 7. Punch Press Guard in Fig. 6 with the Ram in its Lower Position

Fig. 10 shows how the common dog can be prevented from his vicious biting.

It is not the custom in the United States to make such common use of women in the shops as the German practice does. The safeguarding the women's hair from being caught in belts or other moving parts should, however, not be neglected. The electrical zone surrounding a fast moving belt is particularly fatal to loose strands, and the entanglement of hair between a belt and a pulley can result in a most distressing accident, which is usually severe enough to be fatal. The wearing of close-fitting caps, covering all of the hair, prevents accidents of this kind.

Accidents in the shop do not originate alone in the danger zone of a power driven tool. The process of chipping often sends a flying particle with considerable force over quite a distance, and the delicate tissues of the eye can easily be pierced by such a barbed missile. In Fig. 11 is shown a safeguard in simple form; a screen of burlap is stretched upon a light frame in the path of such steel particles. The fibrous character of the screen catches what is thrust against it, and the particles drop harmlessly to the ground.

It must not be overlooked that the mechanical force which may strike a man down is not alone manifest or developed at the operating point of the tool. The means of transportation within the shop and about the yard, when operated by power, can be as fatal as the machine tool. The door into

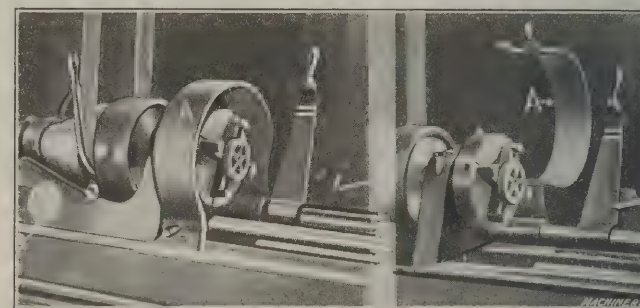

Fig. 8. Guard for the Lathe over Faceplate or Chucks

one of the plant buildings may open directly upon the line of a railway. On a stormy day when the wind is high, or late in the afternoon when the shop is bright, but outdoors is dark, a man may step from the door directly into the danger zone of the railway. He may be intently thinking of something

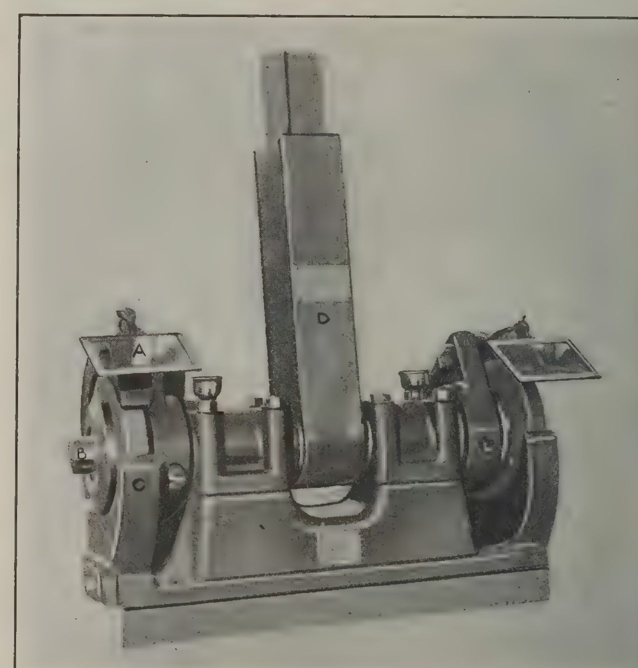

Fig. 9. Emery-wheel Head Effectively Guarded

else, or young lads may be full of the thought of release from toil at the end of the day. The simple expedient of a gate which shall compel a man who comes out through the door to turn and face parallel to the building before he attempts to cross, will at least direct his attention to the danger of the

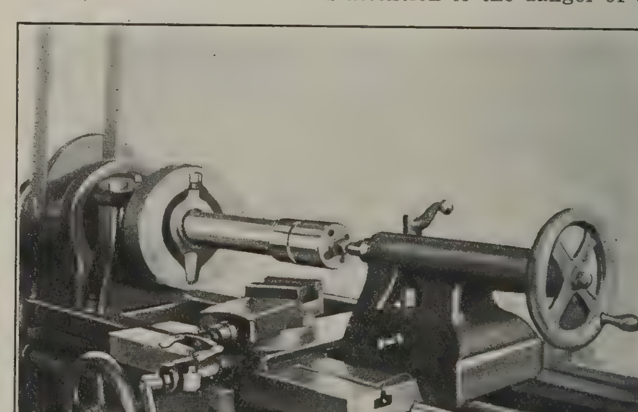

Fig. 10. Lathe Dog Guard

railway line by compelling him to pass around the end of the gate.

The workman whose business it is to oil shafting may meet with an accident by placing his ladder at rather an acute

angle with the floor, and a slippery surface may permit the ladder to fall, bringing the man and his tools to serious injury, particularly if he should fall into moving machinery. It is a good safety device to equip the foot of such a ladder with large contact areas (Fig. 12), and to fit this with a rubber or other surface of high frictional resistance. The protection of traveling cranes, of hoistways and hatches, and of safety hooks and gangway railings, all belong in this general class.

Interlocking Safety Devices

It will be apparent, however, from a consideration of most of the foregoing devices for safety that, even when they are

Fig. 11. Screen for Preventing Chips from flying around

used, it is entirely possible for industrial accidents to occur if the workman is careless or uninterested. The highest principle in safety devices is that which in other departments of engineering is called the "interlocking" principle; that is, it may be made mechanically impossible for the operator to have his fingers in the danger zone and have the tool set in motion while his fingers are there. This principle is introduced in two ways. The first is to have the engaging device require a concurrent action of both hands, in order that the machine

Fig. 12. Large Special Feet for Ladders, with Rubber Soles to increase Frictional Resistance

may function. In a press, for example, it may be arranged so that the belt has a tendency to pass to the loose pulley unless a counterweight attached to the shifter is held in a certain position by the right hand. When the right hand has gripped this one lever, it still requires that the left hand shall throw the clutch lever to make the machine operate. Obviously, the workman has no hand free to put in the path of the plunger of the press. The engagement may also be pneumatic, and require that two valves be opened, one of which is worked with the right hand and the other with the left.

The second interlocking principle is applied in centrifugals or kneading machines which are fitted with a cover. It can easily be made mechanically impossible to throw on the power until the protecting lid has been closed down over the working parts. When this has been done, the belt may be shifted or the clutch thrown in. Conversely, when the clutch is in or the belt is driving the machine, the lid cannot be lifted until the power has first been shut off. For the machines to which this principle can be applied, there is nothing additional to be desired in the way of a safety provision.

It is, however, impossible to apply interlocking to all machines, and there remains, therefore, the necessity for getting the workmen interested in preventing accidents. One of the most satisfactory agencies to this end has been the formation of Safety Committees in the works, of which the workmen themselves are made members in rotation, serving with a certain number who do not change from week to week. While it is true that no soldier makes a good captain until he has first served as a private, it is equally true that no man makes so good a private as one who has carried the burdens of a captain. Service on the Safety Committee and familiarity with the line of thought which reaches after safety, makes the men themselves far more willing to take precautions.

We need an educational process which shall, on the one hand, inform the manufacturer as to what safety devices and systems of shop rules have worked well in other plants, and on the other, instruct the men as to the precautions and safeguards which they have a right to expect in their plant. The labor union may very properly exert itself to protect its members by an insistence upon adequate provisions for safety. The factory inspector may properly insist that every works manager lives up to that standard in safety matters which has been found practical in other establishments of the state.

* * *

The Machine Tool and Engineering Association of Great Britain announced at its last annual meeting that eighty firms had joined the association. A communication had been received from the Home Office, one of the governmental departments in Great Britain, with respect to the question of adequately guarding the gears of machines. It was stated in this communication that British firms had lost several orders owing to the inadequacy of the guards over gears, and that machine tool manufacturers in other countries supplied their machines with better guards. A prominent man in the machine tool trade, speaking about the way in which some of the gears and parts were indiscriminately arranged around a machine, to the danger of the operator, suggested that the builders should look at the human frame as a model to which to build their machines, since in this all the important elements are carefully concealed within perfect guards. A designer, he intimated, should make a machine a pleasing thing to look at besides being an article of utility. Mr. Walter Deakin of Messrs. H. W. Ward & Co., Ltd., called attention to the fact that the reason why the British mechanical industries were not in the lead, as they had been in the past, was chiefly due to the narrow view that the members of the trade had entertained. They had, he said, rather kept to themselves and thought that it would be the best policy to cultivate their own little patch, without attempting to recognize the general bearing of questions concerning the whole industry. Evidences, however, indicate that this feeling is disappearing among British manufacturers.

* * *

Radium emits three kinds of rays which for convenience are called alpha, beta, and gamma rays. Of these the gamma rays, which greatly resemble the Roentgen or X-rays, are of tremendous penetrating power. It has been possible to obtain fine photographs with these rays through 12 inches of steel. The alpha rays emitted by radium are in reality small particles of matter that can be detected when the radium is exposed to a zinc sulphide screen; the bombardment of the screen by these particles, which travel at a very high velocity, produces scintillations which under a magnifying glass, look like millions of shooting stars or sparks. Through the constant giving off of particles, the radium atom gradually breaks up, but the process is so slow that only one-half of the atom is broken up in about 1300 years.

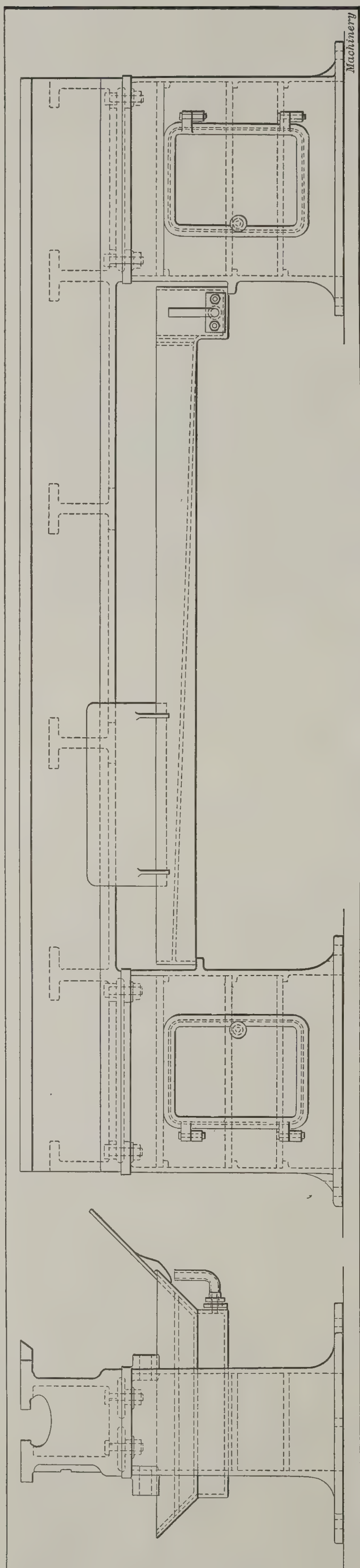

Fig. 1. Lathe Bed supported on Cabinet Standards or Legs with Provision for Lubricating the Cutting Tool

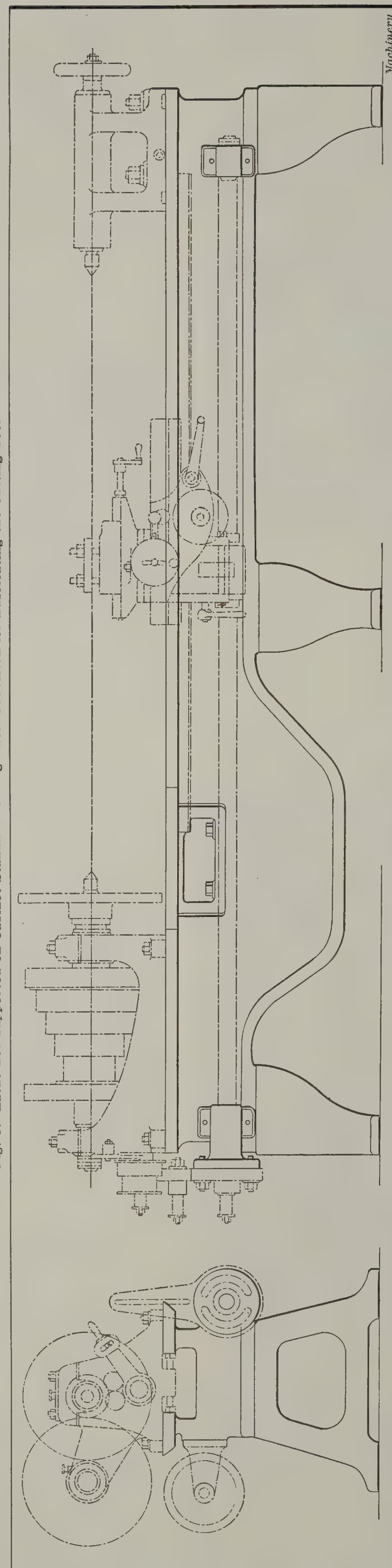

Fig. 2. Gap Bed supported on Three Legs

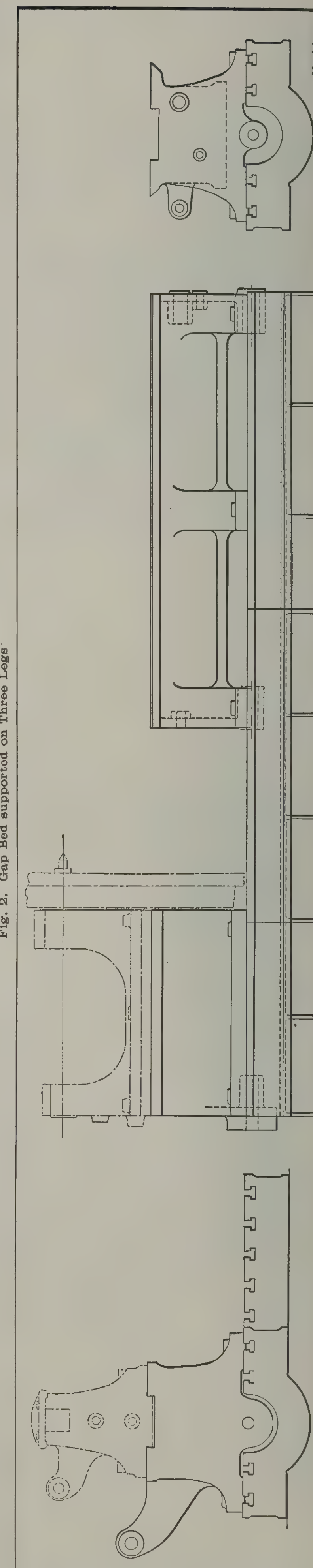

Fig. 3. Large Sliding Gap Bed

THE FORMS OF LATHE BEDS -3

THE LONGITUDINAL FORMS OF BEDS

By JOSEPH G. HORNER*

The remarks made in the previous installments relative to the flexure and torsion of lathe beds need not be repeated here, but we shall consider, with the aid of the representative illustrations, how flexure is best resisted, and how the longitudinal shapes are modified to serve different functions. The principal differences which are made in the forms of beds are those arising from variations in dimensions, while subsidiary differences are produced by special designs of lathes, or additional functions, or by the particular class of work which is done in the lathe. Thus, the shapes of beds of similar dimensions for ordinary screw-cutting or engine lathes and those for turret lathes are very often radically different. In the one case provision has to be included for the screw-cutting and feeding devices, for the carriage motions, and for the tailstock, while in many turret lathes these features are absent, and the bed is plainer, with provision only for clamping the turret base and the cross-slide. On the other hand, the arrangements for lubricating the cutting tools and work often introduce complications into the design of turret lathe beds, and the casting is of a more elaborate character below the bed proper—around the top of the legs or standards.

The length of a bed has an important influence upon its construction and the number of supporting points, and if a gap is included, this also modifies the form to a considerable degree. The number of supports ranges from the single cabinet standard in some small lathes, and the two standards or legs in those of ordinary dimensions, to the three or more supports in longer beds. A continuous bed of full depth for the whole length is employed in lathes for heavy work and large swing, and is supported solidly on concrete foundations. The truth and rigidity of a lathe bed depends to a certain extent upon how it is fastened down. Ordinarily, beds are bolted rigidly to their foundation, which may be a wooden floor or a stone or concrete base.

Many years ago Prof. Sweet suggested the adoption of a tripod support for lathe beds, and this suggestion has been acted upon in practice. One end of the lathe is bolted down by the usual means, and the other is pivoted on a pin which passes through lugs in the bed and in the leg. The only support at that end is the pin on which the leg is free to adjust itself. Many firms also adopt the three-point support principle without any pivoting device: sometimes there are three points of contact with the foundation, and sometimes the bed is united to the legs at three points. The effect of an untrue foundation is thereby neutralized. Another method of affording good support is that of casting the bed with, or bolting it to, a single column of box form, which makes the lathe self-contained, and obviates any risk of distortion or winding. This construction is employed both for small ordinary lathes, and for turret lathes up to fairly large dimensions.

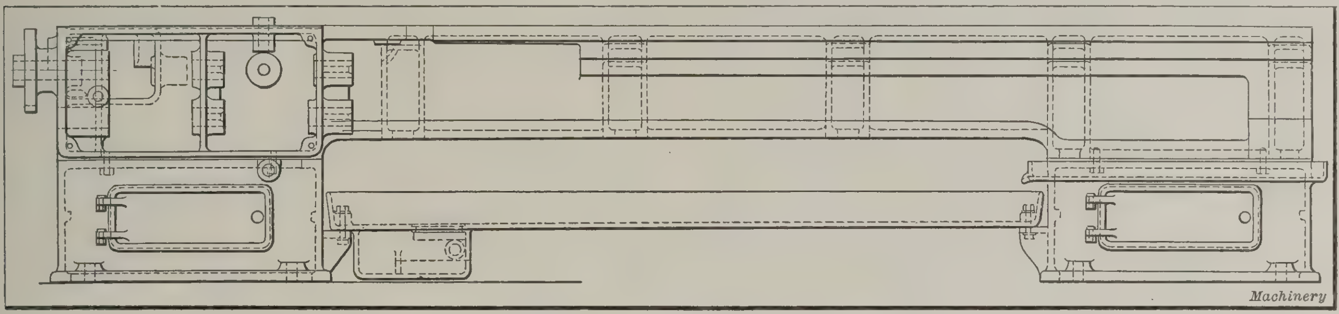

Fig. 4. Bed for 20-inch High-speed Lathe built by Smith & Coventry, Ltd., Manchester, England

Legs or Supports for Lathe Beds

When legs are used to support the bed, it is the custom of some makers to spread the legs under the head to a greater extent than those under the right-hand end, to resist the vibration, which is more pronounced at the headstock end. Other firms do not put ordinary ribbed legs at all under the headstock, but prefer a boxed cabinet support, even when there are legs at the other end. The principle of this seems faulty, since, if it is considered necessary to put a box support under the headstock end, the use of a flimsy support at the other end of a heavy bed appears unreasonable. Many makers view the matter in this light, and place the bed on equally solid and substantial supports at both ends; sometimes the supports are of identical pattern, but frequently they are a little larger at the headstock end, in order to afford more cupboard room for tools and appliances.

The practice of placing the supports a certain distance inward from the ends, mentioned in a previous installment, is followed in many instances, and a further development of this principle is found in the case of some lathes, particularly those with gaps, where the metal of the boxed bed is carried down to a considerable depth under the headstock, gradually tapering off towards the ends. A great many turret lathes have their supports placed some distance inward from the ends of the bed, and the under side of the latter is often tapered or curved upward from the outside of the legs to the ends of the bed.

Gap Lathes

The question of forming a gap in a lathe bed has long been the subject of controversy. A gap lathe bed is practically as common in England as a straight bed. Theoretical considerations have been urged against it, chiefly on the ground that the bed is weakened, because its continuity is broken; but an English lathe maker would argue that the metal which is removed can be more than compensated for by extra metal placed underneath and beyond the gap, and in the heavier lathes by metal brought down to the ground in the form of a broad foot. The real objection to a gap is its unalterable dimensions—it is wider than is required for some jobs, and not wide enough for others. The fitting of the bridge-piece is also liable to become slightly inaccurate when a lathe has done much service, but this can be rectified.

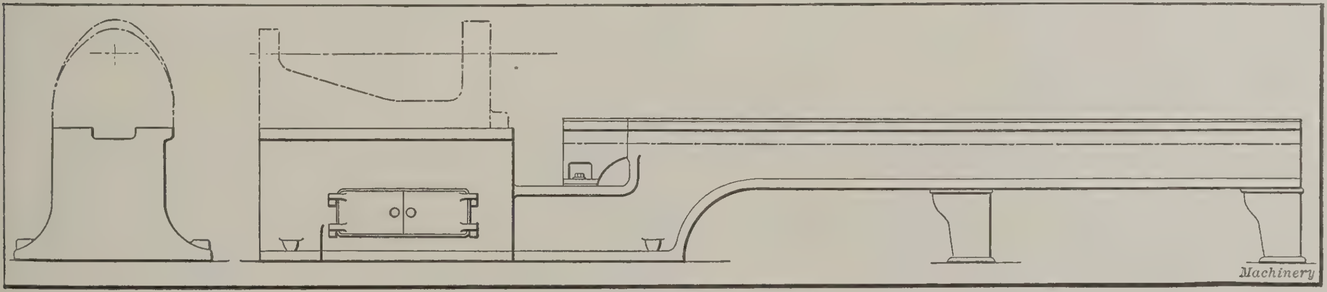

Fig. 5. Gap Bed with Support under the Gap

The gap is nevertheless a great favorite because of the gen-

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eral and miscellaneous character of the work which has to be handled in most shops. Thirty or forty years ago such lathes predominated over all others, but gradually, with the growth in specialization, they have been displaced, to some extent, by straight-bed lathes on the one hand, and by regular facing lathes, and vertical turning and boring mills, on the other. Nevertheless, the rigid gap bed retains an important place in nearly all English shops, and is likely to do so because of its adaptability to so many varied classes of work. Usually, the makers now supply identically the same lathe with and without the gap. In some designs a sort of compromise is made, in that the metal immediately in front of the headstock is recessed to a moderate depth and width, leaving a gap which very considerably increases the usefulness of the lathe, but no gap-piece is required. The metal removed at the recess is compensated for by carrying the bed down deeper underneath, or by casting it with a continuous foot extending from the end of the bed to a certain distance beyond the gap.

The movable-gap is used to a moderate extent, in medium and large sizes of lathes, and would be adopted more extensively but for the fact of the ever-growing specialization. The breadth of gap is adjustable within a wide range, or it may be closed up entirely, the object being, of course, to support the carriage as close as practicable to the cutting point of the tool under all conditions. The most serious defect in gap lathes, perhaps, is the fact that the lead-screw has to be kept low down to be out of the way. In the movable-gap lathes another difficulty arises in the driving of the lead-screw, which has to be done from gears at the right-hand end of the bed.

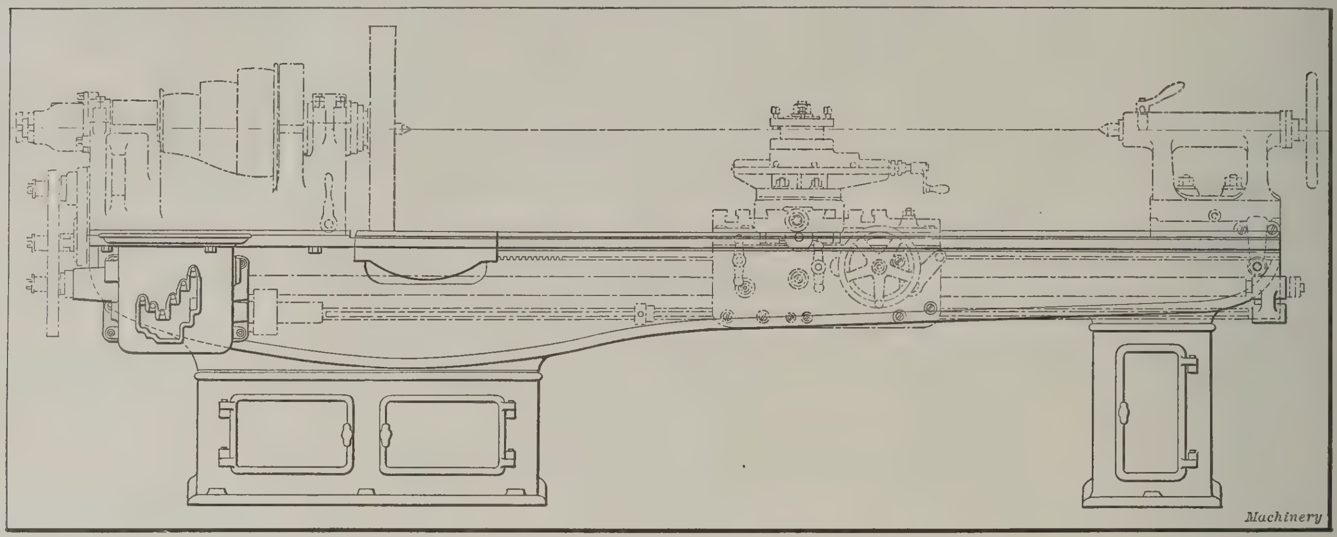

Fig. 6. Gap Bed of French Design

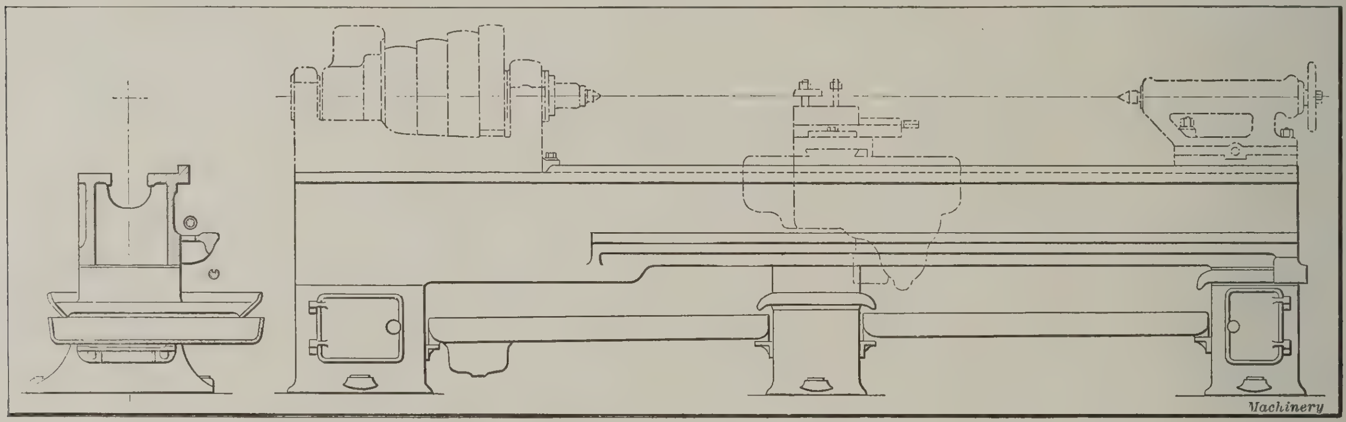

Fig. 7. High-speed Lathe Bed with Three Supports, as built by Darling & Sellers, Ltd., Keighley, England

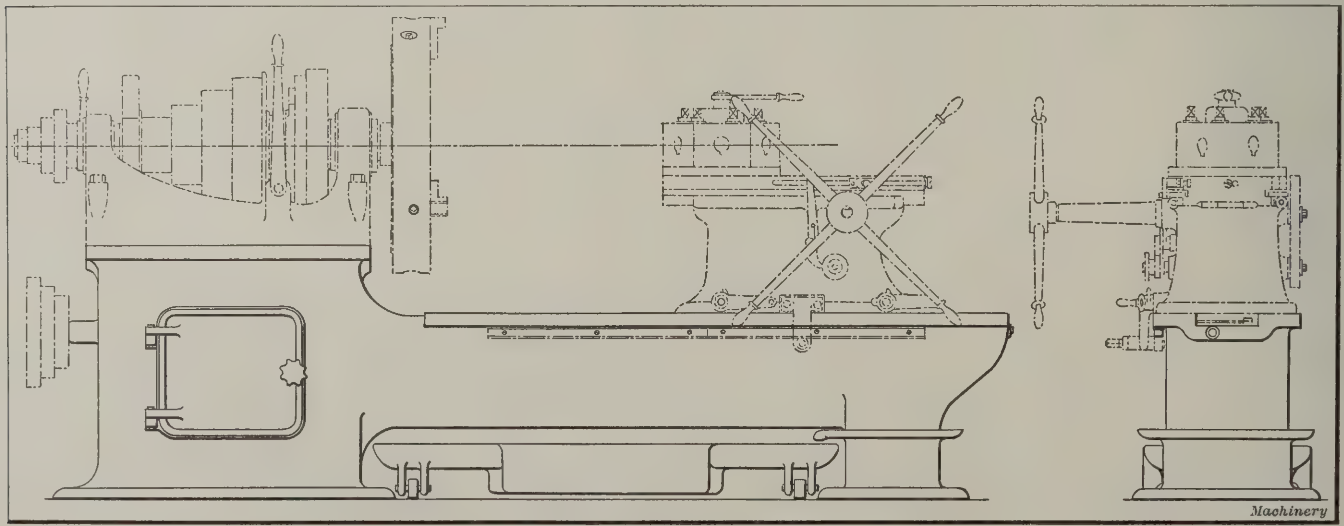

Fig. 8. Type of Bed used for Chucking Lathe

Types of Lathe Beds

The first illustration, Fig. 1, shows the form of a good type

of bed, supported on box standards at both ends. The bed is equipped for the use of cutting lubricant or oil, though not in such a perfect manner as some beds shown later. A more

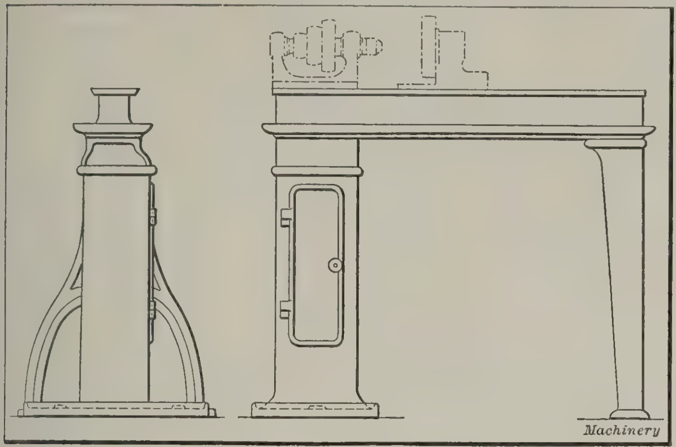

Fig. 9. Bed for Small Lathe

elaborate type of bed for a 20-inch high-speed lathe, built by Smith & Coventry, Ltd., of Manchester, England, is shown in Fig. 4. The cross-sectional shape of this bed was shown in a previous installment of this article. The details of the boxing and cross-ribbing and the joining of the bed to its standards will be observed. The right-hand standard is surrounded by an oil rim which conducts the lubricant into the trough, and at the top of the bed, close to the headstock, a space is left for the oil and chips to drop down into the trough.

The two principal designs of gap lathes are represented in Figs. 2 and 5, the first having the gap compensated for by the usual deepening underneath, and the other having a continuous base, such as is adopted for heavier lathes. In each case an intermediate leg is located under the bed, owing to its length. It will be noticed that in one case the gap-piece entirely fills the opening, while in the other it only partially does so, leaving a space for a large face-plate or chuck to remain in place, and still providing sufficient length for the support of the saddle.

Fig. 6 shows a French design of gap bed in which the metal is carried down in a graceful curve under the gap. The bed is well supported at this point on the wide cabinet base. An example of a straight bed supported on three equidistant bases is shown in Fig. 7, this being the bed of a Darling & Sellers' lathe, the section of the bed and saddle for which was shown in a previous installment. It will be noted, from the elevation, how the lower tier or guide rail would support the carriage if a gap were used. A design of bed for a chucking lathe is illustrated in Fig. 8; this is of the box type, with ample support underneath the headstock.

Two designs of beds which embody the same idea, with different proportions, are shown in Figs. 9 and 10, the first being for a small lathe, and the second for a larger one. A cabinet leg is used under the headstock end in each case. For beds of the proportions shown in Fig. 9 it is not generally the practice to use a cabinet base, but regular ribbed legs at both ends are used instead.

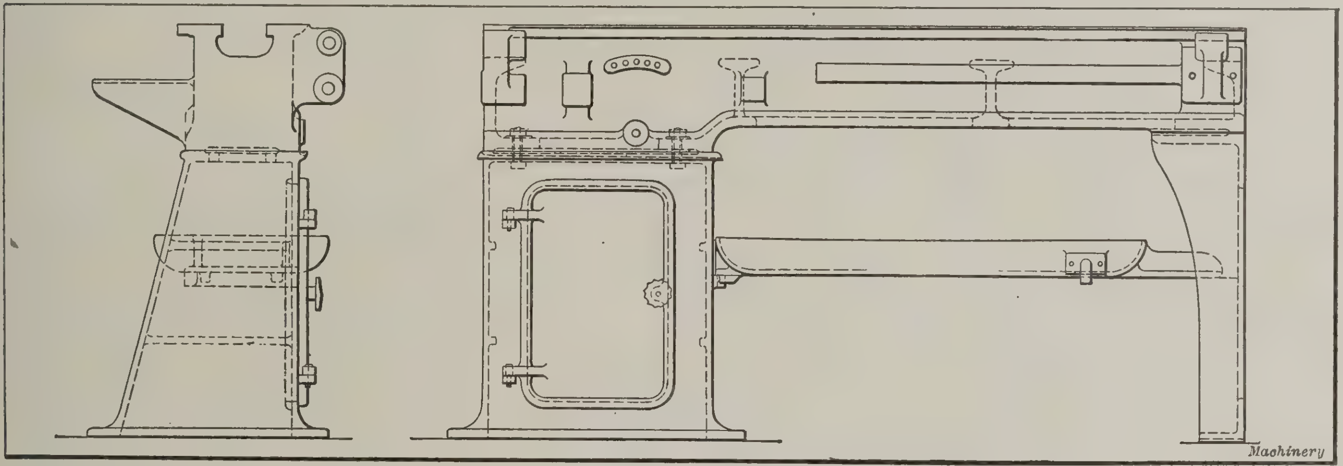

Fig. 10. Bed with Wide Cabinet Standard at One End

The arrangements for lubrication of the cutting tool and work, as mentioned before, affect the extent to which the bed is provided with oil-catching devices. The most complete method, short of placing the entire bed in a tray, is that represented in Fig. 11, with each base surrounded with an oil rim, leading into the trough between them. This arrangement does not provide for splashing, unless a sloping guard is fitted in front, or in both front and rear. A step further, as shown in Fig. 14, consists in fitting a single tray large enough

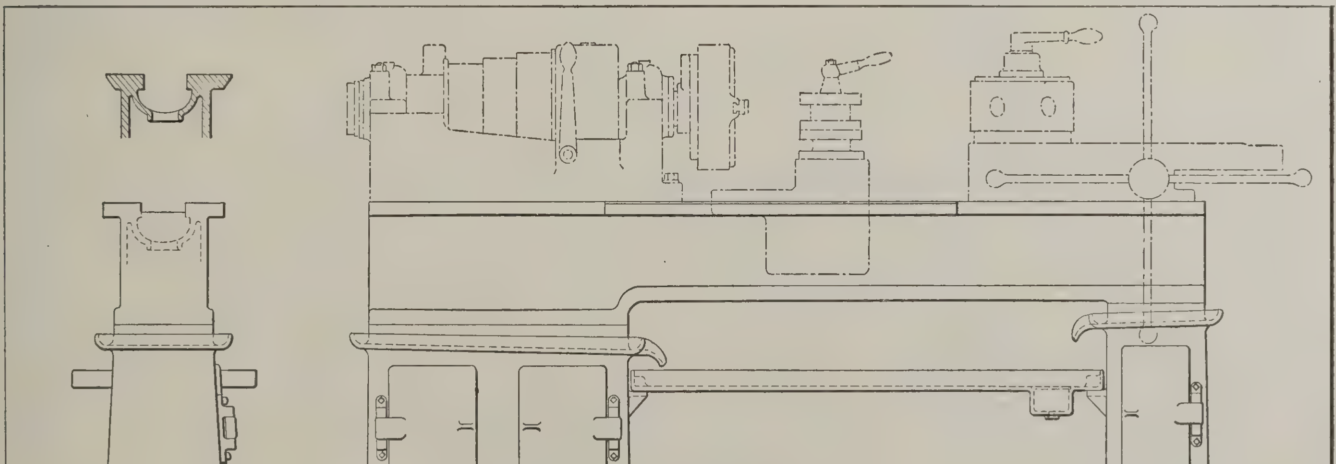

Fig. 11. Bed with Two Cabinet Standards of Unequal Size

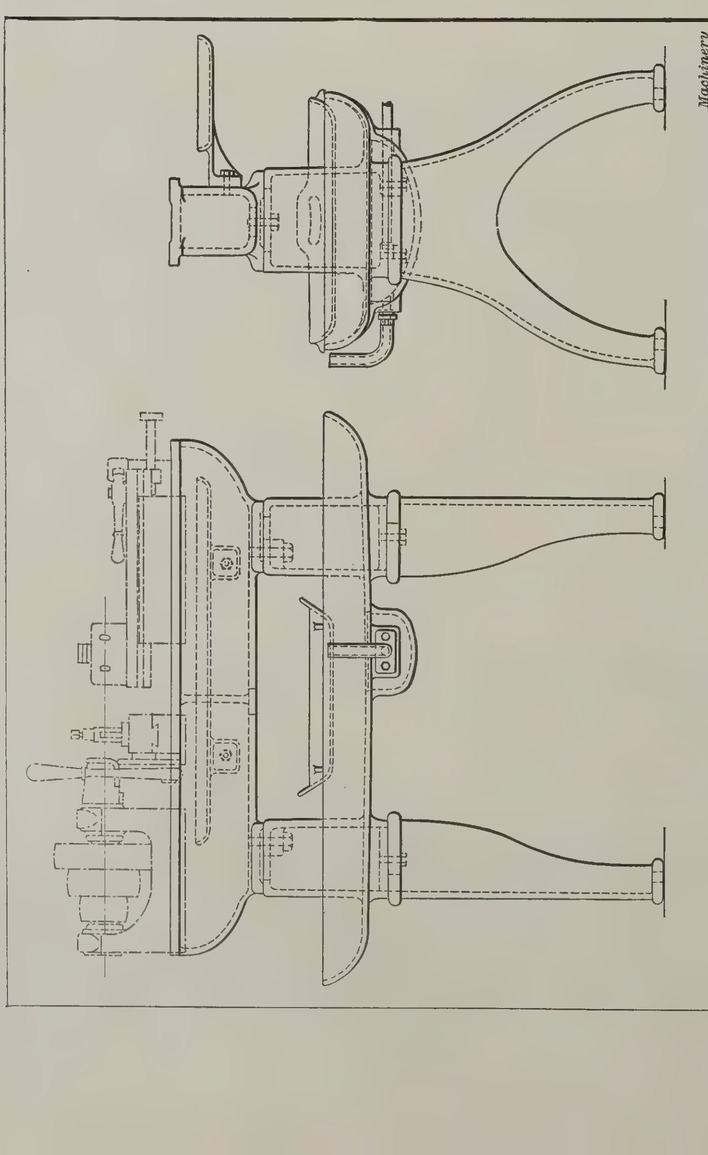

Fig. 12. Bed for Turret Lathe, showing Complete Cutting-tool Lubrication Arrangement

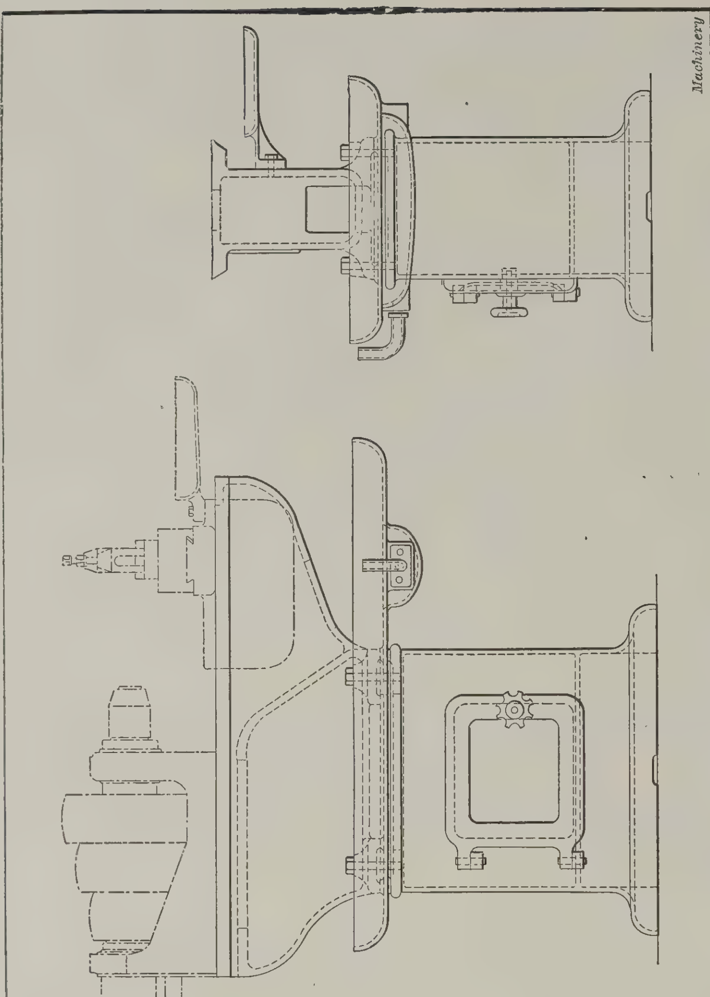

Fig. 13. Bed for Shaving Lathe with Single Cabinet Standard

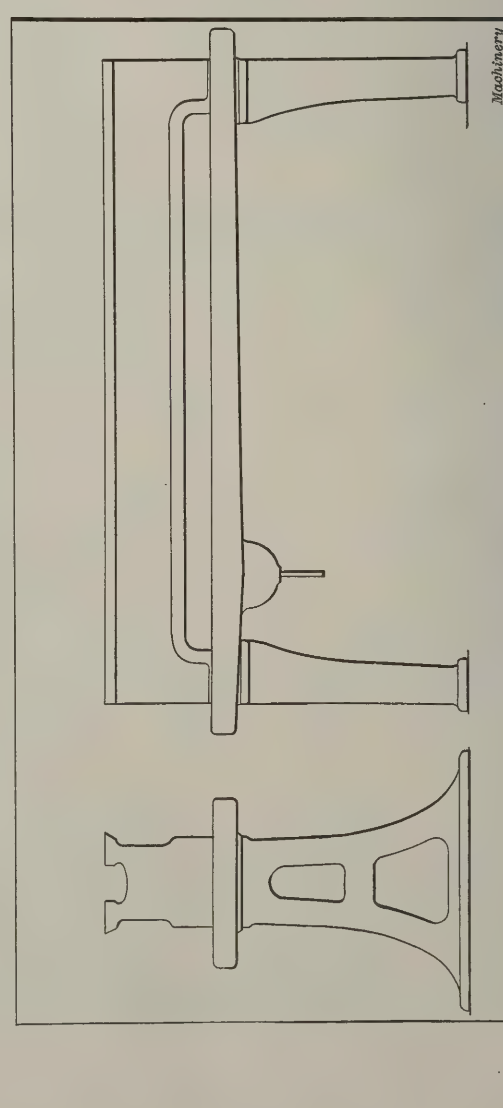

Fig. 14. Light Lathe Bed with Plain Leg Supports and Oil Tray

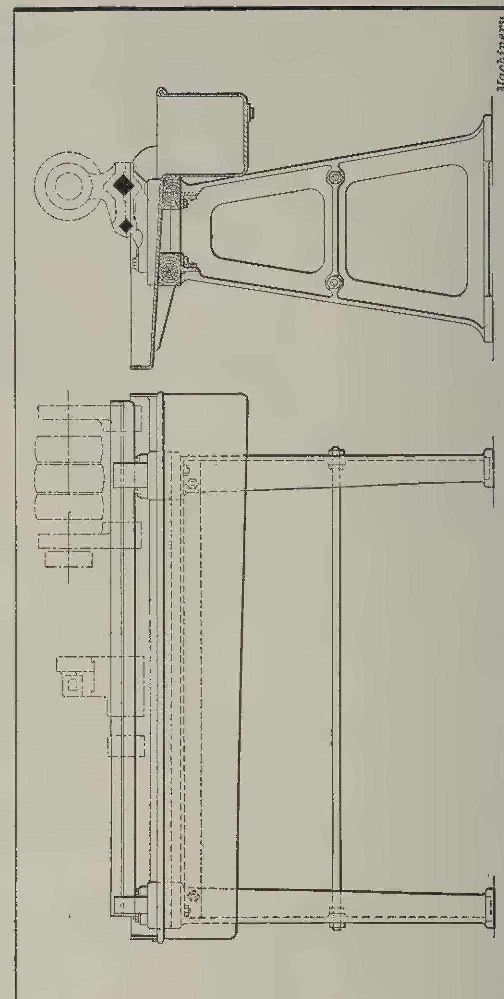

Fig. 15. Double-bar Type of Lathe as built by Brenot, Buronfosse & Cie., Paris, France

to extend around the entire bed. A more elaborate design is illustrated in Fig. 12, in which the tray is of ample capacity. An addition is sometimes made in the shape of sloping guards

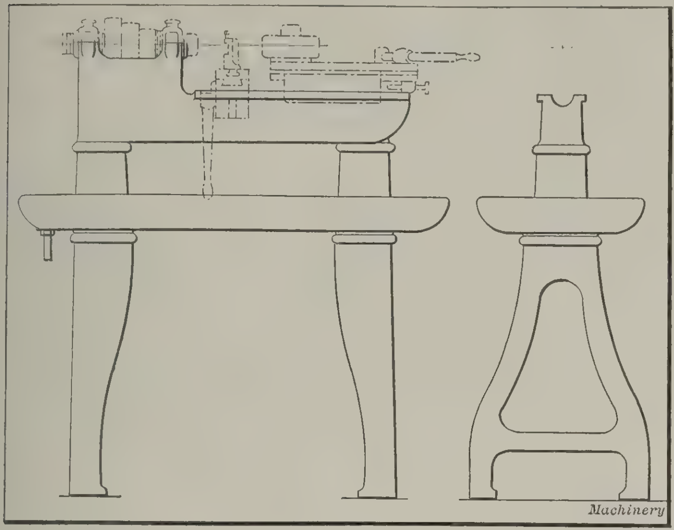

Fig. 16. Turret Lathe Bed with Head cast Solid with it

or oil catchers hung on the rim, not only at the front and the rear, but also at the ends. Single-standard beds, Fig. 13, are fitted in the manner shown, and for lathes of a size suitable for this design, are admirably adapted as regards steadiness and convenience.

The practice of casting the headstock in one piece with the bed is becoming more and more common both in ordinary lathes and in those of the turret type. It is not always cheaper than to make the head separately and bolt it on, but it may be so if quantities of similar beds are cast. In this case the machining will be cheaper also, provided there are proper facilities for dealing with the work. The principal idea, however is to gain greater rigidity and strength and consequent freedom from vibration. By carrying the webs up between the two bearings, as in Fig. 16, the two bearings are firmly tied together. This design is adopted largely in high-speed lathes with all-geared heads, the webbing extending up from the bed to form the lower half of the gear guards. There is then an opportunity of coring out a cavity large enough to receive big cone pulleys or gears, which could not be done if the head were made separately.

As a contrast to the foregoing examples, Fig. 15 seems like a reversion to primitive construction; this is the Brenot, Buronfosse & Cie screw-making lathe, with the two steel bars for a bed, illustrated in a previous installment. These bars are clamped in brackets at both ends; the brackets are supported on wooden bearers resting on A-shaped legs, tied together with distance bolts. The tray and tank are of galvanized plate.

A neat design of bed and head for a small lathe is shown in Fig. 17, cast with the tray for tools around it. Fig. 18 shows the bed used in some of the German Pittler turret lathes which are supported on a single box base arranged as shown with a strainer and trough for the lubricant and a receptacle for tools, etc. The cross-sectional view shows the jointing of the bed on the standard, and the section of the ways, which carry the turret saddle on vees. The dotted circle indicates the diameter of the vertical turret.

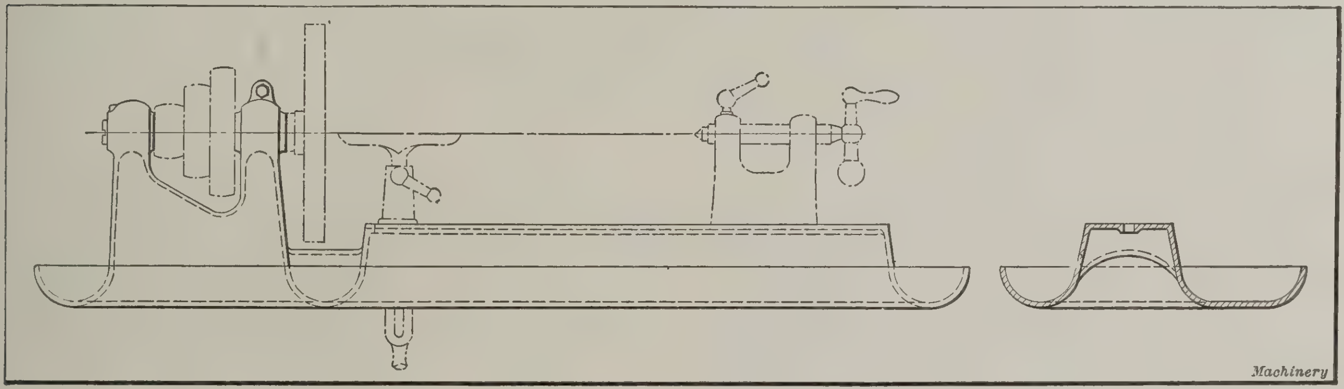

Fig. 17. Bed for Small Lathe with Head and Oil Pan cast Solid with it

Beds for lathes of large size embody the general principles which have been stated, but they are subject to a number of modifications which are not met with in those of medium and small size. Supporting legs are necessarily absent, the under side of the bed resting on its foundations for its whole length. Joints in the longitudinal direction as well as in the cross direction become necessary on account of convenience in casting, machining or transportation. Gaps or pits are

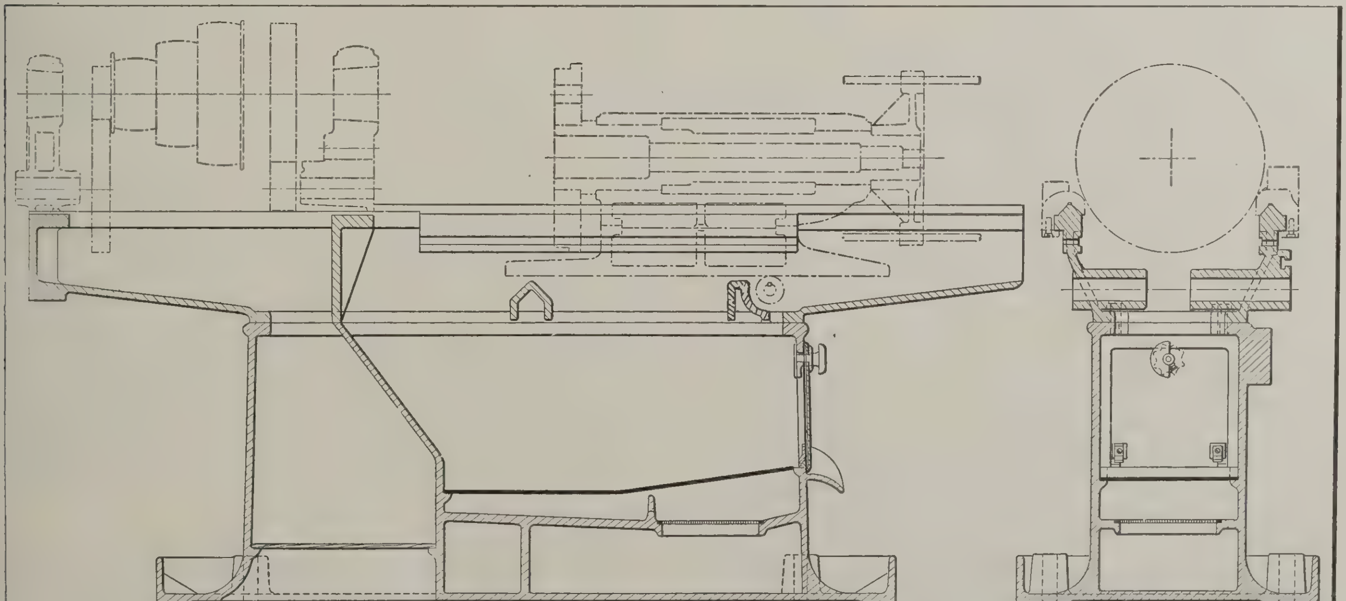

Fig. 18. Bed for the Pittler Turret Lathe as built by the Leipziger Werkzeug-maschinenfabrik, Leipzig-Wahren, Germany

used for lathes required for swinging large diameters, and sometimes the head is independent of the bed, except that it is mounted on the same foundation, that is, the cast-iron bed is not continuous. In some facing lathes the bed does not extend in the longitudinal direction, but comprises merely a support for the slide-rest. The slide movements are obtained only from the rests, and not from the bed. Sometimes the

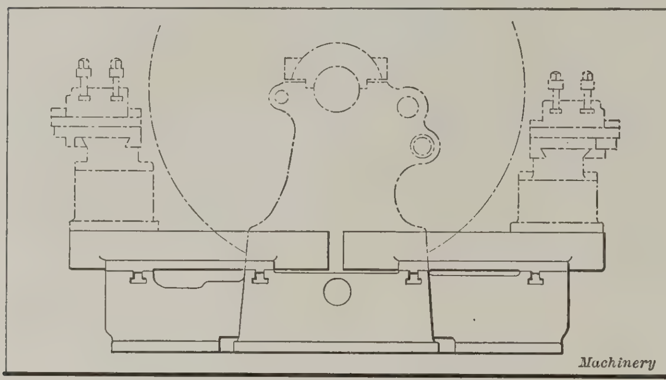

Fig. 19. End View of Bed for Wheel Lathe

longitudinal extension of the bed from the headstock carries only a tailstock or a boring head, and the rests are supported on wings extending toward front and back. In the sliding-gap lathes there is a pillar or pillars on the wings extending out from the front of the gap to carry rests, in addition to the regular saddle on the slide bed.

Figs. 19 and 20 show a bed for a wheel turning and boring lathe which has supplementary extensions to receive the four

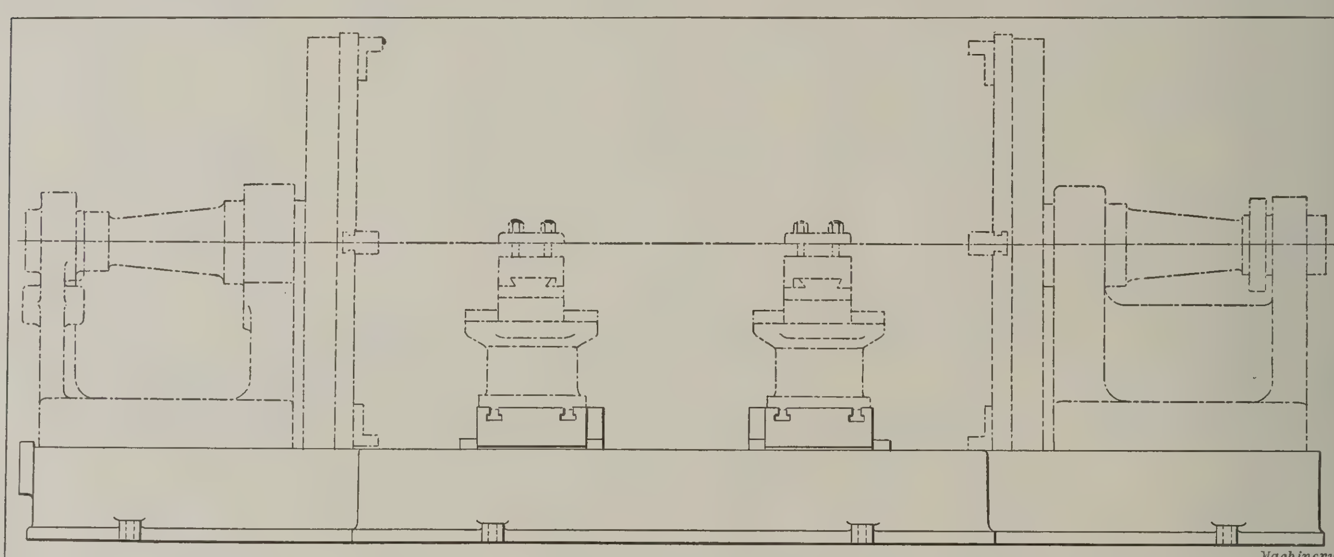

Fig. 20. Bed for Wheel Lathe

slide beds that carry the saddles. These beds are adjusted independently on the main bed; this is typical of a great many beds for different kinds of lathes.

Fig. 3 illustrates a built-up bed, with curved ribbing underneath, and a slide bed for carrying the tailstock and the saddle. The extension plate at the front carries the saddle of the rest for turning large work.

* * *

The laws passed by the legislatures of several states prohibiting the use of common drinking cups have created a large demand for collapsible and other forms of individual cups. Paper cups coated with paraffine are dispensed by automatic vending machines, the common cost being one cent each. But in many places it is not feasible to charge, although necessary to provide the sanitary cups. In order to provide for free distribution the cups must be made very cheaply. Automatic machinery has been developed which forms cups from paper disks, crimping the sides and forming a curved edge and coating them with paraffine at the rate of sixty a minute. The cups are packed automatically in cartons and human hands do not touch them at any stage of the manufacture. These cups are sold in sealed boxes containing ten for family use. at five cents. They are sold much cheaper in quantities to theaters, hotels, clubs, hospitals, etc.

ACTUAL AND CONSTRUCTIVE PATENT INFRINGEMENT—1

By E. D. SEWALL*

When entering upon the investigation of a subject at a point in its advanced development, there is a chance that one may reach erroneous conclusions by overlooking some fundamentals amid the intricacies of detail. It is well, therefore, to revert to the primer of patent law in seeking to discover what infringement of a patent is.

The Constitution authorizes Congress to secure for limited times to inventors the exclusive right to their discoveries. As ideas are not susceptible of exclusion from the apprehension of men who chance to perceive them, and as notions of natural justice do not admit of restraining the individual from putting the ideas he receives to innocent use, the exclusive right to a discovery can be secured only by affording inventors the aid of the public force to restrain all others over whom its authority extends from making practical use of the inventor's ideas.

This provision of the Constitution, Congress has sought to carry into effect by enacting that the patent right shall be conferred upon any person who has invented or discovered any new and useful art, machine, manufacture or composition of matter, under certain conditions, among others that he shall disclose clearly in writing the nature of his invention, and shall particularly point out and distinctly claim the part, improvement or combination which he claims as his invention or discovery; thereupon the government shall grant to him this right by an instrument under seal known as letters patent, for the term of seventeen years. (Sections 4886 and 4888, U. S. R. S.) This right, which does not exist except as created by statute, having been granted, becomes personal property, like other incorporeal chattels, except that, not being a common law right, it is not enforceable at common law, but only by enactment of the power that created it. Therefore, violations of the patent right, Congress has enacted, shall be remedied in the District Courts of the United States in the first instance, with appeal to the Circuit Courts of Appeal, and, in certain eventualities, in the Supreme Court of the United States, on *certiorari*. Damages for the infringement of any patent may be recovered by action on the case in the name of the owner of the patent; or injunctions may be had according to the course and principles of courts of equity, to prevent the violation of any right secured by a patent.

Nature of Patent Rights

The right secured by a patent, then, is an incorporeal right—a right of action in the U. S. courts to restrain others from making profitable use of the invention without the owner's consent, or for recovering damages for unauthorized use. It extends no further. All other rights in the property that may result from the invention remain to be adjudicated in the same manner as if this right created by Congress did not exist.

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Of the nature of a patent right, the Supreme Court of the United States has thus spoken:

"Whenever this court has had occasion to speak, it has decided that an inventor receives from a patent the right to exclude others from its use for the time prescribed in the statute." (Marshall, C. J., Grant vs. Raymond, 6 Peters, 243.)

"The franchise which the patent grants consists altogether in the right to exclude every one from making, using or vending the thing patented, without the permission of the patentee. This is all he obtains from the patent." (Taney, C. J., Bloomer vs. McQuewan, 14 How., 539.)

"The right to sell [the patented manufacture] was not derived from the letters patent, but it existed and could have been exercised before they were issued, unless it was prohibited by valid local legislation. All which they primarily secure is the exclusive right in the discovery. That is an incorporeal right, or in the language of Lord Mansfield 'a property in a notion having no corporeal tangible existence.'" (Harlan, J., Patterson vs. Kentucky, 97 U. S., 501.)

"Congress by its legislation made in pursuance of the Constitution has guaranteed to him [the patentee] an exclusive right to it [the invention] for a limited term; and the purpose of the patent is to protect him in this monopoly, not to give him a use which save for the patent he did not have before, but only to separate to him an exclusive use." (Brewer, J., U. S. vs. Bell Telephone Co., 167 U. S., 224.)

Thus Mr. Justice Miller before elevation to the Supreme Court:

"It is to be observed that no constitutional or statutory provision of the United States was or ever has been necessary to the right of any person to make an invention, discovery, or machine, or to use it when made, or to sell it to some one else. Such right has always existed and would exist now if all patent laws were repealed. It is a right which may be called a natural right, and which so far as it may be regulated by law belongs to ordinary municipal legislation, and it is unaffected by anything in the Constitution or patent laws of the United States." (*In re* Brosnahan, 18 Fed. Rep., 62.)

Proper Tribunals for Cases Involving Patented Articles

Remedies for wrongs against patented property, then, may be had by the same procedure and in the same tribunals as remedies for wrongs against unpatented property; but wrongs against the "property in the notion," the right of exclusion, which is an artificial right created by Congress, may be remedied only in the way and by the tribunals designated by Congress. When one patents an invention, he has all the rights and remedies respecting the invention that he had before, and when these rights are invaded his remedy is at common law or equity; but when the government grants the patent, it undertakes, figuratively, to police the industrial territory reserved to him, by preventing others from making, selling and using the patented product without his consent. If no one else attempts to make, use or sell the patented product, the benefits derived from the invention are not augmented by reason of the patent, and wrongs to the property of the inventor may be redressed by the ordinary machinery of the law; but when others seek without authority to make, use and sell that product, thus encroaching upon the reserved territory, the government steps forward and, as it were, ejects them.

A patent right is inconsistent with the natural rights of individuals. It often denies to others the common right of utilizing the products of their independent inventions. Hence, as the patent law confers a privilege that is in derogation of natural right, it should be invoked only to enforce the right that it creates, namely, to restrain others from making, using, and vending without the patentee's consent that which the claim of the patent defines as the thing patented. "The taking away of rights is not favored by the law. Therefore, statutes in derogation of common right are in the construction kept within their express provisions." (Bishop on Written Laws, Sec. 19.)

There is therefore a distinct kind of property in the patent right, injuries to which will be remedied by the U. S. courts in a patent suit; and another distinct kind of property in the industrial process or product to which the patent right pertains, injuries to which will be remedied in the state or other courts wherein violations of rights relating to personal property generally are adjudicated. Each of these two kinds of property rights should be adjudicated in the particular tribunals provided and under the particular laws relating to them respectively, lest there be danger of confusing the two rights, and a failure of justice by reason of the application, to one right, of the law that was designed to have application solely to the other.

Infringement of Patents

Infringement, generally, is a violation of a legal right. Infringement, in the language of the patent law, is a violation of the patent right only, and the term is not appropriate, in speaking of patents, to an invasion of those rights which the patentee has aside from the patent. The only persons whose rights can be infringed under the patent law are the owners of the whole or a part of the patent; they are the patentees, and no one else may bring an action for infringement. The owner may be the inventor, or one or more persons to whom he has assigned the patent. A purchaser or lessee of a patented article, or one who has a permission to make, use and vend the patented thing, owns no interest in the patent, and has no power to sue for infringement.

Infringement of a patent right consists usually in making the thing patented without the consent of the patentee, and in selling or using a thing so made, or in so using a patented process. The thing patented is that which is defined in the claims. The claims measure the invention. "As the inventor is required to enumerate the elements of his claim, no one is an infringer unless he uses all the elements." (Cimriotti Unhairing Co. vs. American Fur Co., Day, J., 198 U. S., 399.) If one makes, uses or vends without permission the exact combination claimed in a valid patent, he infringes the patent; also, if without authority he makes, uses or vends that which contains as a part thereof the exact combination claimed; but if he takes only a part of that combination, he is not an infringer.

Contributory Infringement

There is, however, a wrong to patentees known in the patent law as contributory infringement. Prior to 1896 the text books and legal precedents taught that contributory infringement consisted in conspiring with another, or abetting or wilfully aiding another, to make, use or vend an instrument, or to use a process defined in the claims of a valid patent without permission from the patentee.

"An infringement of a patent is a tort analogous to trespass or trespass on the case. From the earliest times all who take part in a trespass either by actual participation therein or by aiding and abetting it, have been held to be jointly and severally liable for the injury inflicted. There must be some sort of concert of action between him who does the injury and him who is charged with aiding and abetting, before the latter can be held liable. When that is present, however, the joint liability of both the principal and the accomplice has been invariably enforced." (Thomson-Houston Co. *vs.* Ohio, 80 F. R., 712, Taft, J.)

Necessarily, an act of contributory infringement presupposes an act of principal infringement by another. One may become liable for contributory infringement by assisting in constructing or renewing a patented combination, by furnishing to one who has no authority from the patentee some of the necessary parts with intent that they shall form a part of the infringing thing. These parts may be common, unpatentable things of general utility, or they may have no known use except in the patented combination. If the parts are of general utility, the person furnishing them must be proven to have had knowledge that they were to be used in constructing the patented thing, otherwise he is no infringer. (Snyder *vs.* Bunnell, 29 F. R., 47; Bliss *vs.* Merrill, 33 F. R., 39.) If they have no use except in the patented combination, the infringing purpose of the person furnishing them will be presumed, and he will be deemed a contributory infringer without other proof. (Wallace *vs.* Holmes, 9 Blatch., 65; Thomson-Houston Co. *vs.* Ohio, *supra;* Alabastine Co. *vs.* Payne, 27 F. R., 559; Leeds & Catlin Co. *vs.* Victor Talking Machine Co., 213 U. S., 318, McKenna, J.)

The law of contributory infringement, in substantially the circumstances noted above, must be deemed to be settled, since the U. S. Supreme Court has upheld it in the talking machine case above cited, wherein defendant, charged with making nonpatented record disks of a kind particularly adapted to be used as a part of a patented combination comprising the record disk and a reproducing stylus in defined relation thereto, was held to be a contributory infringer. In the opinion it was said:

"A combination is a composition of elements . . . It is, however, the combination that is the invention, and is as much a unit in contemplation of law as a single or non-composite instrument. Whoever uses it without permission is an infringer of it. Whoever contributes to such use is an infringer of it . . . It can make no difference as to the infringement or non-infringement of a combination that one of its elements or all of its elements are unpatented."

Complicated Questions of Contributory Infringement

Although the law as above set forth is believed to be just, yet nice discrimination is often required to avoid stretching the law to restrict the common right of freedom of trade. Shall not only he who purposely makes and supplies the record disk to be assembled by an infringer with the motor and stylus to make a patented instrument, be liable as a contributor to the infringing act, but also he who furnishes the raw materials with knowledge that they are to be used to make such record disks?

Not only may infringement by a principal infringer be aided by one supplying necessary parts of the patented thing, but also by one providing an instrument with the purpose that it shall be used in practising a patented process without the consent of the patentee. Thus where a filter was furnished with the intent that it should be used in carrying out a patented process of filtering beer without the patentee's consent, and it was so used, the one furnishing the filter was held liable for contributory infringement of the process. (Loew Filter Co. *vs.* German-American Filter Co., 107 F. R., 949.) In such a case it must affirmatively appear that the one furnishing the instrument was knowingly a direct accomplice of the principal infringer, and the question is to be decided upon the particular facts of the case, for it cannot be deemed settled that the seller of a common mechanic's tool is guilty of infringement because he knows it is to be used in aiding to practise a patented process.

Case of the Commercial Acetylene Co. vs. Autolux Co.

One may also become liable as a contributor by supplying to a principal infringer an instrument adapted to aid in making a patented article. Here also the liability of him who supplies the instrument depends upon proof of intent to aid the principal in invading the patent right; and the circumstances that the instrument is a common one of general utility, or on the other hand of utility only in the manufacture of the patented product, may have effect one way or another on the liability of him charged as an accomplice. In the case of Commercial Acetylene Co., *et al.*, *vs.* Autolux Co., 181 F. R., 387, the complainants were the owners of patents granted to Claude and Hess for a package containing acetylene gas. Among the claims of the patents is the following: "A gas package comprising a holder or tight vessel; a contained charge of acetone; a volume or body of gas dissolved by and compressed and contained within the solvent, and a reducing valve applied to an opening extending to the interior of the holder above the level of the solvent." The invention was one of great commercial value. It provided a solution of the problem of safely storing acetylene in large or small quantities in condition for use as desired. The patent was not for a special tank but for a package of gas held under pressure in solution. An exclusive license to make, use and sell this package in the United States had been accorded to the Prest-O-Lite Co.

According to the text of the decision, one of the original officers and stockholders of the Prest-O-Lite Co. severed his relation therewith for the purpose of establishing a plant for the manufacture of an infringing device, and also for recharging the tanks made by the Prest-O-Lite Co. when the gas had been consumed by the individual users. He was actively engaged in committing direct infringing acts until enjoined by an order of the court, on final hearing, from making the infringing device, which was known as the autogas tank, or committing any other infringing act. The party thus enjoined and his associates then organized a new corporation under the name of the Autolux Manufacturing Co. for the purpose of manufacturing an apparatus known as a high pressure generator, which, the court said, had been extensively used in recharging Prest-O-Lite gas packages and other gas tanks used on automobiles.

Now, the Claude and Hess patents contained claims for a receptacle containing gas dissolved in acetone. When the gas had been consumed the combination was destroyed, and whoever again assembled or conspired with another to assemble that combination without the patentee's consent made the patented article and infringed the patent. The receptacle alone was not patentable, but only the receptacle containing the gas in solution. The recharging of the package was as much a making of the patented article as would be the reconstructing of a patented sewing machine, which had been worn out, by taking the unpatentable table, drive wheel, and treadle, and assembling therewith new parts to make a new machine. Although the court made the statement that the generator supplied by defendants was extensively used in recharging Prest-O-Lite *and other gas tanks used on automobiles*, it must have satisfied itself that the maker of these generators intended them to be used in reconstructing Prest-O-Lite gas packages and was guilty as an accomplice of the person who actually procured the recharging of such tanks without the permission of the Prest-O-Lite Co., thus deriving profit by aiding others to do that which the patent reserved to the patentees and their assigns and licensees.

The fact, assumed to have been proven, that the defendant company actively and directly assisted others in reproducing a patented article, was one ground of the decision in the Prest-O-Lite case, and appears to be in accordance with the long established principles of contributory infringement. Another ground of the decision is based upon a more recent extension of the doctrine, to be referred to later.

Summary

It appears, therefore, to be settled that not only he who makes, uses and sells a patented thing without permission from the patentee infringes the patent and may be sued under the patent laws, but also he who actively and knowingly assists in the unauthorized making of a patented thing; and probably also that he who actively and knowingly assists another person in selling or using a patented thing that has come into the possession of that other person *against the permission of the patentee* may be likewise liable under the patent laws. The fact that not all acts that aid more or less directly or indirectly in infringement by another can be deemed to be acts of contributory infringement does not affect in any way the point under consideration, which is that such acts as invade the *patent right* only, raise any question under the patent law. If the allegations of fact are that the act complained of invades the monopoly—narrows the reserved market of the patentee by aiding in the unauthorized manufacture, sale and use of the thing patented, and which the patent reserved to him—the case made is one to be tried under the patent law, because the common law and laws of the states make no provision for property in a right to restrain others from making and dealing in useful commodities, but only the patent laws.

Thus far it has been sought to show, no doubt with some repetition, what right a patent confers, when it is infringed, and where the remedy for infringement lies. It has also been asserted that rights regarding patented property which do not bring into question the patent right to exclude others, have the same adequate remedies under general law as other property rights, and it has been intimated that the adjudication of the one kind of right in the courts provided for adjudicating the other, or the attempt so to do, may result in the inappropriate or inadequate remedy, or none at all.

The Questions to be Decided in a Patent Case

Very briefly may be discussed the tests that may be applied to determine whether an alleged injury to a patentee's rights is an infringement of the patent right. A charge of infringement of a patent puts in issue either (1) the title of the patentee; (2) the validity of the patent; or (3) the identity of the alleged infringing product or process with that claimed in the patent. One charged with infringement may defend by (1) denying the validity of the patent; (2) denying the title of the patentee; (3) denying the identity of the thing alleged to be made, sold or used by him with that defined in the claims of the patent. If, on the other hand, the alleged infringer concedes all these, but alleges an agreement with the patentee or his nominee whereby he was permitted to use the

patented thing, a question of contract is raised out of the violation of which the wrong to the patentee, if any there be, proceeds, and which the ordinary law of contract is adapted to remedy. (Wilson *vs.* Sanford, above; Dale Tile Co. *vs.* Hyatt, 125 U. S., 46, Gray, J.)

If one surreptitiously destroys a patented still, because he deems the manufacturer of alcoholic liquor immoral, he does not thereby deny the title of the patentee, the validity of the patent, nor the identity of the still destroyed with that which is patented. The wrong complained of raises a question for the ordinary criminal law to deal with. So, if the patentee of a butter substitute seeks to sell it in a state the laws of which make the sale of a butter substitute of that character a penal offense, the action of the state in preventing the sale thereof is not a denial of the title of the patentee, the validity of the patent, nor the identity of the substance sold with the patented substance, but is a criminal prosecution and one in which the validity of the laws of the state may be put in issue. (*In re* Brosnahan, above; Patterson *vs.* Kentucky, above; Webber *vs.* Virginia, 103 U. S., 344, Field, J.)

If a patentee makes a shipment of patented articles and they become damaged *en route* by the fault of the common carrier or his agents, no question of title, validity of the patent, or identity arises, the injury being a simple tort cognizable in the state courts, or in the federal courts solely on the ground of amount involved, diversity of citizenship, or interstate commerce. If a patentee of a useful article makes a contract with a manufacturer of an inferior article having a similar use, whereby the patentee agrees for a money consideration not to place his article on the market, or license others so to do within the state wherein the manufacturer of the inferior article is situated, no question affecting the validity, ownership or scope of the patent is raised, and the patent law has no dominating influence such as would prevent the courts of the state holding the contract to be one in restraint of trade, and imposing penalties accordingly. (Blount Mfg. Co., *vs.* Yale-Towne Mfg. Co., 166 F. R., 555.)

[The Supreme Court of the United States handed down a decision March 11 which apparently will have far-reaching consequences in furthering monopolistic control of patented apparatus by the makers. By a decision of four to three it was held that the maker of the Dick patented rotary mimeograph machine has the right to restrict the use of the machine to the supplies furnished by the maker. Chief Justice White in the dissenting opinion pointed out how dangerous the decision may be:

"My reluctance to dissent, is overcome in this case: First, because the ruling now made has a much wider scope than the mere parties to this record, since, in my opinion, the effect of the ruling is to destroy in a very large measure the judicial authority of the states by unwarrantedly extending the Federal judicial power.

"Second, because the result just stated, by the inevitable development of the principle announced, may not be confined to sporadic or isolated cases, but will be as broad as society itself, affecting a multitude of people and capable of operation upon every conceivable subject of human contract, interest, or activity, however intensely local or exclusively within state authority they otherwise might be.

"Third, because the gravity of these consequences which would ordinarily arise from such a result would be greatly aggravated by the ruling now made, since the ruling not only vastly extends the Federal judicial power as above stated, but as to all the innumerable subjects to which the ruling may be made to apply, makes it the duty of the courts of the United States to test the rights and obligations of the parties not by the general law of the land, in accord with the conformity act, but by the provisions of the patent law, even although the subject considered may not be within the embrace of that law, thus disregarding the state law, overthrowing, it may be, the settled public policy of the state and injuriously affecting a multitude of persons."

In view of the gravity of the decision which was made by four out of seven judges, whereas a full court consists of nine judges, the effort probably will be made to have a rehearing of the case before a full bench. It is generally conceded that the decision may lead to the creation of monopolies of the most oppressive sort.—EDITOR.]

* * *

To furnish good lockers is the duty of the institution—to take good care of them is the duty of the men using them.

BRASS ENGRAVING BY MACHINERY

By CHESTER L. LUCAS*

Among the many operations now being done by machinery instead of by hand, the engraving of brass signs and plates is of more than passing interest. The old way of making brass signs was to chip out the letters by hand, the quality of the work depending wholly upon the skill of the workman. Naturally the progress was very slow. At the present time many brass signs are etched, and a considerable number are cut by machinery. Another large field for brass engraving by machinery is in the making of printing plates for printing wooden box-sides. Not only has the introduction of engraving machinery resulted in faster work, but it has made it possible to do this work without the employment of skilled engravers.

Fig. 2 shows a Wesel routing machine in use at the Schwerdtle Stamp Co., in Bridgeport, Conn. The machine is shown at work on a brass sign, the work being more clearly

Fig. 1. Brass Dies for Bookbinders' Use and Cutters used for Engraving

shown in Fig. 3. The most essential features of a machine of this kind are that straight cuts can be quickly made either vertically or horizontally; that the cutter spindle rotates at a high speed without vibration; and that the cutter can be easily moved to any part of the work, there still being no play between the connecting joints. In this machine, a pulley on the vertical driving shaft transmits motion to the two-step cone pulley *A*. This pulley is mounted upon the swinging arm *B*, and its position is adjustable to allow for slight variations in belt lengths. From the adjustable slide *C* a second arm extends at right angles to arm *B;* this second arm is free to swing in the same plane as the first arm, and at its extreme end the cutter spindle is mounted.

The cutter spindle and adjacent parts are shown on a larger scale in Fig. 3. The cutter spindle (*D* in Fig. 3) receives its motion from the belt that passes over pulley *E*. This pulley is located at the center of the cutter spindle, thus equalizing the pull on the bearings. As the spindle revolves at the rate of 16,000 R. P. M., it is essential that the bearings should be good. The cutter *F*, or "bit," as it is called, is held in the end of the spindle. Just above it is a small aluminum fan *G* that blows the chips away from the cutter, leaving the lines to be followed in plain sight.

It will be noticed that the cutter spindle is mounted in a slide *H* that may be raised or lowered to accommodate thick or thin plates, or long or short cutters. This slide is operated by means of screw *I*. To supply artificial light, when needed, the two incandescent lights are provided; the use of two lights, on opposite sides of the cutter, eliminates

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the shadows. The cutter-head is supported by means of a bar *K*, resting upon a small grooved roll on rail *L*, Fig. 2. By means of hand-rod *M*, the cutter is moved to and from the operator to make the perpendicular lines of the letters, and by moving bar *K* along the rail, the horizontal cuts are made. A bracket that is hidden by pulley *A* guides the horizontal movements of the cutter. Handwheel *N* is tight-

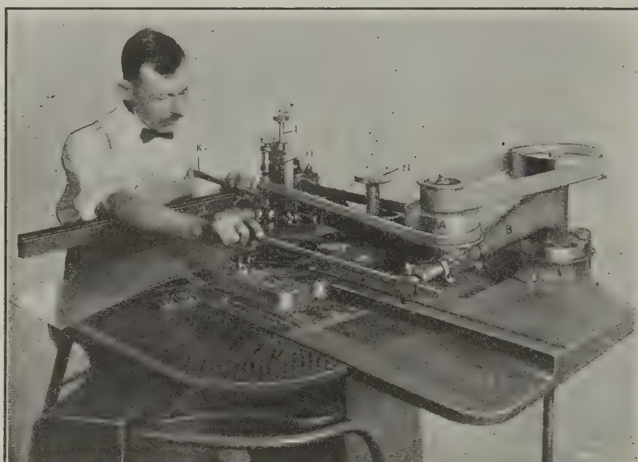


Fig. 2. Wesel Routing Machine at Work on a Brass Sign

ened only when the routing machine is used as a radial arm machine, in which case cuts may be made in any direction.

The cutter-head is raised by a foot treadle when necessary to jump from one letter to another, and the machine is started and stopped by another foot treadle. The work is held in place by clamping jaws, one of which is shown at *O*. This jaw is movable, and is tightened against the edge of the plate by handwheel *P*.

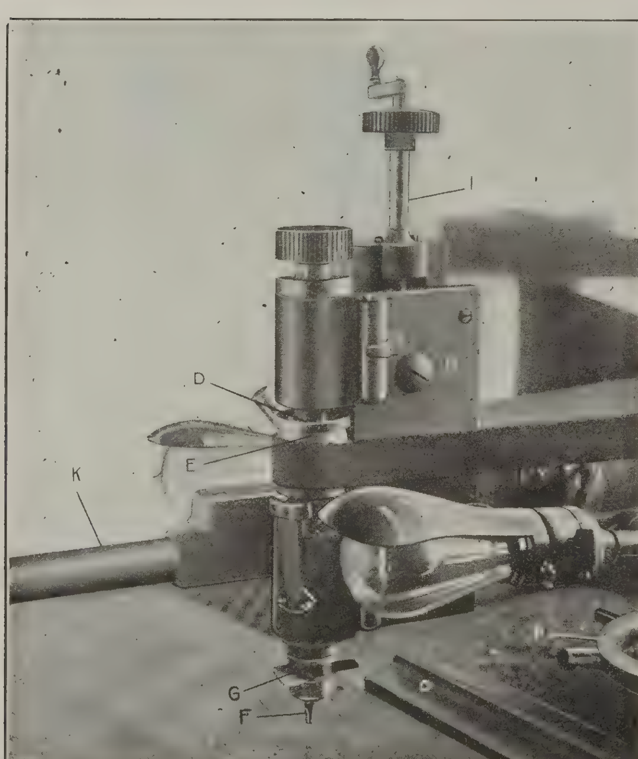


Fig. 3. Cutter-head at Close Range

The work of an engraving machine is not confined to large signs and plates, but is also utilized in getting out brass dies for bookbinders' use, similar to those shown in Fig. 1. It is impossible to finish completely such work as these dies on the machine, but the bulk of the metal in and around the design may be removed to good advantage. Some of the cutters used on this class of work are also shown in this illustration, most of them being of the one-lip variety, as this style of cutter is strong and has plenty of chip-room.

On work of this nature, the skilled engraver is still required to finish up the work, truing up the lines and cutting the parts that it is impossible to finish on the machine. Engravers' tools of various shapes are used for this part of the work. Fig. 4 shows an engraver, Mr. Louis F. Schwerdtle, finishing up brass dies. The work is held in a ball vise, made especially for engravers' use. Two jaws *B*, which swivel, are mounted upon the secondary jaws *C*. The jaws *B* contain numerous small holes in which pins may be placed to grip the work. These pins are usually shaped so as to grip the work without marring it. The secondary jaws *C* are located and held in place by large dowel pins upon the primary jaws *D*, which latter are operated by the right- and left-hand screw *E*, working in base *F*. It will be seen that this

Fig. 4. Finish-engraving Small Dies*

vise is doubly useful, for when not in use on small work, as shown, the vise may be utilized on large die work, by simply pulling off the secondary jaws *C*, which allows the primary jaws *D* to be used independently.

* * *

BOILING POINT OF METALS

In a paper presented at a meeting of the Faraday Society, London, England, Mr. H. Greenwood gave the boiling point of various metals at atmospheric pressure, as follows:

	Degrees F.
Antimony	2625
Bismuth	2550
Copper	4200
Lead	2775
Magnesium	2050
Silver	3500
Tin	4125
Aluminum	3250
Chromium	4000
Iron	4450
Manganese	3450

* * *

ARMOR PLATE VS. PROJECTILES

The competition between increased thickness and quality of armor plate versus big guns has come to a point where it is very evident that the big gun is victorious. The armor carried by battleships of the Dreadnaught type cannot prevail against the latest guns carried by the same ships. The latest guns made by the British navy and used on the *Orion* and the *Lion* fire a 1250-pound projectile. When it is remembered that an 850-pound projectile will pierce 17 inches of the best Krupp steel, it is evident that only an excessively thick armor would insure a vessel against the attacks of these new heavy guns. It, therefore, seems likely that the man-of-war of the future will carry less heavy armor, protection being obtained instead by high speed. This idea, in fact, has been carried out in the British navy in the battle-cruiser *Lion*, in which high speed, heavy guns and light armament has been consistently adhered to throughout the design.

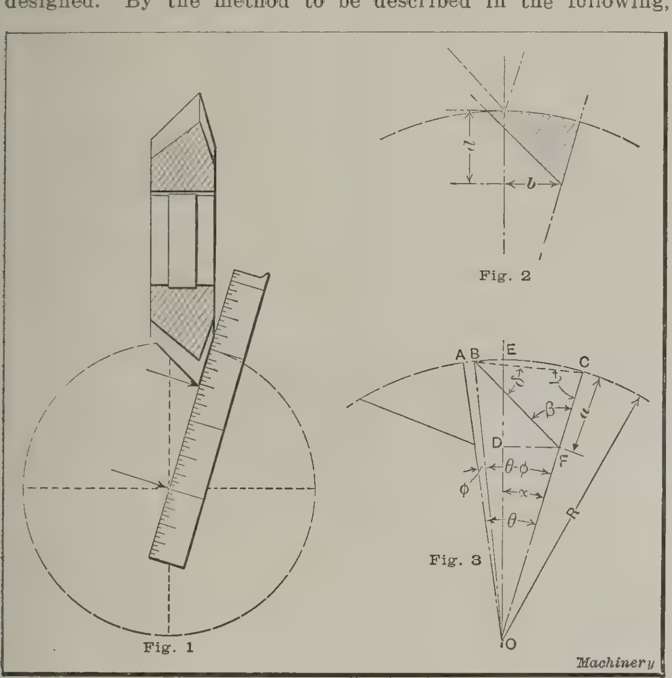
* For a complete description of the engraver's vise see MACHINERY, June, 1909, "Making an Engraving Block."

SETTING DOUBLE-ANGLE FLUTING CUTTERS*†

By GEORGE W. BURLEY‡

The ordinary method of setting double-angle milling cutters when fluting spiral mills and reamers is only an approximate one, and depends entirely upon the skill of the milling machine operator for its success. This method is indicated in Fig. 1. As will be seen from this illustration, two operations have to be performed simultaneously: the cutter has to be so arranged with respect to the center or axis of the blank that the edge of the scale or rule laid alongside the cutter, as shown, passes through the blank-axis, and that the distance from the center to the point of the cutter is a definite amount. This definite amount is a predetermined quantity, and is equal to the difference between the radius of the cutter or reamer to be fluted and the depth of the flute, which, of course, are elements in the design of the cutter or reamer.

It is fairly obvious that errors can readily be made; and it is not inconceivable that angular errors up to 1 degree and linear measurement errors up to 1-64 inch, or even greater, are being continually made. When this is the case, the finished cutters or reamers are not the same as those originally designed. By the method to be described in the following,



Figs. 1 to 3. Finding Formulas for Determining Setting of Double-angle Fluting Cutters

however, it is possible to set the fluting mill with respect to the cutter blank without recourse to the use of a rule, either for the purpose of making linear measurements or obtaining correct angularity. The method involves the setting of the cutter central (that is, with the angular point of the cutter exactly over the axis of the blank) and at a distance from the axis equal to the radius of the blank, as is indicated by the dotted lines in Fig. 2. This is done in the usual way. To get the off-set, the table is moved transversely an amount equal to b (Fig. 2), and raised an amount equal to d. These distances vary considerably, the exact values depending upon the radius of the blank, the number of flutes to be cut in it, the width of land, and the angles of the fluting cutter; but, whatever these distances are, they can be obtained on the machine directly from the micrometer dials on the feed-screws. The values of d and b for any particular case can be calculated in the manner indicated below, or taken directly from the accompanying Data Sheet Supplement.

Let R = the radius of the cutter to be fluted.
N = the number of teeth to be cut in it.
W = the width of the land of the tooth.
θ = the angle subtended at the center of the cutter by any one tooth.
a = the depth of each tooth measured radially.
α = the small side-angle.
β = the included or total angle of the angular fluting cutter.

R is the radius of the finished cutter, and as the blank is invariably left a little large, corrections, as will be indicated later, may have to be made for d, but not for b; usually, it will be found that the correction is a very slight one.

$$\theta = \frac{360}{N} = A\,O\,C \text{ (Fig. 3)};\ E\,O\,C = \alpha, \text{ and } B\,F\,C = \beta.$$

The width of the tooth-land, as usually defined, is measured on the face formed at the back of the cutting edge by the grinding wheel, and it is, therefore, a straight-line quantity, whether the land is formed by a cup-wheel (forming a flat land) or a disk wheel (forming a concave land). This is, therefore, not exactly the quantity $A\,B$ (Fig. 3), measured as an arc of the circle, but the difference between the two is usually so slight as not to be worth consideration from a practical point of view. As a matter of fact, the writer has found that the difference in the most extreme cases amounts to only three or four thousandths inch, an amount which, under the circumstances, is negligible. Hence, in what follows, we shall assume that the actual width of the land and the arc AB are equal. Let the width of the land and, therefore, the length of the arc $A\,B$ be equal to W. Then angle ϕ is the angle subtended by arc W at the center of the circle, and can, therefore, be determined by first calculating the angle in radians or fractions of a radian, and then consulting a table of angles for the equivalent angle in degrees. If no such table is handy or immediately procurable, the angle in degrees can be obtained as follows:

$$\phi \text{ (in degrees)} = \frac{W}{R} \times 57.296 \qquad (1)$$

From this angle and the angle θ, the angle $(\theta - \phi)$ can be obtained. This angle is the one which is subtended at the center of the circle by the chord $B\,C$; therefore,

$$\text{Angle } B\,C\,O = \gamma = \left(90 - \frac{\theta - \phi}{2}\right).$$ The angle $C\,B\,O$ is also equal to this. Hence,

$$\text{Angle } CBF = \delta = 180 - (\beta + \gamma) = 180 - \left(\beta + 90 - \frac{\theta - \phi}{2}\right)$$
$$= 90 - \left(\beta - \frac{\theta - \phi}{2}\right).$$

Let the length of the chord $B\,C = c\,R$, c being the length of the chord of a unit-radius circle which subtends the angle $(\theta - \phi)$ at the center. Then,

$$\frac{c\,R}{\sin\beta} = \frac{a}{\sin\delta}; \text{ therefore,}$$

$$a = \frac{c\,R\sin\delta}{\sin\beta} = \frac{c\,R\sin\left(90 - \beta + \frac{\theta - \phi}{2}\right)}{\sin\beta}$$
$$= \frac{c\,R\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta} \qquad (2)$$

From this expression, assuming any given data, the actual depth a of the flutes to be milled in the cutter blank can be calculated.

$$O\,F = (R - a)$$
$$= R - \frac{c\,R\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta} = R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}$$

Now, d (Fig. 2) $= E\,D$ (Fig. 3) $= R - O\,D = R - O\,F\cos\alpha$

$$= R - R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \qquad (3)$$

Usually the radius of the cutter or reamer blank is made a

* With Data Sheet Supplement.
† For information on allied subjects, see "Milling Axial Teeth in Cutter and Reamer Blanks," March, 1912, and articles there referred to.
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little larger (a few thousandths inch) than the finished cutter. Therefore, in actual practice,

$$d = R_1 - R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \qquad (4)$$

where R_1 = the radius of the blank.

For any given values of $\frac{W}{R}$, N, α and β, the expression:

$$\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \text{ is a constant.}$$

Let this constant be represented by x; then,

$$d = R_1 - x R. \qquad (5)$$

This is the "elevation" formula, the values of x for a large number of combinations of $\frac{W}{R}$, N, α, and β, occurring in practice being given in the tables in the accompanying Data Sheet. The values of x for any combination not included in the tables can be determined as indicated above, or obtained by interpolation.

Further, b (Fig. 2) $= DF$ (Fig. 3) = the cross-movement required $= OF\sin\alpha = (R - a)\sin\alpha =$

$$R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}\sin\alpha \qquad (6)$$

Again, for any given combination of $\frac{W}{R}$, N, α, and β, the expression:

$$\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}\sin\alpha \text{ is a constant.}$$

Let it be called y. Then $b = yR$. (7)

This is the "cross-movement" formula, the values of y for a large number of combinations being given in the accompanying Data Sheet beside those of x for the same combinations.

In regard to the values of $\frac{W}{R}$ which have been selected, the lower values are those usually chosen for milling cutters of medium and large sizes, the higher values being usually chosen for small cutters and reamers. If the value adopted in any particular design is not found in the tables, a simple calculation is all that is necessary for the determination of the corresponding values of x and y. By way of an illustration, let us suppose that 0.030 has been adopted as the value of $\frac{W}{R}$, and that $N = 20$ teeth, $\alpha = 12$ degrees, and $\beta = 60$ degrees. Then, upon consulting the accompanying tables, we find that when $W \div R = 0.020$, $x = 0.7750$, and $y = 0.1643$, and that when $W \div R = 0.040$, $x = 0.7908$, and $y = 0.1677$. By simple proportion, which in this case is sufficiently accurate, when $W \div R = 0.030$, $x = 0.7829$, and $y = 0.1660$. Therefore for the combination chosen,

$$d = R_1 - 0.7829\,R \text{ and } b = 0.1660\,R.$$

Dealing further with this case, let us assume that $R = 2.5$ inches, and that $R_1 = 2.503$ inches. Then,

$d = 2.503 - (0.7829 \times 2.5) = 2.503 - 1.9572 = 0.5458$ inch, and $b = 2.5 \times 0.1660 = 0.4150$ inch.

If this method of interpolating is not deemed sufficiently accurate, then the values of θ, ϕ, α, β and c can be determined for any particular case and introduced into Formulas (4) and (6). This method is, however, sufficiently accurate for all the ordinary cases that occur in everyday practice.

* * *

Solder which has been exposed to damp air for some time and has become more or less oxidized on the surface will not give as good results as fresh solder.

ROLL PRESSURE AND POWER REQUIRED FOR ROLLING MILLS

In a recent issue of *Stahl und Eisen*, Prof. M. Hermann gives some formulas for obtaining the roll pressure and power required for rolling mills. The *Engineering Digest* gives a summary of these formulas, which apply to the rolling of rectangular sections.

Let A = reduction of sectional areas per pass, in square inches,
k = limiting stress of lateral extension of metal, in pounds per square inch,
t = reduction of thickness of billet per pass, in inches,
D = roll diameter, in inches,
v = velocity of bar leaving rolls, in feet per second,
a = arc of contact of billet with the roll, in degrees.

Then $\cos a = 1 - (t \div D)$, from which $\sin a$ may be found.

Force required to draw billet through the rolls: $F = 2kA$.

Roll pressure in pounds: $P = \dfrac{kA\left(1 + \frac{1 - \cos a}{2}\right)}{\sin a}$

H.P. (exclusive of power required to run rolls empty)

$$= \frac{Fv\left(1.1 + 0.12\frac{P}{F}\right)}{550}$$

The value of k is difficult to determine; it increases with the number of passes, and decreases with increasing temperatures. Prof. Hermann gives a table taken from Puppe's experiments in which k (average) for the fifth to eighth passes ranges from 6940 pounds per square inch at 2237 degrees F., to 10,042 pounds per square inch at 2091 degrees F.; and for the ninth to seventeenth passes from 7965 pounds at 2237 degrees F., to 11,547 pounds at 2091 degrees F.; or the mean value of k for the 12 passes ranges from 7609 pounds at 2237 degrees to 11,265 pounds at 2091 degrees.

Example.—Let $A = 4$ square inches; $k = 8000$ pounds per square inch; $t = 0.75$ inch; $D = 20$ inches; $v = 6$ feet per second.

Then, $\cos a = 1 - (0.75 \div 20) = 0.9625$. Hence $\sin a = 0.2712$. $F = 2 \times 8000 \times 4 = 64{,}000$ pounds.

$$P = \frac{4 \times 8000\left(1 + \frac{1 - 0.9625}{2}\right)}{0.2712} = 120{,}000 \text{ pounds, approximately.}$$

$$\frac{P}{F} = 1.88$$

$$\text{H.P.} = \frac{64{,}000 \times 6\,(1.1 + 0.12 \times 1.88)}{550} = 925, \text{ approximately.}$$

* * *

It has been said of great scientists and engineers that they take nothing for granted and accept nothing as final simply because it has been done in a certain way since time immemorial. The really great engineer sees things as they ought to be rather than as they are, and that is the keynote of his preeminence in his chosen field. John Ericsson was one of those mechanical seers who are constantly at war with the mechanical superstition of their day. No better example could be cited to illustrate the fact that he would take nothing for granted, than a humorous incident from the days of his early childhood. When he was learning his alphabet, the shape of the letters did not suit his fancy and he had very decided opinions of his own about how they ought to be formed. He quickly perceived that the letters were symbols of sounds, and hence of arbitrary origin, and he forthwith proceeded to construct letters of his own design that to his mind possessed certain advantages of simplicity that were lacking in those of the time-honored Latin alphabet.

* * *

The estimate of Portland cement production in 1911, made by the United States Geological Survey, is 77,877,236 barrels. The production in 1910 was 76,549,951 barrels. The average factory price per barrel in 1910 was $0.891, and $0.867 in 1911.

THE TESTING OF SPIRIT LEVELS

By EQUA

In order to be able to produce accurate work on machine tools, it is necessary that they be set up level. Frequently there are complaints of the working of lathes and planers and the manufacturer is blamed for sending out a poor machine, when the real trouble is that certain parts of the machine are under a strain because of not having been set up level. Hence the spirit level is an important part of the equipment used by the machinist when erecting machinery.

The spirit level consists of a glass tube or cylinder, the inside of which is ground to a barrel shape. This tube is nearly filled with spirits of wine, ether, or some similar fluid, and hermetically sealed at each end. It is ordinarily spoken of in the shop as the "bubble," and is mounted in a brass tube having an opening at the top so as to make it possible to see the air space in the bubble or level. The brass tube is fixed to a block of brass or iron with suitable screws, so that it can be adjusted to be parallel to the base surface of this block.

It is readily understood that the chief part of the complete level is the glass tube, and the accuracy of the instrument depends entirely upon the curvature to which the inside of the tube has been ground. The makers of spirit levels use a device called a "level tester" for determining the accuracy of the bubble. A device of this kind is shown in the accompanying engraving, Fig. 1, the principle of the device being simply that upon turning the adjusting screw at one end of the bar or plate, this end is raised or lowered, so that the air space in the level will run from end to end. By means of this testing device it is possible to ascertain the curvature of the interior of the glass tube. The accuracy of a level is defined by saying that so many seconds of arc are equal to one-tenth or one-twentieth inch, etc. It will be seen in Fig. 1 that by turning the screw carrying the graduated disk we raise or lower the bar about the points A as pivots. The action of the screw is not the same as if the bar had worm teeth cut in it and the screw were a worm, but as the screw only has to move the bar through an arc of about two or three degrees, the error resulting from considering the action as that of a true worm and worm-wheel, is negligible. The adjusting screw on the testing device has 100 threads per inch and the graduated disk has 120 divisions. Each division should be equal to an angular movement of the bar about points A of one second. From this the distance from A to B can be determined. As the disk has 120 divisions and each division is equivalent to one second, one revolution of the screw will equal a movement of two minutes of the bar. The movement of the bar, however, is also equal to 0.01 inch for one revolution of the screw, and as there are 21,600 minutes in a complete circle, the total circumference of the circle having point A for a center and the distance AB for radius must be $10,800 \times 0.01 = 108$ inches. This circumference corresponds to a diameter of 34.377 inches and a radius of 17.188 inches, which is then the distance between A and B. It will be seen that for the accuracy of the device it is highly important that this distance be exact.

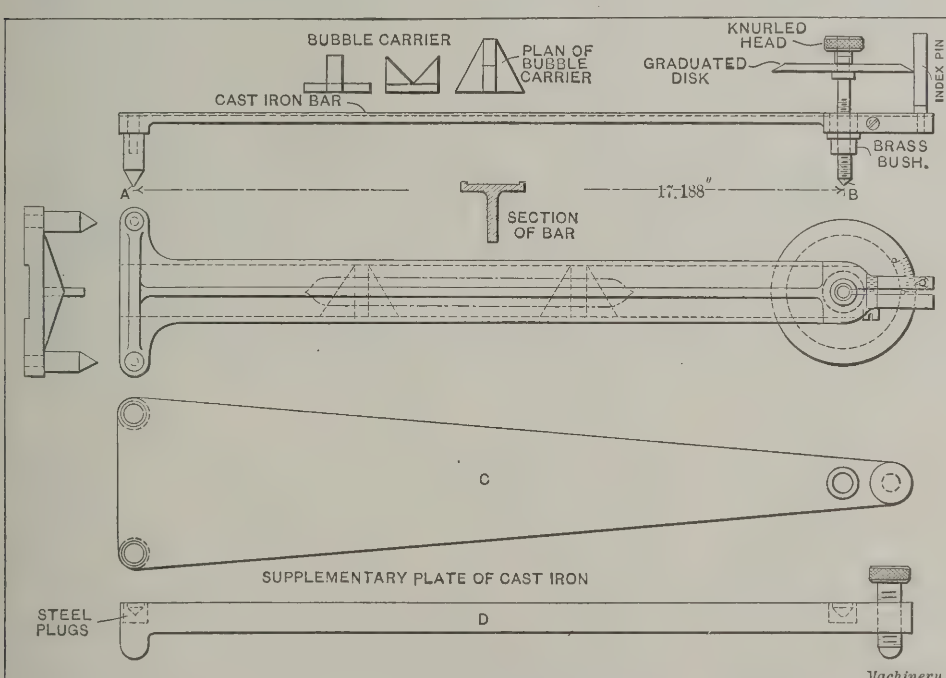

Fig. 1. Device for Testing Spirit Levels

With a first-class testing device a supplementary plate having a screw of coarser pitch than that already mentioned is also provided. This supplementary plate is shown at C and D in Fig. 1. One of the purposes of this plate is to enable the testing device to be quickly adjusted, and another object in view is to test the accuracy of the fine pitch screw. Suppose, for example, that we wish to test the screw. We place a level on the test-bar, set the graduated disk at zero, place the testing device on the supplementary plate, and by means of the coarse screw we bring the air space near the center, carefully noting its location. Then we turn the fine screw half a revolution or 60 divisions and find that the air space has moved, say, 12 divisions. Then by means of the coarse screw we bring the air space carefully back to its first place, and then turn the fine screw another half a revolution or 60 divisions in the same direction and note how much the air space has moved. Should it have moved only 11½ divisions, for example, we know that the lead of the screw or its point is slightly out of true. This test should be carried out over various parts of the screw, and if it is found that one half of a revolution is slightly finer than the other half, there is nothing to do but to take the average of the error and proceed with the calculations on this basis. Of course it is still better to get a new screw, if one that is perfectly correct can be obtained.

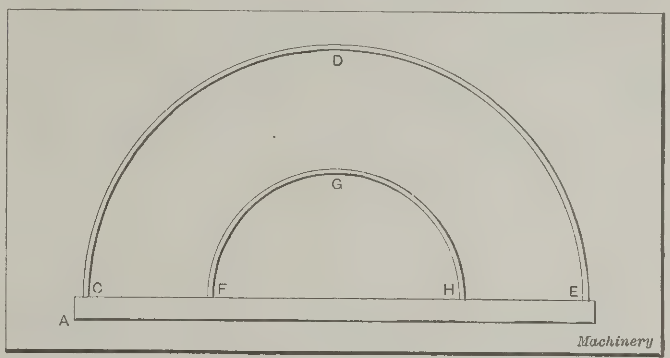

Fig. 2. Diagram illustrating Effect of Curvature on Sensitiveness of Level

When using the testing device it must be placed on a very firm foundation, free from vibration. The level to be tested is placed on the bubble carriers and allowed to come to rest. Should the bubble have been held in the hands just before putting it on the testing device, a few minutes must be allowed for the cooling of the tube and its contents.

The method of testing will be best understood by referring to an actual example. Suppose that the level to be tested is 6 inches long, and that it is divided into tenths of an inch. The three or four last divisions at each end may be ignored, as the level is rarely sealed up without disturbing these divisions. Of the sixty divisions on the level in question, however, fifty-four will be assumed to be serviceable. Assume further that the air space takes up twenty divisions.

The method of testing varies somewhat. Some testers will test every division, while others take the average of four or

five divisions. In this example we will take the average of every five divisions. The air space, at the beginning, is nearly at one end, and we note the lines between which it is located. Now the knurled head of the adjusting screw is carefully turned and the number of divisions on the graduated disk that are required to move the air space five divisions is noted. We find that it takes 60 divisions on the disk for the first five divisions on the level, and 63, 65, 65, 63, 61, 60 and 59 divisions, respectively, for the remaining sets of five divisions each. The average of this is 62 divisions on the graduated disk; therefore each division on the level is equivalent to $62 \div 5 = 12.4$ seconds of arc.

A level that varies more than 5 per cent from the average is spoken of as fair, one that varies 2½ per cent is termed good, and one that varies only ½ per cent is known as first-class. Hence the level tested in this case would be classed as a fair specimen. In making these tests, the temperature plays a considerable part. Nevertheless, a good level should show very little variation in its sensitiveness with a difference in temperature not exceeding 40 to 50 degrees F., although, of course, the air space will vary in length with this difference.

In order to understand how the curvature of the level affects its sensitiveness, it is perhaps best to take an extreme example. In Fig. 2 are shown two glass tubes *CDE* and *FGH*, bent to a semi-circular shape. One has a diameter of 12 feet and the other a diameter of 6 feet. As these tubes represent exactly half a circle, we will have 648,000 seconds of arc. The linear length of the larger tube, in inches, will be $(12 \times 12 \times 3.1416) \div 2 = 226.1952$, and of the smaller, 113.0976. Suppose that we have a girder 13 feet long and capable of being turned about *A* through an angle of 90 degrees. Now place the tubes on the girder, taking care to keep them in an upright position. The air space will be at *D* and *G*. Turn the girder through an angle of 90 degrees and the air space will have run to *E* and *H*, respectively. Now the air spaces in both tubes have run through 90 degrees, but the one in the larger tube has moved 113.0976 inches and that in the smaller tube 56.5488 inches. Thus we would say that the larger tube is twice as sensitive as the smaller, for it will be seen that to move the air space one inch in the larger tube, we need only to turn the tube through one-half the number of degrees required for the smaller tube. Of course in actual practice we never have to deal with tubes of this shape, but the principle is the same.

In all modern work the levels are divided on the outer surface to tenths and twentieths of an inch, except when they are divided according to the metric system. The following table gives the curvature of levels of various sensitiveness, the divisions on the level being in tenths of an inch:

Division of Arc of Circle to Each Graduation	Corresponding Diameter of Curvature of Level in Feet
1 second	3437.73
2 seconds	1718.86
5 seconds	687.54
10 seconds	343.77
20 seconds	171.88
30 seconds	114.59
1 minute	57.29
1 degree	0.954

All levels should be ground, although it often happens in cheaper ones that the glass tube is just bent to the approximate curve. These latter levels are not to be recommended except for work which does not require any particular accuracy.

The value of a division of a level may be found roughly by using a piece of metal about 12½ inches long and wide enough to support the level. Take, for instance, a piece of brass 12½ inches long and file away the lower surface so that it bears on two points exactly 12 inches apart. Put the level to be tried on it, bringing the air space near the center by putting packing under one of the bearing points. Note carefully where the air space is, and then put a feeler gage of 0.002 inch thickness under one of the bearing points of the brass bar. If then the air space runs say 0.1 inch, what is the value in seconds of arc of one division of the level, and what is the curvature to which the level has been ground?

The distance from the bearing point to the feeler gage is 12 inches; this is the radius of a circle whose circumference is 75.3984; hence 75.3984 inch is equivalent to 1,296,000 seconds of arc, and from this we find that 0.002 inch equals 34.3 seconds of arc; or in other words, each 0.1 inch on the level equals 34.3 seconds of arc. To find the curvature, we know that 34.3 is to 1,296,000 as 0.1 is to the total circumference of the curvature circle. Hence:

$$\frac{0.1 \times 1{,}296{,}000}{34.3} = 3749.27 \text{ inches,}$$

which is the circumference of the curvature circle of the level, the diameter being 99.1 feet. This calculation indicates the simplicity of finding the sensitiveness of the level, and further if the user of a level does not know the value of a division on the level, he can by this means ascertain more easily how much out of level a piece of work is that he is setting up.

A good level is one of the most sensitive instruments made, and the utmost care should be exercised when using it. Levels are generally fixed in the brass tubes with plaster of paris. This method is satisfactory for all levels of an accuracy of about 5 seconds to 0.1 inch. For finer levels it will be found best to fix one end only with plaster of paris and the other end with cork, for if the level be fixed rigidly with plaster of paris at both ends, there will be a strain on the level at the extremes of temperatures at which it may be used, and as the coefficients of expansion of glass and brass are different, an inaccuracy is liable to occur. For fine levels it is also best to have an extra glass tube around them in order to prevent the heat of the hand from affecting them. In general practice, the length of the air space is from one-quarter to one-third of the length of the level. A level of 1 minute to 0.1 inch is most serviceable for general use. One having an accuracy of 30 seconds to 0.1 inch must be used on a floor free from vibration, and still finer levels are used mostly on surveying and astronomical instruments.

* * *

POSTAGE FOR FOREIGN COUNTRIES

By FINK

As an employe of a European firm which has an extensive correspondence with American manufacturers, the writer has observed that a great many letters from the United States are prepaid with only two cents instead of five cents, which is the regular foreign postage. It is true that letters from the United States to England or Germany need but two cents postage, but for every other European country the postage is five cents. Of course everyone who receives American letters insufficiently prepaid knows that the trouble is due to errors on the part of the clerks having charge of the mailing, but nevertheless, it is not exactly pleasing for the European business man to have to pay for the carelessness of the employes of an American firm, especially as this extra expense in a large house may amount to quite a considerable sum during the year, and this expense, with some attention, could be easily avoided.

The postage required to be paid on the European side is double that which is lacking, so that six cents has to be paid for every letter which is provided with a two-cent instead of a five-cent stamp. The writer feels sure that American manufacturers would regret the condition even more than the receivers of the letters, if they knew that their European customers sometimes pay six cents extra postage for practically every letter sent them. On the other hand, it is true that some firms always prepay the full postage on their letters.

Now I do not doubt that American manufacturers may have had this called to their attention in the past, but it is a matter that is easily overlooked. As a rather amusing incident in this connection, I might mention that I sent a letter similar to this to another highly esteemed mechanical journal in the United States, but my contribution was returned with an explanation that my remarks would not be of interest to the readers of that periodical. However, in spite of the fact that this journal considered my remarks too trivial to be worthy of publication, and that they contained nothing of interest to American manufacturers, the very letter in which my manuscript was returned was prepaid with only two cents instead of five cents, so that I had to pay the extra postage of six cents. I believe that this clearly shows that the matter to which I have called attention is one which American firms in general would do well to give some attention.

FEATURES OF APPRENTICESHIP SYSTEM AT THE G. E. CO.'S LYNN WORKS

By CHESTER L. LUCAS*

The apprenticeship system in vogue at the Lynn Works of the General Electric Co. was described in MACHINERY, in the April and September, 1906, numbers. As the apprentice department has recently moved into a large new building, and as some of the work being done at the present time is especially interesting from a mechanical standpoint, a description of the new quarters, and an outline of some of the work of the apprentices, may, perhaps, prove of interest.

The apprenticeship system, which is under the general supervision of Mr. Magnus W. Alexander, was started in February, 1902, with twelve boys. At the present time there are enrolled over three hundred boys, who have come from all parts of the United States, and even from Canada, to learn to be machinists and toolmakers, patternmakers, iron or brass molders, steam-fitters, etc. Although applicants for this course must be well qualified, educationally as well as physically, and come well recommended, and although the requirements as to home study and class standing are rigorous, there is always a long waiting list of young men who are looking for opportunities to take the course. This condition is due to the fact that it has become well known in mechanical circles that graduates of these courses are qualified to take responsible positions as skilled mechanics or as assistant foremen, and later as foremen and superintendents.

During the past year the apprentice department has moved into a large new building, designated as building No. 40 of the Lynn Works, where a well-lighted and ventilated training room for machinist and toolmaker apprentices is located. This room has over one hundred machine tools. The building also has large and well appointed class-rooms in which instruction is given in arithmetic, algebra, geometry, plane trigonometry, physics, mechanical drawing and tool-design, as well as in English and industrial history. This department occupies a space of 80 by 450 feet. A smaller, but equally well equipped training room for patternmakers is located in the wood-working building. A view of the machine shop is shown in Fig. 1, from which it will be seen that the shop is well appointed, of modern construction, and equipped with the best of machine tools. The General Electric Co. does not believe that "anything is good enough" for an apprentice, and the lathes, shapers and other machine tools are modern in every respect. It is also interesting to note that all machines are motor driven, so that no overhead belts are required.

A trial period of two months must be served by all applicants for positions on the course, after which time, if the applicant is found to be satisfactory and adapted for learning the chosen trade, he is permitted to sign the apprentice agreement. Compensation is paid, even during the trial period, at the rate of eight cents per hour for the first half-year, ten cents for the second half-year, twelve cents for the second year, fourteen cents for the third year, and sixteen and one-half cents for the fourth year. If the four years' work has been satisfactorily completed in every respect, a cash bonus of one hundred dollars is given to the graduate. The courses for molders and steam-fitters, however, are completed at the end of two years, and the rate of compensation is ten cents per hour for the first half-year, twelve cents for the second half-year, and fourteen cents for the second year, and graduates receive a bonus of fifty dollars at the completion of the course.

The company also maintains apprenticeship courses for high-school graduates who, during a three-year period, desire to fit themselves for efficient service as draftsmen, designers, engineers, electrical testers, erection and installation men, or salesmen. Their initial training consists of well supervised machine work in the apprentice training-room. These apprentices receive ten cents per hour for the first half-year, twelve cents for the second half-year, fifteen cents for the second year, and twenty cents for the third year. A bonus of seventy-five dollars is also paid upon completion of the course. The class-room work is of a high order, and a high standard of work is maintained in the shops and testing departments.

Mr. Charles K. Tripp is the superintendent of apprentices and is in charge of all work. The educational feature of the course is a strong attraction to all, and a great deal of attention is given to this side of the work. The educational work is under the direction of Major A. W. Lowe, and a corps of instructors instructs the boys in those subjects that are closely allied to their work. Fig. 2 shows the interior of a class-room. Mr. Tripp is here instructing a class of apprentices in the proper methods of sharpening lathe tools, illustrating on the black-board methods which are right as contrasted with those which are wrong. As will be noticed, the apprentices are provided with pencils and paper in order that they

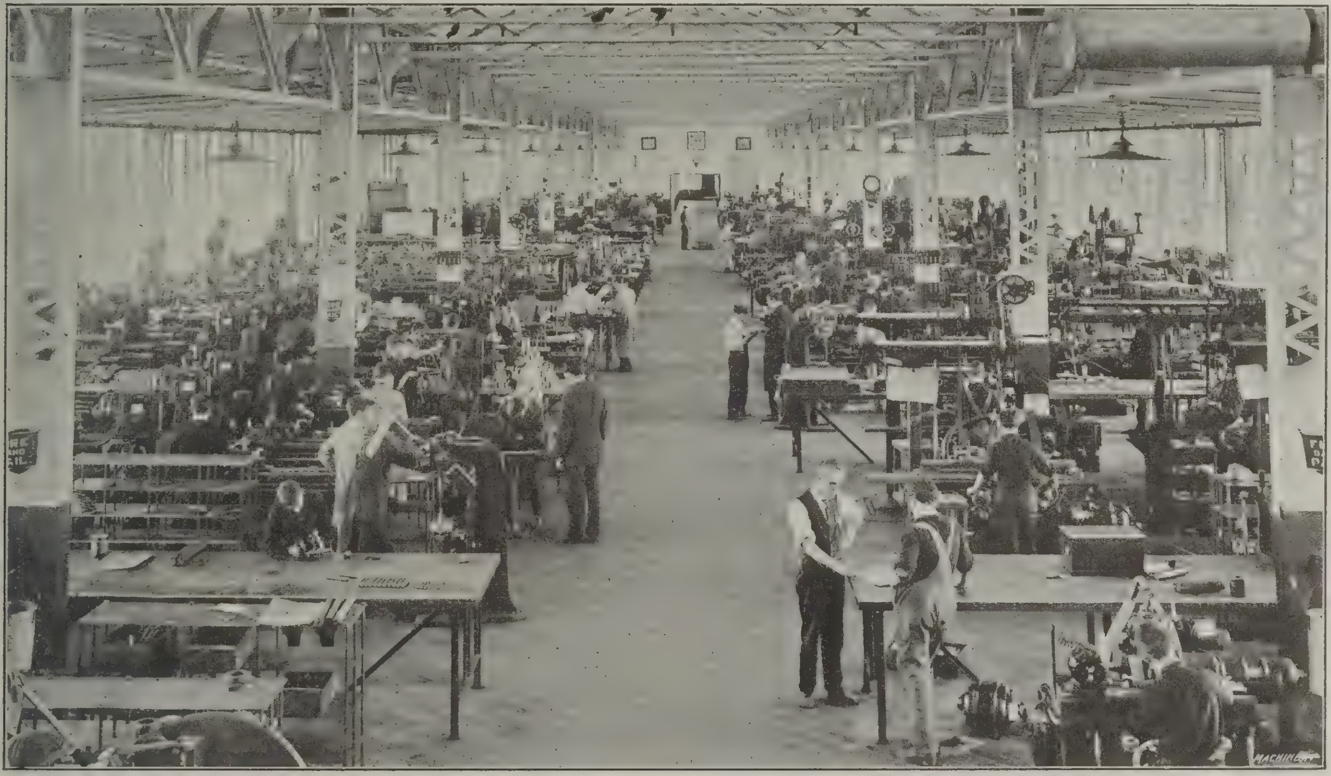

Fig. 1. A View in the New Training-room of the Apprentice Department

* Associate Editor of MACHINERY.

may take notes, for they are expected to remember the points brought out in these lectures when the time comes for their practical application in the shop.

The chief aim of the educational side of this course is to develop proper thinking on the part of the boys, and to familiarize the apprentices with such problems as are apt to come up in their everyday work. Practical examples are always selected to impress upon their mind the value of the information they get. Many boys are dropped from the course on account of their inability to keep up with the class work, this inability being due either to natural dullness or to indifference.


Fig. 2. Another of the Class-rooms with the General Foreman showing Methods of Tool-sharpening

Work done by Apprentices

The following examples are given to convey an idea of the class of work that the apprentices perform in the training-room, before being placed in the various departments of the plant. All of the work described, as well as many of the tools used for doing the work, has been done by apprentices more or less advanced in the course.

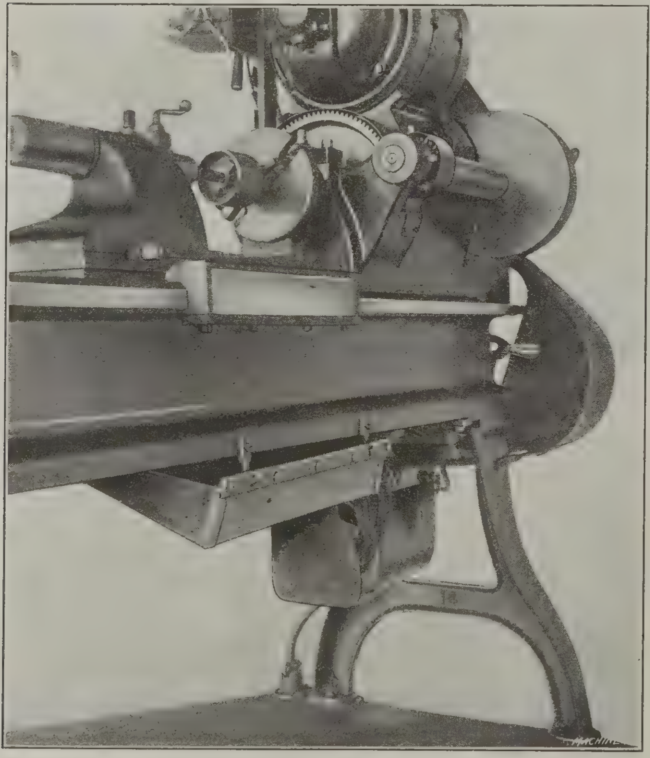
Fig. 4. Chip-pan and Method of attaching to Lathe

T-slotting in the lathe, as shown in Fig. 3, is an unusual operation, but in the apprentice department it is employed to good advantage on turbine work. The piece of work—a turbine valve shown at *A*—is held in a block *B*, bolted directly to the carriage of an old lathe. The cutter *C* is then held in the universal chuck, and a straight slot milled by feeding the cross-slide on to the cutter to the required distance. This operation is followed by inserting T-slotting cutter *D* in the chuck. This cutter mills the bottom of the slot to the proper size and shape. This method has the advantage of cheapness, as it requires only an old lathe instead of a first-class milling machine, and it certainly produces a very good job.

The simple little contrivance shown in Figs. 4 and 5 helps to keep the floors beneath the lathes clear of oil and chips. Fig. 4 shows the pan in position. In cleaning out the pan, it is simply unlatched at the front and allowed to drop, and the chips and oil are caught in a regular dirt pan, as shown in Fig. 5.

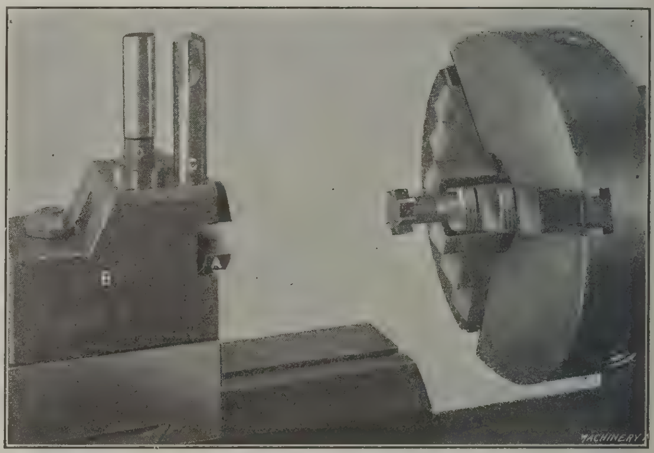
Fig. 3. Using a Lathe for T slotting

A little kink that often proves useful in shops where comparatively little cutting-off is done, is the method of cutting-off short duplicate lengths of round stock on the lathe, as shown in Fig. 6. The solid chuck grips the work, while the other end is supported by the tail-center. The cutting-off, of course, is done with the usual cutting-off tool, and the distance the bar enters the chuck governs the length of the pieces.

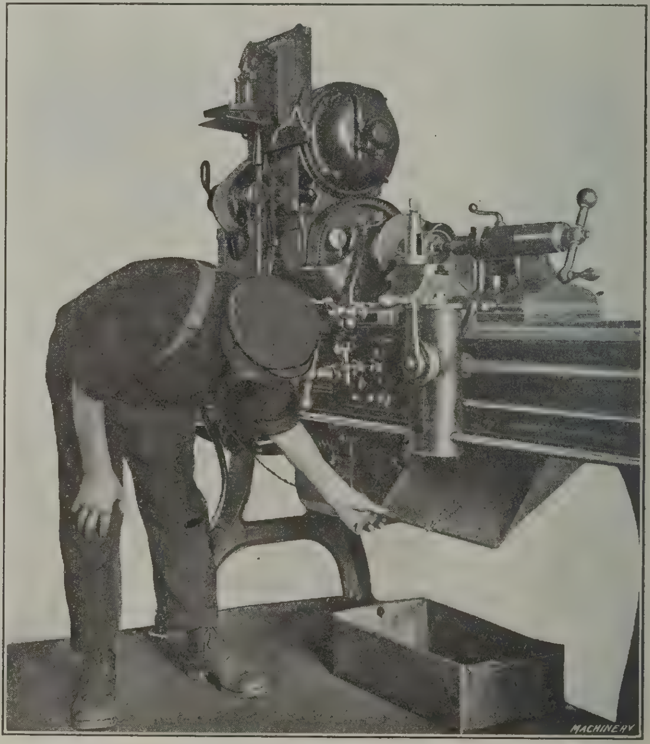
Fig. 5. Removing the Chips and Oil

Valve-seats, a group of which is shown finished in Fig. 7, present some unusually interesting machining methods. At *A*, Fig 7, is shown a rough casting from which the valve-seats are turned, and in Fig. 8, is shown a line-engraving of the valve-seat. It is important that these castings be internally gripped and held central on the arbor by the three points *M*, shown in Fig. 8. For this purpose the special arbor

shown at *B*, Fig. 7, is employed. This special arbor consists of a steel core *C*, on which is slidably mounted a sleeve *D*, one end of which terminates in a tapered flange. At the opposite end of this core is permanently located a collar *E* in which three pins are equidistantly placed about the flange. These pins are so supported that when the sleeve *D* is moved toward the collar *E*. the pins are forced outward due to the action of a taper bearing under the pins.

In operation, the casting is slipped over the arbor, care being taken to locate the three internal spots *M* over the pins that extend from the arbor. Sleeve *D* is then inserted and

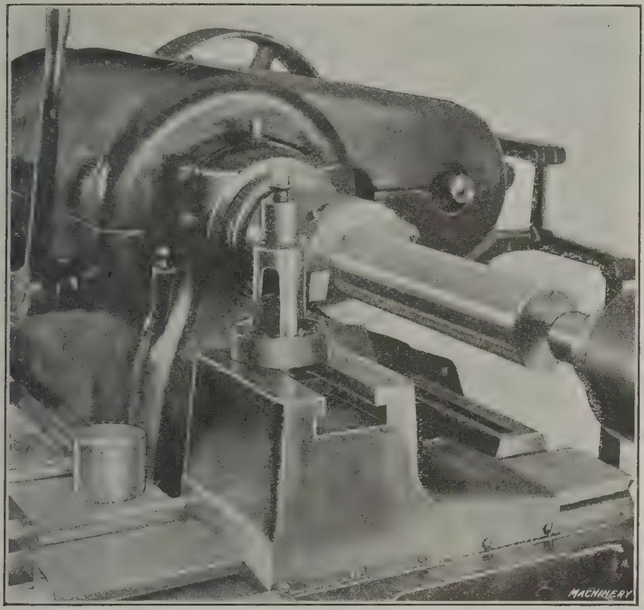

Fig. 6. Cutting-off Short Pieces of Stock

nut *G* tightened. This operation forces the three pins to grip the casting internally, while the tapered flange on the sleeve centers the other end of the casting. In this position the outside of the casting is turned. Next, the casting is removed from this arbor, and one end is held in a chuck while the body of the valve-seat is supported by a steady-rest, thus leaving the interior clear for machining. After being rough-bored, reamer *H* is run through, after which the succeeding counterboring tools, *I*, *J*, and *K* are used. Each of these tools is held in the tail-center of the lathe and each counterbores some particular part of the valve-seat. The interior of the valve-seat being thus finished, it is finally slipped on the arbor *L* and the exterior of the work polished with emery cloth.

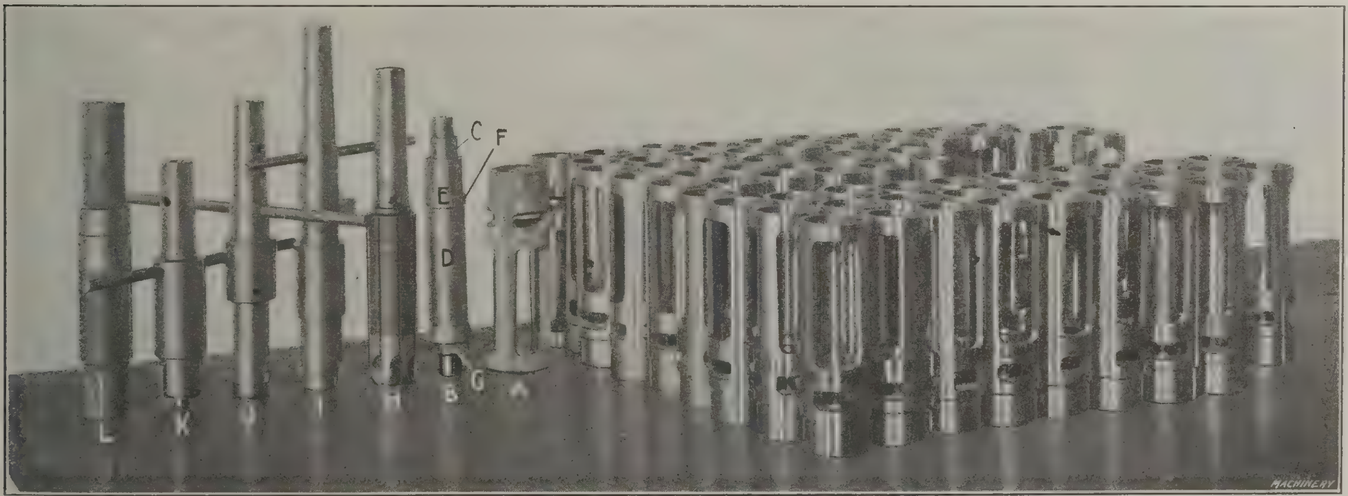

Fig. 7. Turbine Valve-seats and Tools for Machining. A Specimen of Apprentices' Work

Large numbers of cast-iron pulleys are turned in this department, this work being one of the first jobs that the prospective machinist receives. In finishing these pulleys considerable filing must be done, and with the ordinary face-plate and dog, there are plenty of chances for a novice to have his jumper-sleeve caught, with possible injury to himself. To overcome this danger, the lathes in the apprentice department are fitted with faceplate guards, consisting of a piece of sheet metal bent into circular form and fastened to the edge of the faceplate with small screws. The guard (see Fig. 9) extends over the dog, and there is no possible chance

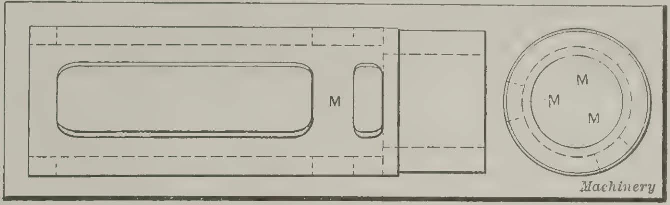

Fig. 8. Turbine Valve-seat Casting before Machining

for any part of the workman's sleeve or arm coming in contact with the dog.

In connection with the pulley work there is a splining operation, which is interesting on account of the method by which the splining bars are made. The bar is mounted on

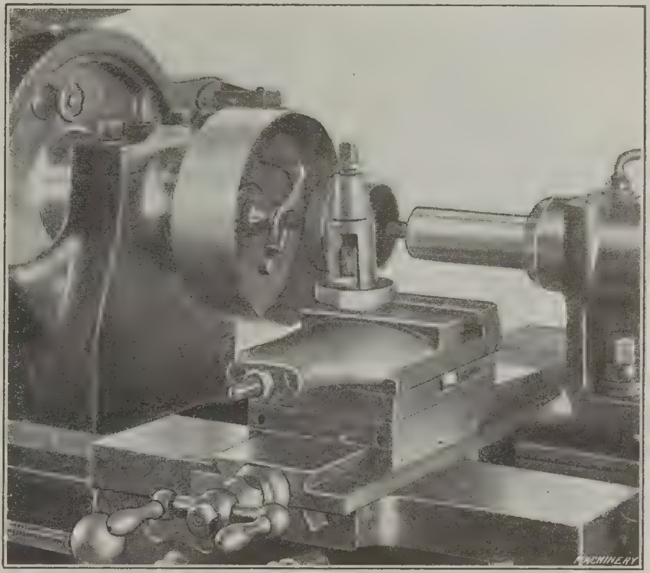

Fig. 9. Guard for Faceplate and Dog when filing in the Lathe

the table of a vertical milling machine, with one end slightly raised. The holes for the teeth are then milled to the same depth, measured from the surface of the table. This, of course, results in each hole being slightly shallower than the preceding hole. As the teeth are made the same length, it will be readily seen that when soldered in place, they will project from the bar with regularly increasing amounts.

Fig. 10 illustrates the way in which the apprentices are taught to run the various machines, the example illustrated being a grinding machine. The apprentice who is to learn to run the machine is instructed by an older apprentice who has already performed work on this machine in a satisfactory

manner. The younger apprentice operates the machine under the guidance of the more experienced boy, and the two work together until the younger apprentice is proficient in handling the work alone. This illustration shows the operation of grinding shafts, of which a great many are used by the General Electric Co., in building small motors. As soon as the younger boy becomes experienced in handling this machine, the older apprentice is taken off and started at work on some other job, and, in due time, the younger boy proceeds to instruct a new recruit. All of this work, of course, is under the supervision of the foreman and his assistants.

In Fig. 11, one apprentice is shown running the machine

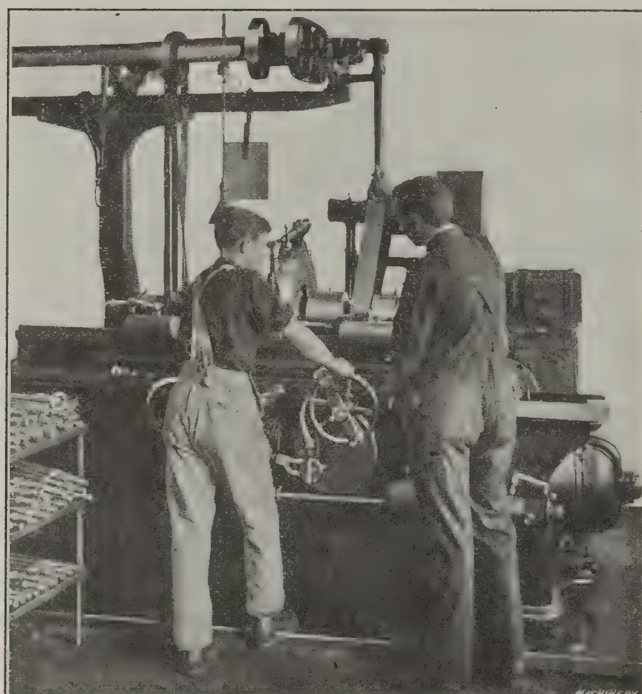

Fig. 10. How One Apprentice instructs Another to operate a Grinding Machine

while the other, who is more experienced in the work, is measuring the finished motor shafts with micrometers. This work, being regular production work, is extremely good practice for apprentices to work upon, as the limits of accuracy are held to within 0.0005 inch. The grinding machine here shown was built by apprentices. The illustration also shows

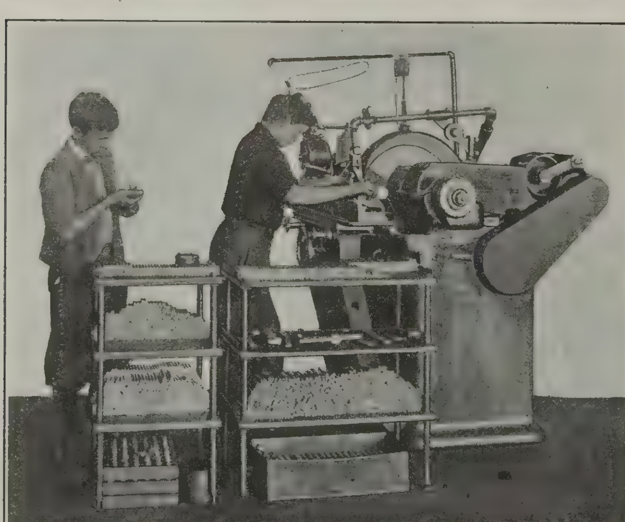

Fig. 11. Grinding Small Motor Shafts. Grinding Machine made by Apprentices

a simple type of homemade shop-stand, built up of iron plates and short lengths of pipe, the whole being held together by long bolts with nuts at the top.

Fig. 13 shows an extremely convenient type of dog used for driving work on the grinding machine. The tail of the dog, which comes in contact with the driving pin, is hinged in the frame of the dog. The hinged end is made cam-shaped so that the slightest pressure upon the tail causes the cam to grip the work, and as the pressure increases, the cam grips the work still harder. The eccentric is kept normally on the work by a spring *A*. This dog is the design of Mr. Tripp and is used exclusively for small grinding work in the apprentice department.

In Fig. 12 is shown an interesting example of turning. The piece of work is a bronze oil deflector, approximately six

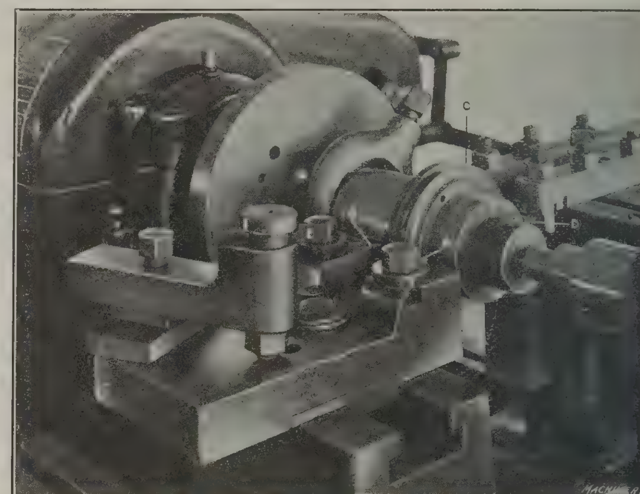

Fig. 12. Multiple-turning an Oil Deflector

inches in diameter, made from large bronze tubing cut to lengths slightly longer than the finished pieces. It is necessary that the inside of this piece be perfectly smooth and accurately sized within 0.0005 inch. This sizing is done by forcing a perfectly smooth arbor through the hole after it has been brought approximately to the required internal diameter. This operation is practically a planishing operation, in that it leaves the metal with a fine finish—far better than could be produced by reaming. Another important reason for using this method in preference to reaming, is the fact that reamers dull very quickly in cutting this hard bronze.

The method of doing the lathe work on this piece is interesting, because it involves multiple-turning. After the interior of the piece has been finished, it is held upon an

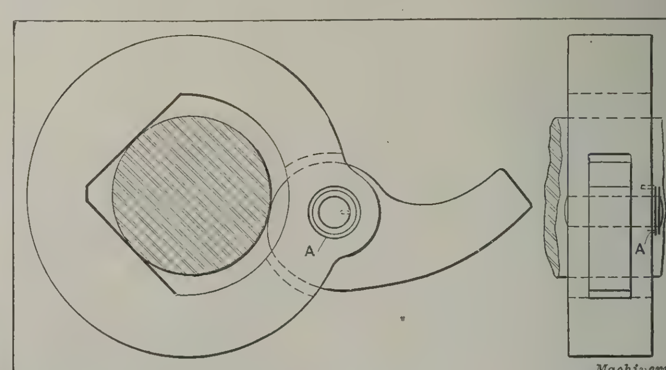

Fig. 13. Dog with Cam-grip; used in Driving Work for Grinding

arbor and placed between the centers of the lathe. Tools *A* and *B* are used for facing the sides of the work, at the same time sizing the piece. These tools are, of course, operated by running in the cross-feed of the carriage-slide. As soon as this operation has been completed, the cross-slide is withdrawn, bringing tools *C* and *D* into contact with the surface of the work. These tools each cut away certain parts of the metal, after which tool *E* is set to cut the grooved section near the center of the oil deflector. In this manner the pieces are finished very quickly and accurately.

In Fig. 14 is shown an example that aptly illustrates the work of the apprentices in fixture making. The operation being done is that of milling a turbine detail, and not only is the work done by apprentices, but the fixture used has also been made by them. The method of doing this milling, in common with many of the other jobs that have been previously described in this article, originated with Mr.

Tripp, who is constantly working out new ideas to be carried out by the apprentices. Referring to the illustration, the work A is clamped on the faceplate B, of a fixture C. It is located at the bottom by set-screw D, and at the top by latch E, which engages in the longitudinal slot in the work. The seats for the work are V-blocks F. The faceplate B is removable from the body of the fixture; it is located accurately by two removable dowel pins G, and held in place by four swing-bolts H.

It will be noticed that one section of the cut is slightly deeper than the other part, a condition that is met by using cutters of different diameters. As soon as one cut has been made in the work, the top half of the fixture is loosened and reversed, and the second cut is made at the other end of the turbine part. While this cut is being taken, the apprentice clamps a new part in a duplicate faceplate, and at the completion of the cut, he simply removes the top half or faceplate of the

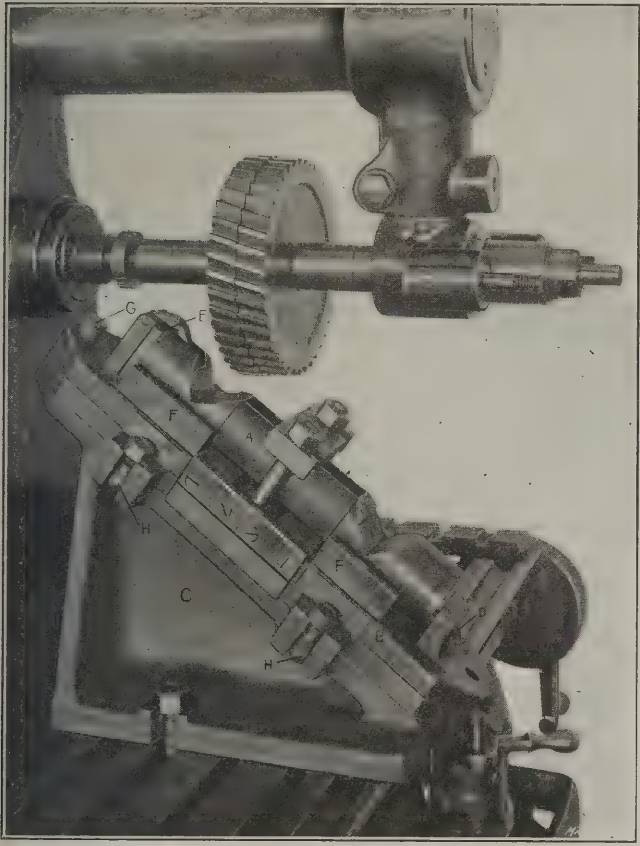

Fig. 14. Fixture employed in milling Turbine Parts

fixture, replacing it with the duplicate faceplate that has a new piece in it, and is ready for milling. In this manner the machine is kept at work all the time.

There are many other jobs done by the General Electric apprentices that are worthy of description. Screw-cutting bench lathes and other machines have been built complete in this department, and some unusually good punch and die work and general toolmaking has been done, but enough has been said to make it plain that the apprentices on this course get "real work" to do.

* * *

During the last thirty-six years the fire losses in the United States, according to an article by Mr. S. G. Koon in the *Engineering Record*, have amounted to more than $5,000,000,000. This is more than seven per cent of the average estimated national wealth during this period. The fire loss per capita is considerably over two dollars a year, which is about six times the fire loss per capita in some of the leading European countries. When it is known that over ninety-five per cent of all fires in buildings equipped with automatic sprinklers are either completely extinguished by the sprinklers or held in check so as to be easily handled by the firemen, it is evident that these enormous fire losses are not necessary. A department store with a sprinkler system stopped the progress of the Baltimore fire. Had the building in which this fire started been properly protected in this manner, there would have been no conflagration to stop.

DAD'S BOY

By A. P. PRESS

We had a new man come in lately. This is not, in itself, an unusual thing, for new men come in every day. In fact this one came in with a "bunch" of five; but he "stuck out" from the rest, although he did not put himself forward—he just stuck out, anyway. He had on a blue woolen shirt, but it was clean; and he had blue eyes—and they were clean too. He did not have much of a kit—none of the boys do nowadays. A kit is in the way on the bench if kept in a chest, and on the set-up job it is not needed anyhow; but what tools this new man had were first-class.

He started in just the same as the rest of the men, and no favors were shown him, but one thing we noticed was that he "peeled off" before he started, the same as the molders do, and put on some rough clothes.

The floor boss came along past the desk, that noon, just as we were eating lunch, and said:

"Say, but that new man is all right." (He didn't say which new man, but we all knew who he meant.) "He showed me how to get the angle on that big brace without a protractor and it came out right, just as the drawing called for. You can't get a protractor on it very well anyhow—there is no planed surface to work from."

"A good man, is he?"

"He sure is," was the reply, and the matter was dropped.

About a week after that we wanted a nice lathe job done. It was a kind of a government job. It happened this way. We broke down one of the big cranes, and it was due to carelessness, so we hated to ask the office for an order to fix it, as that would mean a lot of explanations as to how it was done. It only needed a new bushing with a taper hole in it to make it as good as new, so we asked the floor boss if he had a good lathe hand in the gang.

"Sure and I do not think of one, sir; but wait a minute and I'll ask that new man and see what he knows."

Back he came in five minutes. "Yes, sir, the new man says he can do anything in the way of a lathe job; and that is not all—he has a pair of 'mikes' and a pair of vernier calipers in his coat pocket, both in little cases."

We got the use of a good lathe in the experimental room and sent the new man in there with a sketch showing what was wanted, and a solid casting to cut it from. Along in the afternoon he came out with the job and fitted it into the crane—it *was* a fit, too—and went back to his floor work, and said nothing.

A week after this the man on the big planer was taken sick, and word came from the planing job to ask if we had a man who could take his place for a week, as the planer had all it could do every hour of the day. We called in Mike, the floor boss, and put it up to him.

"Sure, and that new man does have a machinery paper, and he is reading most every noon; I will ask him." Back he came and said, "Yes, he says he has run big planers and is not afraid to take hold of this one—in fact, he is very willing to do it." So on the planer he went and he made good, and stayed there until the regular man got back again; and then he went back to the floor.

A month went by, and one morning we got a telephone message from Mike. "Sure," said he, "and I was going upstairs with a hod of coal, and I fell and hurted my ankle. The doctor says that it will be a week before I can get in." Well, we were stuck, for that meant that we either had to find a piece of stock on the floor that we could hammer a floor boss out of, or be boss ourselves. The new man was the first one that came into our mind, so we went gunning for him at once.

"Did you ever handle any men?"

"Yes, sir, on several jobs, sir," was the reply.

"How many?"

"Oh, anywhere from five to fifty," was the quiet reply.

"Can you take hold of this gang and run it until Mike gets back?"

"I can try," he answered.

"Go ahead."

And "go ahead" he did; and although Mike's one week with his injured leg, stretched out into three, things ran so smoothly that we should never have known he was out—as far as the work was concerned. Mike came back at last, and then our curiosity got the best of us, and we called the new man into the office.

"See here, now, what are you doing here? You have been here four months and you have shown that you are an expert lathe hand, a good planer hand, and also a good floor boss—and still you are working for a journeyman's pay. We know drinking is not the trouble."

"Well, boss, you see it is like this: Dad is superintendent of the Smith Co. (naming one of the largest concerns in the country) and it has always been his brag that he was a self-made man and came up from the ranks. He said that any boy of his had got to do the same—and that is just what I am doing now. I started in three years ago in the lumber mills of Vancouver, worked my way along to Seattle, put in a year in 'Frisco, and then worked my way through the gulf shops to New York. I put in nine months in a big garage there before I came here—and I would like to respectfully give you notice that I wish to leave next Saturday night. I am going across to the old country for a year in France and on the Continent. Then I am going home to Dad."

Now, we have not the pleasure of the acquaintance of "Dad," but we certainly have the highest respect for him and his method of bringing up the boy—and we should like to be in Dad's shoes when the kid gets home.

* * *

TABLE OF ALLOWANCES AND LIMITS

FOR DRIVING, PULLEY, RUNNING, SHRINK AND SLIDING FITS

By H. M. NICHOLS*

In manufacturing machinery where the parts must be interchangeable, it is necessary to have some standard of allowances and limits in order that parts made at different times will go together without fitting. The accompanying table gives the allowances and limits for sizes from zero up to 8 inches for driving, pulley, running, shrink and sliding fits. The allowances are in all cases added to the even dimensions to determine the dimension that is put on the drawing for the mechanic to work to. The limits are given after the important dimensions on the drawing, and all pieces must be made to the degree of accuracy called for by these limits; that is to say, if the limits for a particular piece are +0.001 and —0.000, it must at least caliper to the size and must not be more than 0.001 inch over to pass the inspector.

As an example, suppose we have a 3-inch shaft and a collar to be shrunk onto it. Referring to the accompanying table we find that there is no allowance for the bore, and consequently the dimensions for the bore of the collar would be written $3.000 \frac{+0.000}{-0.0005}$. The allowance for the shaft is 0.003 inch, so that the dimensions for the shaft would be written $3.003 \frac{+0.0005}{-0.000}$.

It is customary to write dimensions that have to be accurate to the thousandth part of an inch in the form of a decimal, annexing ciphers in case a particular dimension happens to come out an even figure. All other dimensions are written in sixteenths or multiples of sixteenths. This enables the workman to pick out all dimensions requiring accurate work. The limits are usually given in small figures immediately following the main dimensions and a little above the main dimensions. Some concerns have letters to represent their standard limits which they add to the general dimensions requiring limits.

[While the values given in the table for shrinkage and force fits are all right for average conditions, they cannot be used in all cases, the allowance to be made depending on the length of the work, diameter of the hub, character of the bore, and numerous other conditions. For a more extended treatment of the subject, reference should be made to the article on "Shrinkage and Force Fits in the Bradford Shops," which appeared in the August, 1911, number of MACHINERY, engineering edition, and also to the two articles by William Ledyard Cathcart, entitled "Shrinkage and Force Fits," in the April and May numbers of MACHINERY, engineering edition.—EDITOR.]

TABLE OF ALLOWANCES AND LIMITS

Diameter in Inches	Driving Fit			Pulley Fit		Running Fit			Shrink Fit			Sliding Fit		
	Bore, No Allowance	Shaft		Bore, No Allowance	Shaft, No Allowance	Bore		Shaft, No Allowance	Bore, No Allowance	Shaft		Bore		Shaft, No Allowance
	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches
0 to ¼	+0.000 / −0.00025	0.000	+0.00025 / −0.000	+0.00025 / −0.000	+0.00025 / −0.000	0.001	+0.000 / −0.00025	+0.000 / −0.0005	+0.000 / −0.0005	0.0005	+0.00025 / −0.000	0.0005	+0.000 / −0.00025	+0.000 / −0.0005
¼ to ½	+0.000 / −0.00025	0.000	+0.0005 / −0.000	+0.0005 / −0.000	+0.0005 / −0.000	0.001	+0.000 / −0.0005	+0.000 / −0.0005	+0.000 / −0.0005	0.00075	+0.0005 / −0.000	0.0005	+0.000 / −0.00025	+0.000 / −0.0005
½ to 1	+0.000 / −0.00025	0.0005	+0.0005 / −0.000	+0.0005 / −0.000	+0.0005 / −0.000	0.001	+0.000 / −0.0005	+0.000 / −0.0005	+0.000 / −0.0005	0.0015	+0.0005 / −0.000	0.00075	+0.000 / −0.00025	+0.000 / −0.0005
1 to 1½	+0.000 / −0.0005	0.00075	+0.0005 / −0.000	+0.0005 / −0.000	+0.0005 / −0.000	0.0015	+0.000 / −0.0005	+0.000 / −0.0005	+0.000 / −0.0005	0.002	+0.0005 / −0.000	0.001	+0.000 / −0.00025	+0.000 / −0.0005
1½ to 2	+0.000 / −0.0005	0.001	+0.0005 / −0.000	+0.001 / −0.000	+0.0005 / −0.000	0.0015	+0.000 / −0.0005	+0.000 / −0.001	+0.000 / −0.0005	0.0025	+0.0005 / −0.000	0.0015	+0.000 / −0.00025	+0.000 / −0.0005
2 to 3	+0.000 / −0.0005	0.0015	+0.0005 / −0.000	+0.001 / −0.000	+0.0005 / −0.000	0.002	+0.000 / −0.0005	+0.000 / −0.001	+0.000 / −0.0005	0.003	+0.0005 / −0.000	0.002	+0.000 / −0.00025	+0.000 / −0.0005
3 to 4	+0.000 / −0.0005	0.0015	+0.001 / −0.000	+0.001 / −0.000	+0.001 / −0.000	0.002	+0.000 / −0.001	+0.000 / −0.001	+0.000 / −0.001	0.004	+0.001 / −0.000	0.002	+0.000 / −0.00025	+0.000 / −0.001
4 to 5	+0.000 / −0.0005	0.00175	+0.001 / −0.000	+0.001 / −0.000	+0.001 / −0.000	0.003	+0.000 / −0.001	+0.000 / −0.001	+0.000 / −0.001	0.0045	+0.001 / −0.000	0.0025	+0.000 / −0.0005	+0.000 / −0.001
5 to 6	+0.000 / −0.0005	0.00175	+0.001 / −0.000	+0.001 / −0.000	+0.001 / −0.000	0.003	+0.000 / −0.001	+0.000 / −0.001	+0.000 / −0.001	0.005	+0.001 / −0.000	0.003	+0.000 / −0.0005	+0.000 / −0.001
6 to 7	+0.000 / −0.0005	0.002	+0.001 / −0.000	+0.001 / −0.000	+0.001 / −0.000	0.004	+0.000 / −0.001	+0.000 / −0.001	+0.000 / −0.001	0.0055	+0.001 / −0.000	0.004	+0.000 / −0.0005	+0.000 / −0.001
7 to 8	+0.000 / −0.0005	0.002	+0.001 / −0.000	+0.001 / −0.000	+0.001 / −0.000	0.005	+0.000 / −0.001	+0.000 / −0.0015	+0.000 / −0.001	0.006	+0.001 / −0.000	0.004	+0.000 / −0.0005	+0.000 / −0.001

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MAKING PISTON RINGS*

By C. A. ROGERS†

The subject of making piston rings has been discussed before, but as this is an interesting problem in machine shop practice, the writer feels that there is still more to be said. A great many mechanics insist that piston rings must be ground, yet I have seen very few ground rings that were parallel sideways, and consequently they would not have a perfect bearing when placed in the cylinder. The piston ring, the manufacture of which is to be described in the following, is for a 4-inch cylinder and is shown in Fig. 1. Fig. 2 shows the casting from which the piston rings are made, while Fig. 3

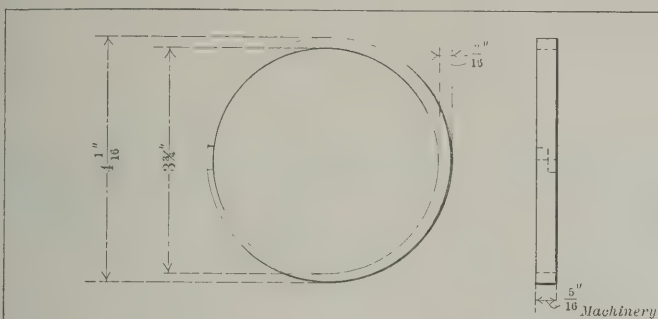

Fig. 1. Piston Ring for a 4-inch Cylinder

is a fixture fitted to the lathe spindle for holding the casting shown in Fig. 2.

The fixture shown in Fig. 3 consists of a casting *A*, fitted to the nose of the spindle and which is machined out on the front end to receive a block *B*. This block is counterbored to fit the external diameter of the casting shown in Fig. 2, the latter being reduced on one end to 4⅛ inches. The casting is held in the block *B* by a binding screw which securely holds

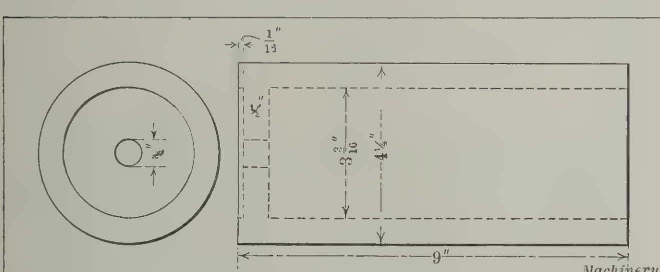

Fig. 2. Casting from which the Piston Rings are cut

the casting while it is being turned, bored, faced, and the rings cut off. The block *B* is provided with a pin *C*, which locates it in two positions so that the castings for the rings can be turned eccentric. The block when located in the desired position, is held by cap-screws as shown.

The casting is turned, faced and cut up into rings by means

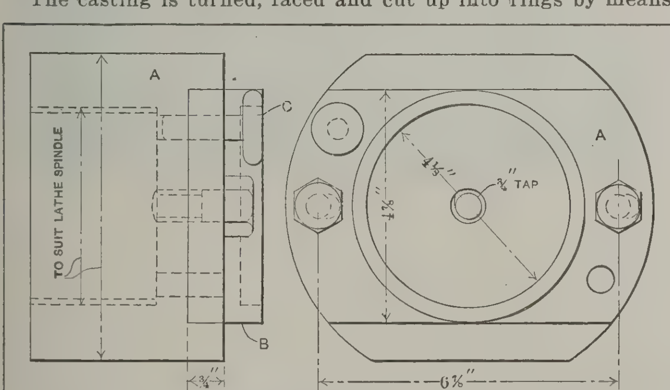

Fig. 3. Fixture for Holding Casting when turning, facing and cutting-off Piston Rings

of tools held in the turret toolpost, shown in Fig. 4, which comprises three blocks of machine steel. The turning tool *A* is used for rough turning; tool *B* for finishing; *C* for cutting off; and *E* and *F* for side facing. The first operation after placing the casting in the fixture, Fig. 3, is to rough down the external diameter with the tool *A*, Fig. 4, at a feed of 1/16 inch per revolution, and a surface speed of 80 feet per minute, leaving 1/32 inch for the finishing tool *B* to remove. Finishing tool *B* is operated at the same speed as tool *A*, and finishes the casting to the required diameter.

Cut-off tool *C* is then brought into position, and is used to face off the outer end of the casting. The carriage is then

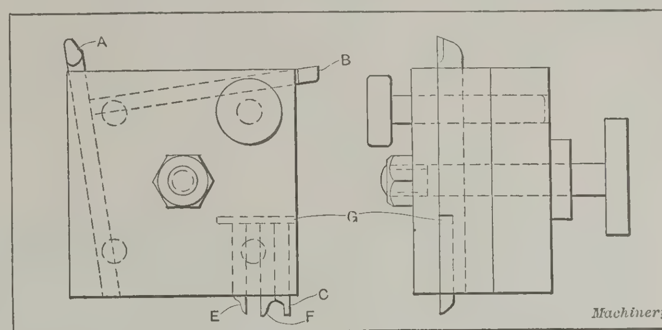

Fig. 4. Turret Tool-post for Holding Turning and Cutting-off Tools

moved 5/16 + 0.020 inch, and the cut-off tool put in to within 1/64 inch of cutting the ring off. The carriage is again moved 5/16 + 0.020 inch, and while the groove is being cut to form the second ring, the two side facing tools *E* and *F* face the first ring and cut it off. This order of operation is repeated until the casting is cut up into rings.

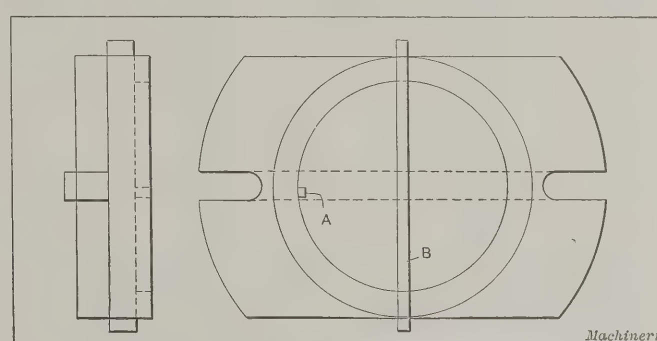

Fig. 5. Fixture used in Splitting Piston Rings

After the rings are turned externally and cut off, they are taken to the milling machine and placed in the fixture shown in Fig. 5. This is a fixture for holding the rings while the slot is milled, a cutter 0.197 inch wide being used. The fixture is set off center, an amount equal to half the thickness of the cutter—0.0985—and all the rings are milled on one side. Then

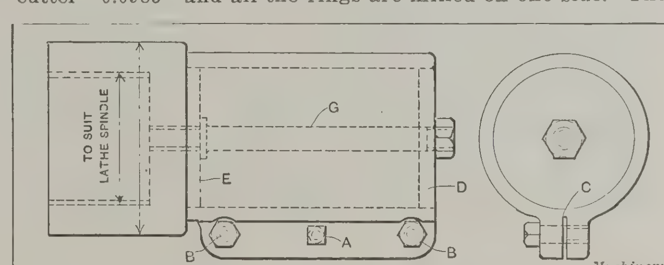

Fig. 6. Fixture for Holding and Clamping Piston Rings when taking the Finishing Cut

the piece *A* is slipped into position to fit the slot already cut, when the rings are milled on the other side.

Following the milling of the rings they are taken back to the lathe and placed in the fixture shown in Fig. 6. This consists of a clamping sleeve which will hold as many rings as are cut off from the casting. To make the sleeve ready for holding the rings, the set-screw *A* is backed out and the binding screws *B* tightened, so that the sleeve is cracked open at *C*; then the fixture is filled up with rings, leaving sufficient room for the washers *D* and the projection *E* on the fixture. The retaining sleeve holding the rings is now slipped over the stud *G*, the washer *D* put on and the nut tightened. The binding screws *B* are now loosened, and the set-screw *A* tightened slightly, when the sleeve can be easily removed. A center is provided in the end of stud *G* so that it can be supported with

* For additional information on this and kindred subjects, see "Automatic Piston Ring Peening Machine," August, 1911; "Fixtures for Machining Eccentric Piston Rings," April, 1910, and articles there referred to; "Turning Gas Engine Pistons in a Turret Lathe," April, 1910; "Making Accurate Automobile Engine Pistons," January, 1910; "Automobile Factory Practice," January, 1910, engineering edition; "Automobile Factory Practice," October, 1909, and other articles there referred to.

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the tailstock center when taking the finishing cut. The finishing tool *B* shown in Fig. 4 is used for this last operation.

As the sleeve is bored the same size as the cylinder (plus 1/32 inch to allow for turning), and as the rings are closed together when they are placed in it, they are thus turned when in their compressed condition so that they fit the cylinder of the engine snugly. The total time required to make these rings is five minutes each, and when made on a good engine lathe equipped with fixtures as illustrated, a very good job will be the result.

Referring to Fig. 5, the strip *B* is used for pulling the rings from the fixture. They require no holding in this fixture, as the cutter should be fed down from the inside, and any tendency for the rings to fly up on the opposite side is easily overcome by holding them down by the fingers. If the rings were clamped down, the time required for clamping would be nearly as long as that required for milling. The strip *G*, Fig. 4, is set in a milled slot to prevent the cut-off and side facing tools from slipping back. The two side facing tools should be packed apart with tin foil so that they can be adjusted for wear, as the rings should be a very close fit in the grooves of the piston.

* * *

SPECIAL ACME-THREAD MACHINE TAPS

By FRANK LANG*

Having had considerable trouble in making machine taps with Acme threads due to the change of the lead in hardening, the writer designed the type of tap shown in Fig. 1. This tap has proved practical and has given very good results. An accurate thread is produced, there is less heating in tapping, and a greater number of pieces can be tapped in the same time, with less chance of breakage. One tap, 1 15/16 inch in diameter with two threads per inch, left-hand, was used for tapping seventy-five pairs of Le Blond heavy-duty lathe half-

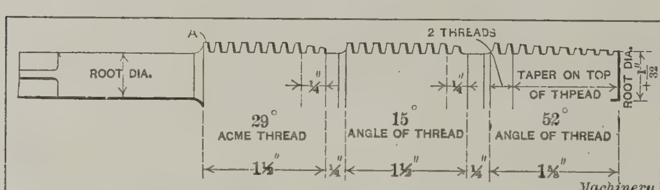

Fig. 1. Method of making Acme-thread Taps

nuts, and not a scratch could be seen on the thread when the last pair was removed from the jig; the tap was ground twice.

When making this tap a tool is first ground to a 52-degree angle, as indicated by the gage shown in Fig. 2. This tool is used for threading the first third or roughing part of the tap. The thickness of the tooth at the bottom of the thread in the tap is made 0.010 inch less than the figures given in a table of the standard Acme thread dimensions. The next third of the tap is made with a tool having a 15-degree angle, the

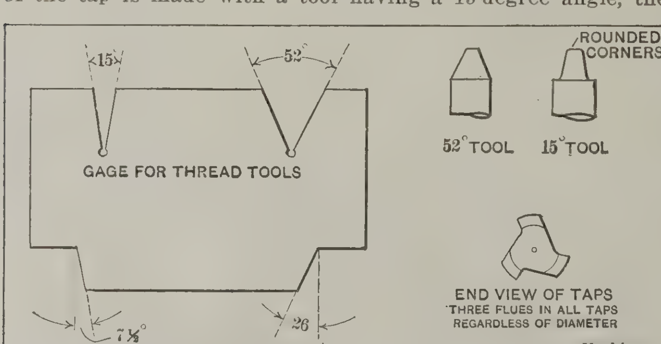

Fig. 2. Gage for Special Thread Tools, Shape of Tools, and End View of Fluted Taps

flat at the top of the thread being made 0.010 inch smaller than the Acme standard. A small round on each corner of the tool is made as shown in Fig. 2. This is a good feature as it makes the tap less liable to break when straightened after hardening. The last third of the tap is made with a regular Acme thread, except that the thickness at the bottom of the tooth is 0.005 inch less than standard, in order to allow this amount to be removed by a hand tap.

The diameter of the shank is made equal to the root diameter, and its length depends on the length of the piece to be tapped. The square in this case is hardened and tempered, as this tap is driven by a tap socket having its square at the outer end, so that the shank has no bearing in the socket and the square does all the driving. A small round corner should be left between the sides of the square, as this strengthens the square. The tap shown in Fig. 1 is ¾ inch in diameter with six left-hand Acme threads. The one-half of a thread shown at *A* should be ground off from each tap, as otherwise it may become distorted in hardening and mar the tapped pieces, and the trouble may never be located. In chasing the threads in the tap, a ⅜-inch square piece of high-speed steel is used in an Armstrong toolholder when the space of the thread does not exceed the width of the tool.

It may be of interest to some of the readers of MACHINERY to know that the hand taps made in our shop are not made exactly to the standard formula, but the outside diameter is made with the following allowances:

Outside diameter, up to 1 inch diameter = nominal diameter + 0.005 inch.

Outside diameter, from 1 to 1½ inch diameter = nominal diameter + 0.007 inch.

Outside diameter, from 1½ inch diameter and over = nominal diameter + 0.010 inch.

The length of the flute is 2½ inches in all cases. This applies to hand taps only.

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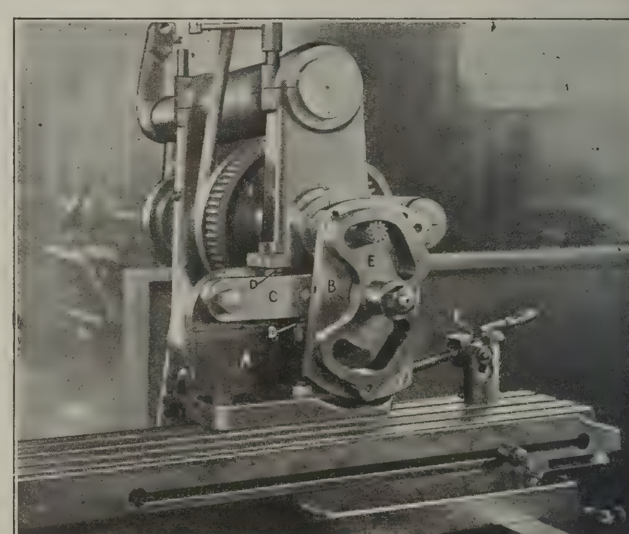
* * *

SHIFTER CAM MILLING ATTACHMENT

The cams used on metal planers for shifting the belts require to be accurately formed and smoothly finished. The accompanying illustration shows a simple milling attachment used by the Cleveland Planer Works, Cleveland, Ohio, for milling out the slots.

The attachment consists of an angle-plate *A* on which is mounted a master cam *B* pivoted in the center. The master cam is not mounted directly on the angle-plate, but on a horizontal piece *C* which has a limited up-and-down motion. This



Belt Shifter Cam Milling Attachment

piece is held in a horizontal position by two short coil springs, *D* and D_1, oppositely placed.

The cam to be milled is mounted on the master cam-plate, as shown at *E* in the illustration, and an end milling cutter having a shank that closely fits the slot in the cam-plate is placed in the spindle. The slot is milled with a horizontal feed of the machine until the curve is reached, when its feed is thrown out. The cam-plate is then rotated by hand by means of the screw and handle *F*, shown at the right. When the curve has been traversed, the horizontal feed is again thrown in and the cutter traversed to the end of the slot.

This simple attachment is found valuable. It insures accuracy of the slots, interchangeability, and saves the time of a first-class mechanic filing out the slots by hand. A boy runs the machine carrying the attachment successfully, and produces work superior to that turned out by a mechanic at the vise.

NOVEL USE OF RETOUCHED MACHINERY PHOTOGRAPHS

Manufacturers that issue illustrated catalogues and circulars accumulate retouched photographs and wash drawings that represent many dollars' investment. They are usually kept carefully stored away where no one sees them except when they are resurrected for use in making new illustrations. That machinery photographs and drawings can be put to other good use is shown in the illustration which shows how the Kearney & Trecker Co., Milwaukee, Wis., utilizes the retouched photographs of its "Milwaukee" milling machines and details of the same. The photographs, large and small, are mounted under mats and glass in oak panels on the four walls of the the president's and secretary's office. In this form the photographs make an effective and pleasing ornament to the office. The large photographs show details of the machines advantageously, and can be studied more easily than if they were loose or in an ordinary portfolio, and the color effects make them more attractive than ordinary catalogue illustrations.

Novel Use of Retouched Machinery Photographs in Kearney & Trecker Co.'s Office

The frames of the panels are of oak, the same as the desks and furniture. Each top and bottom strip of the sections is in one piece and is screwed to the wall, as are the vertical division strips between them. The panes of glass are independently mounted so that changes can be made in any section without disturbing the others. Ordinary picture mats are used with holes cut through of the size of the photograph that is to be shown. Back of the mats and photographs is placed a layer of ordinary corrugated backing which holds the glass against the molding.

The arrangement of the panels and pictures extends all the way around the office with breaks for doors and windows only, and the whole makes a most effective feature, which in this case partially solves the problem of properly taking care of retouched photographs and using them to good advantage.

TAPS AND TAPPING*†

The average user of machine screws and bolts may hear little about the theories and other details relating to tap- and die-making, but he must be interested, nevertheless, in being able to buy or make screws and bolts which can be depended upon to fit the tapped holes in the product he is making. There must always be a difference in dimensions of the screws and the tapped holes in order to make up for unavoidable imperfections in manufacture and for wear of the taps, and also to allow sufficient freedom of fit. The difference, however, should be confined to such limits that the smallest permissible diameter for the tap should be but slightly larger than the largest permissible diameter of the screw. If the limits are too large, a screw which happens to be used in a hole tapped by a maximum size tap would be too loose; again, if the limits are too small, interchangeability when assembling would be impossible, and the taps would not allow a reasonable amount of wear.

The two most vital factors are the size and the lead. In order to talk intelligently about the size, we must understand how a tap is measured. The fit of any screw should be on the sides of the angle of the thread, as the outside and root diameter have comparatively little to do with the actual fit. Unless the angle and the lead of the threads are the same in both screw and tapped hole, and the diameters measured across the angle of the threads are relatively right, a proper fit cannot be obtained.

In Fig. 1 is shown the effect of having nuts and screws of

* Abstract of a paper by Mr. F. O. Wells, read before the American Society of Mechanical Engineers, March 12, 1912.

† See also the following articles on this and kindred subjects previously published in MACHINERY. "Hook-fluted Taps," October, 1911; "Taps and Tapping," June, 1911, and the articles there referred to; "Rules for Threading Square Thread Taps," and "Making Hand Taps in Sets," May 1911, engineering edition; "Rapid Nut Tapping," April, 1911; "Dimensions of Bit-brace Taps," March, 1909; "Power Required for Tapping," June, 1909; "Power Tapping," February, 1909.

different angles of threads fitted together. In this case the screw is shown with a more obtuse angle than the nut, and the bearing between them will be on the sharp, fragile apexes of the teeth. The necessity of measuring correctly in the angle of the thread has led to the adoption of the term "pitch diameter" for screw threads, the same as for gears. In Fig. 2 is shown a micrometer for measuring the pitch or angle diameter. The merit of this tool is that it is not rendered inaccurate by the helix angle of the thread. It will, therefore, measure the finest lead as well as the coarsest within its range.

Fig. 3 shows how variation in the lead will affect the fit between the screw and the nut. The angle in this case is assumed to be correct, but the nut has been tapped with a tap having a long or stretched lead, with the result that at the base there will be a bearing on two threads only, as indicated at *A*, *B*, *C* and *D*. This is not an unusual condition, and explains why a nut tapped with a large enough tap will often start freely on a screw, turn a few turns and then bind. This also places all the strain on one tooth at a time, making it possible, with a sufficient longitudinal strain, to strip one tooth after another with a shearing action.

The difficulties due to variations in the sizes of screws and taps are well known to those who have to use them. For this reason many are using limit gages which are made especially to measure the screw diameters across the angle, and thus insure uniformity, within working limits, of the screws to be

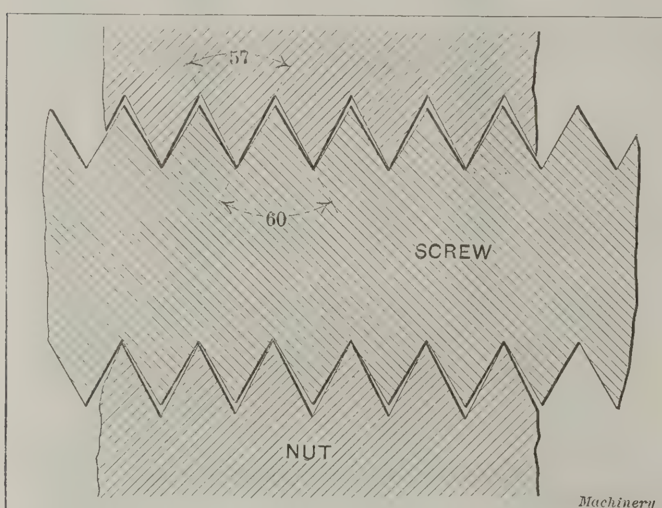


Fig. 1. Effect of Difference in Thread Angle of Nuts and Screws

used. Figs. 4 and 5 show one of these gages in use. The screw being measured has just passed the "go" or maximum limit in Fig. 4 and with the same movement of the hand is carried down to the "not go" or minimum limit, as indicated in Fig. 5. The rapidity and accuracy of this method of gaging is apparent. An inspector can pass on seven hundred and fifty ¼-inch taps per hour, both as regards angle and outside diameter, using, of course, two limit gages of this style. For ordinary screw work requiring less accuracy, he could pass on even a greater number.

As regards the lead of taps, it must be remembered that all steel will change somewhat in length in hardening; hence the lead of taps will vary somewhat from the standard. If in addition to this the hardened tap is warped on the threaded end, the condition of the tapped hole will be as indicated in Fig. 6.

We have now seen the effects that errors in lead, angle, angle diameter and warping in hardening will have on the taps. Add to this the effect of usage, reducing the size of the tap by wear, and then add the commercial variation in the lead, angle and diameter in screws and bolts, and it will be readily seen that under the best possible conditions, there will be a multiplicity of minute errors that must be taken care of by an allowance between the minimum limit of the tap and the maximum limit of the screw. There must also be a maximum limit for the tap and minimum limit for the screw in order to prevent too much looseness in the fit of the threads. There is at the present time a great diversity of opinion among tap and die makers, as well as among screw makers in general, as to what these allowances should be for the regular U. S. standard sizes, and hence the buyer of taps and screws is working under a serious difficulty in his efforts to obtain proper fits and interchangeable work. The standard adopted by the American Society of Mechanical Engineers for machine screws has been of great value, but the question of limits for the larger sizes of screw threads is still unsettled.

When a tap breaks or anything goes wrong in connection

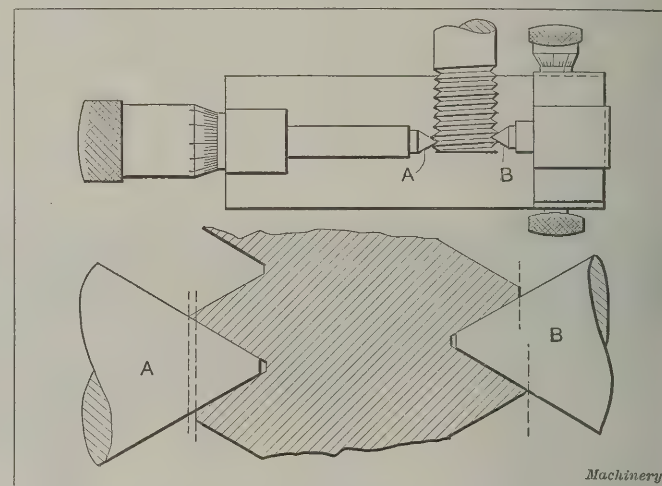


Fig. 2. Device for Measuring Angle Diameter, and Enlarged View showing its Application

with its work, it is probably the most natural thing in the world to blame the tap maker. In many cases, however, the trouble is due entirely to the condition under which the tap is working. In order to determine some of the practical questions in this connection, such as the proper sizes of tap drills, the best lubricants, the correct cutting angles and shapes of the flutes, the right number of threads among which the cutting should be distributed, the best method of hardening to increase the life and strength of the taps and to prevent undue distortion and shrinkage, the proper way to grind cutting edges, etc., the Wells Bros. Co., of Greenfield, Mass., built special testing machines showing the power required to drive any tap. A record of the cutting action was taken on indicator cards or charts.

Tap manufacturers often find that users of taps actually punch or drill the holes to be tapped of a smaller diameter than the root diameter of the thread, so that the end of the

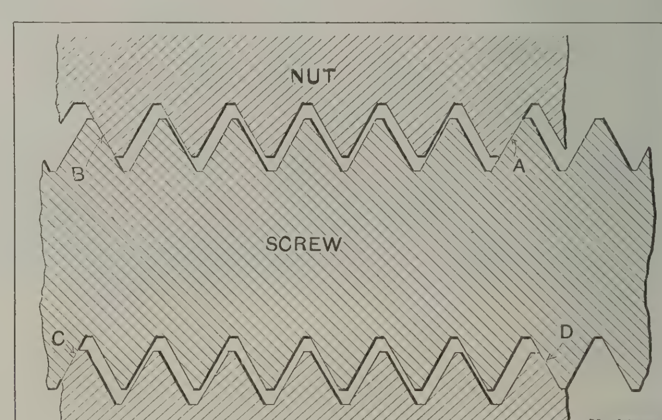
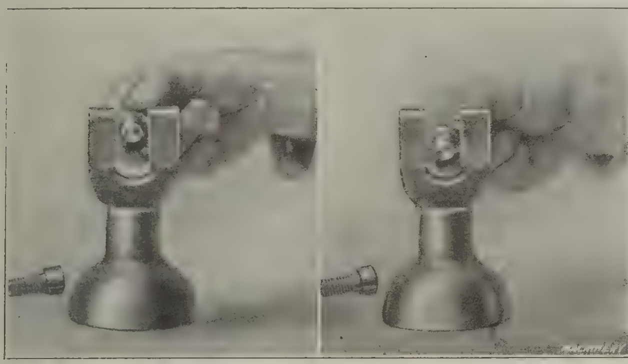


Fig. 3. Effect of Difference in Lead of Screw and Nut

tap must act as a reamer before the thread can be cut. In Fig. 7 are shown sections of such nuts through which taps have passed. In this case the tap becomes a taper reamer, reaming a tapering entrance to the hole, as shown in the nuts at the top. Frequently the tap will refuse to "catch the thread" at all and will ream clear through the nut. Should the thread happen to "catch" after reaming part way, however, a short, weak thread results, as indicated by the two nuts at the right in the lower part of the illustration. This condition evidently requires considerable power, and explains why taps frequently break as soon as they begin to cut. When it is remembered that generally not more than 80 per cent of the

standard thread depth is necessary in ordinary manufacturing work, and that in many cases not more than 50 per cent is required, it is apparent how useless it is to have the holes too small, and, in most cases, to even attempt to secure a full thread.

Tap drill sizes for machine screws, in particular, should be varied according to the material to be tapped and the depth of the tapped hole. In general, for holes where the screws enter more than one and one-half times the diameter, one-half of the full thread is usually sufficient. Soft, tough materials, such as copper, Norway iron, drawn aluminum, etc., should have a larger hole for the tap than the hard, crystalline materials, such as cast metals. The reason for this is that otherwise the taps of the threads of the softer materials will



Figs. 4 and 5. Limit Gage for Screw-thread Diameters, and its Use

be torn off, thus actually decreasing the effective depth of the thread of the tapped hole as compared to what it would be had the hole originally been drilled larger. On the other hand, if the hole is originally drilled large, the tap will, when cutting tenacious materials, especially after the keen edge has been slightly dulled by use, reduce the size of the hole by drawing the metal at the top of the thread, thereby increasing

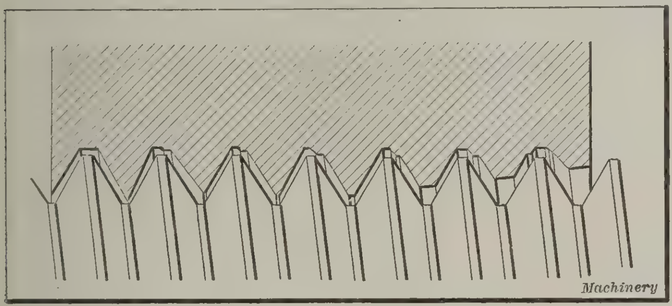


Fig. 6. Thread resulting from Tapping with a Warped Tap

the depth of the threads. It should also be remembered that it is impracticable to tap a hole with the basic root diameter size, unless serial taps or taps with long steps are used, so as to divide the work into a series of successive operations.

The size of the hole also affects very materially the power required for tapping. This is particularly important in machine tapping. The power is also affected by the kind of lubricant

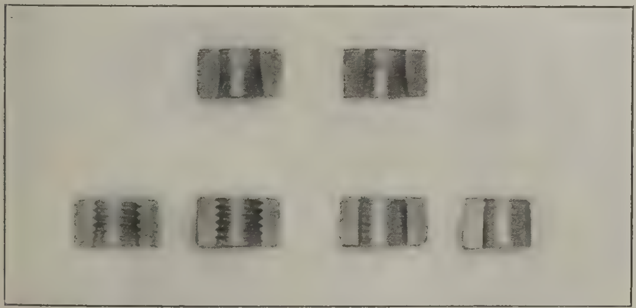


Fig. 7. Nuts, having too Small Tap Holes, reamed by End of Tap

used, by the condition of the tap as regards being sharp or dull, by the shape of the cutting edges and their effect on the shape of the chip, and by the shape of the flutes. In Fig. 8 are shown three taps with different kinds of flutes. The tap in the middle (having what is called a "hook" flute) produces a long, curling chip which in a deep hole will have sufficient length to curl up tightly, jam the tap and cause it to break off if there is sufficient driving power. The chips from this tap are shown in Fig. 9. In Fig. 10 are shown two nuts in which these long curled chips have rolled up and broken the tap. The end of the broken tap is also shown.

The tap shown to the right in Fig. 8 does not cut properly, but pushes the metal ahead of it, often accumulating so much compressed metal as to resist further compression, which

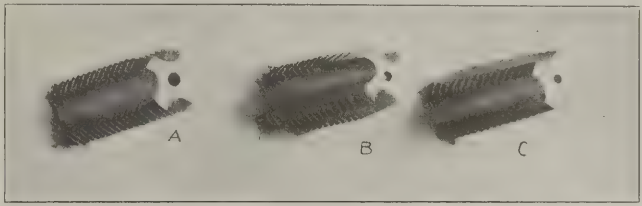


Fig. 8. Taps with Different Flutes having Different Cutting Action

causes the tap to break. This tap broke while tapping cold punched nuts, twisting off near the shank at a strain of 1100 inch-pounds. The work was divided between 48 cutting teeth. The chips made by this tap are shown in Fig. 12. They are compressed in character and show by their appearance the relatively large amount of power required for tapping. In Fig. 13 are shown sections of four nuts tapped with the type of taps mentioned, and which broke while being tapped.

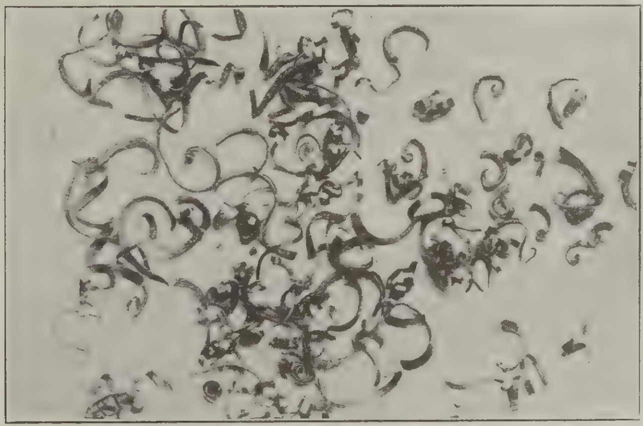


Fig. 9. Chips produced by Tap B, Fig. 8

The compressed mass of metal still adhering to the thread should be noted.

The tap shown to the left in Fig. 8 is properly made. It produces a slightly curling chip, which breaks up into short lengths and easily slides out through the flutes. This tap requires only about one-third of the power of the tap to the right. The chips cut by this tap are shown in Fig. 14. Fig. 11 shows a section of a nut in which this last style of tap was

Fig. 10. Nut tapped by Tap B, Fig. 8, and Part of Broken Tap

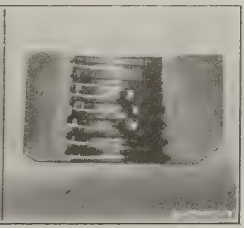


Fig. 11. Nut tapped by Tap A, Fig. 8

started, and the nut was then cut open to show the action of the chip. The smooth thread and the clean, short chips just at the point of breaking should be noted.

As almost all machine tapping is in through-holes, and bottoming taps are seldom used, experiments have been made to determine the effects of sharpening or grinding the taps back from the end for a varying number of threads, so as to ascertain the effect of dividing the work between a greater or smaller number of cutting teeth. By repeated tests and careful records it has been found that it requires approximately 25 per cent more power to drive a tap which has been ground back only four threads (which in a four-fluted tap divides the work between 16 teeth) than for one which has been ground back six threads (thus having 24 cutting teeth); the latter

tap produced a much smoother thread and cut more closely to size.

Chattering in tapping is often due to burrs thrown up on the cutting edges of the tap during its manufacture, and it is very necessary that the taps be free from burrs. Considerable attention should be paid to this point in order to produce good taps.

TABLE I. POWER IN INCH-POUNDS, REQUIRED FOR TAPPING VARIOUS MATERIALS

Taps, ½ inch, U. S. S. Tap drill hole, 0 420 inch. Depth of tapped hole, ½ inch

Material	Test Numbers of Taps													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hexagon drawn brass	60 65	62 60	62 65	60 60	65 65	70 80	60 60	90 95	60 62	60 60	60 60	60 62	60 65	65 65
Crucible tool steel	220 225	242 265	250 268	230 250	240 230	280 260	250 235	375 380	210 205	270 280	260 275	270 260	260 260	258 270
Cold punched hexagon steel nuts	148 130	158 130	168 175	170 190	155 160	150 180	150 132	340 360	165 140	195 160	165 225	175 200	148 180	180 180
Hexagon screw stock	140 160	150 170	165 185	188 165	178 210	180 268	155 170	250 430	140 155	240 190	235 200	168 160	225 205	230 205
Drawn hexagon phosphor-bronze	210 190	175 200	250 300	200 250	230 200	240 250	170 182	338 320	160 190	200 330	220 210	222 245	265 205	210 210

TABLE II. EFFECT OF VARIOUS LUBRICANTS AND DIFFERENT DIAMETERS OF TAP DRILL HOLE

By multiplying the percentages given by 10, the actual average power required for tapping in inch-pounds, may be obtained.

	Lubricant	Animal Lard Oil	Sperm Oil	Graphite, 10 per cent; Tallow, 90 per cent	Cataract Soap Compound	Mineral Lard Oil	None (Tapping Dry)	Machine Oil
0.425 Diam. Tap Hole (75 % Thread)	Power required*	15.9	16.5	16.9	18.9	19.9	29.9	34.2
	Breakages in tests†	None	None	None	None	None	14	15
	Quality of thread	Smooth	Smooth	Smooth	Smooth	Smooth	Rough	Torn
0.410 Diam. Tap Hole (90 % Thread)	Power required*	....	23	....	25.1	36.5	60.2	62.5
	Breakages in tests†	....	None	....	None	None	50	71.5
	Quality of thread	....	Smooth	....	Smooth	Smooth	Rough	Badly torn
0.400 Diam. Tap Hole (Full Thread)	Power required*	....	35.5	....	41	57.5	71.8	100
	Breakages in tests†	....	None	....	None	None	66	100
	Quality of thread	....	Smooth, Taps torn	....	Slightly Rough, Taps torn	Smooth, Taps torn	Torn, partly stripped	Torn, Chips wedged

* In per cent of breaking strength of tap. † In per cent.

The power required for tapping different materials is shown in Table I. This table gives the results found from tapping five different materials with fourteen different taps. The maximum and minimum power required by each tap when tapping consecutive test pieces is given in inch-pounds. The taps Nos. 6 and 8 had a slightly poorer form of flute than the rest and did not cut as smoothly nor as easily. Table II shows the effects of variations in the tap drill sizes as well as the effect of different lubricants. In this chart, which is the final result of a long series of tests, it is assumed, for comparative purposes, that the breaking strength is 100, and the strain produced by tapping holes under different conditions is given as a percentage of this. The power required to break a properly made ½-inch, 13 threads per inch, U. S. S. tap, is approximately 1000 inch-pounds; hence by multiplying the percentage given in the table by 10, the actual average power required, in inch-pounds, may be obtained. The test pieces were common hexagon cold punched nuts, accurately reamed to the respective sizes of holes, the taps being regular taps taken from the stock-room.

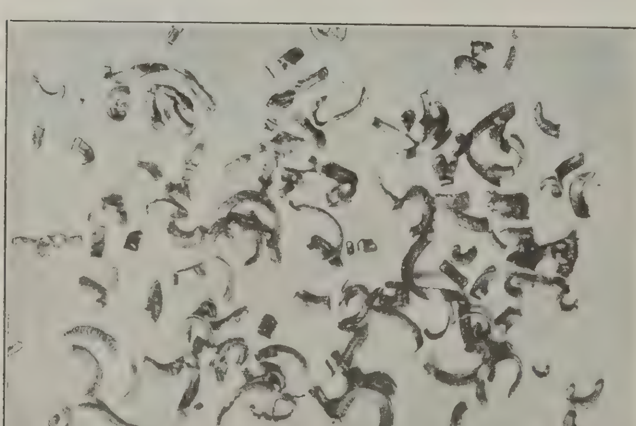


Fig. 12. Chips produced by Tap C, Fig. 8

The points brought out by this series of tests were:

1.—The lubricants used, up to a certain point, have the same effect on the power required for cutting as if more or less metal were to be removed; for instance, to tap a one-half inch nut having a hole of 0.425 inch diameter, using machine oil instead of sperm oil, would have practically the same effect on the power required as if the diameter of the hole to be tapped were reduced 25 per cent of the total depth of the thread. It will be seen in the table that the power is approximately doubled in both cases. When changing from sperm oil, the increase is from 16.5 per cent to 34.2 per cent while when changing from 0.425 inch to 0.400 inch tap drill the increase is from 16.5 per cent to 35.5 per cent.

2.—Animal lard oil, sperm oil, and graphite and tallow mixture are the best lubricants of those tested.

3.—A good soap compound is better than mineral lard oil for tapping.

4.—Machine oil is a detriment instead of an advantage. Taps cut better dry than with this lubricant.

5.—The breakage of taps is greatly reduced by the using of a proper lubricant. Taps should never be used without a lubricant when tapping steel.

6.—The diameter of the tap drill hole should not be smaller than is absolutely necessary to give the required strength. If for any particular purpose the full depth of the thread is required, it would be advisable from a tapping standpoint to gain strength by using a larger size thread instead.

7.—If for any reason it is necessary to produce a thread of full depth, serial taps should be used, with the best lubricant obtainable.

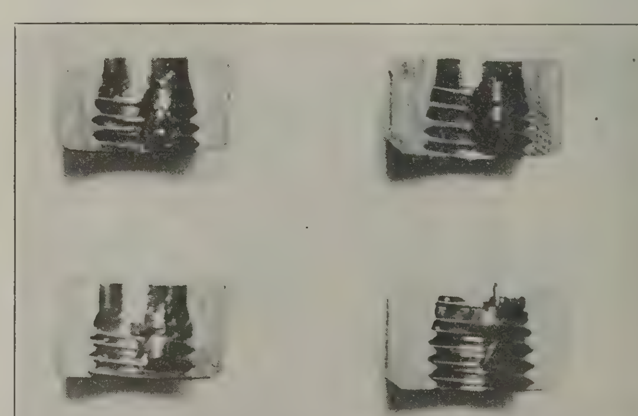


Fig. 13. Nuts tapped by Tap C, Fig. 8

8.—Every decrease of even one-thousandth inch in the diameter of the tap drill hole materially increases the power required for tapping and also the percentage of broken taps.

Referring to the sperm oil column in Table II, it will be

seen that the decrease of 0.015 inch in diameter from 0.425 to 0.410 inch, required only 6.5 per cent additional power, or 65 additional inch-pounds. This is an average of a little over 4 inch-pounds per 0.001 inch. A decrease in the tap-hole size of 0.010 inch, from 0.410 to 0.400 inch, required 125 additional inch-pounds of power, or an average of 12.5 inch-pounds per each thousandth inch.

Discussion of the Paper

In the discussion that followed the reading of the paper abstracted in the foregoing, several interesting points relating to the inspection and use of taps were brought out. Mr. A. A. Fuller spoke of the relation between errors in lead and angle diameter, and presented diagrams showing how limits can be established that take into account the combined effect of these errors. The principle involved was the same as that explained in MACHINERY, July, 1907, in an article entitled "Remarks on the Making of Hand Taps," but Mr. Fuller's method was a refinement of this, and the definite limits established were indicated. It was pointed out that the shorter the hole, the greater could be the allowable error in the lead; but as it is more difficult to tap a long hole with a minimum error than a short hole, it is best, in practice, to adhere to an allowable error per inch in the lead and to compensate for that error by varying the angle diameter. The increase in diameter, for one inch depth of hole and 60-degree thread, should equal the error in lead divided by 0.58. If the depth of the hole is less or more than one inch, it is only necessary to correct the

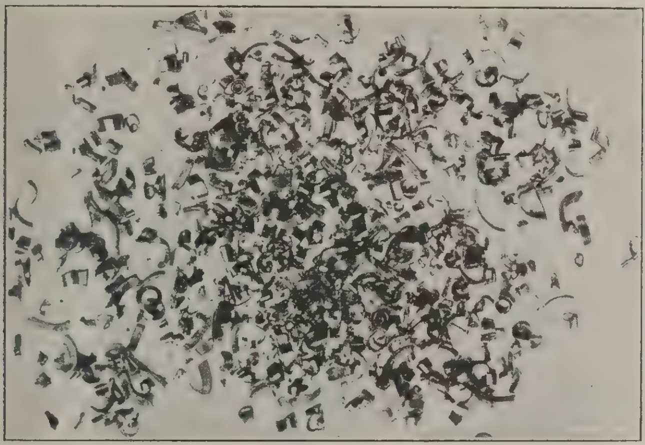


Fig. 14. Chips Produced by Tap A, Fig. 8

diameter in proportion. The error in lead, however, is more objectionable than the error in angle diameter, on account of the lack of bearing which the former produces.

Mr. L. D. Burlingame presented a paper the object of which was to arouse the engineering societies and the manufacturers to the needs for a fine screw thread standard with U. S. S. threads, similar to that adopted by the Engineering Standards Committee of Great Britain, for Whitworth screw threads. (See MACHINERY, October, 1906, "British Standard Fine Screw Thread.") A comparative table of different screw thread standards was also presented. Mr. George W. Adams called attention to the need of education among foremen and machinists relative to the measuring of screw and tap threads. He thought that the tap manufacturers could do a great deal in this respect by giving a greater amount of useful information in their catalogues, and he said that he believed that they would find it to their own advantage to do so, as it would lessen the number of complaints of their products, many of which are due simply to ignorance on the part of the user.

Mr. C. B. Russell stated that in order to determine the progress of the adoption of the U. S. standard thread as compared with the sharp V-thread, he had looked up the sales of the Wiley & Russell Mfg. Co., Greenfield, Mass., and had found that 93 per cent of all tapper taps sold were of U. S. standard, as compared with 7 per cent of the V-form. Of hand taps, however, 50 per cent are still of the V-form.

With respect to lubrication, Mr. J. E. Winter mentioned that in threading steel pipe, cottonseed oil gives even better results than lard oil. The only objection to this oil is that it tends to "gum up" the machines, but it can easily be cleaned off by kerosene oil. Cottonseed oil is much cheaper than lard oil. Mr. G. Pickop mentioned that grape-seed oil has about the same efficiency as lard oil, and is extensively used as a threading lubricant.

Mr. F. O. Wells stated that when new an ordinary commercial tap has an average factor of safety of 2. He also called attention to the influence of lubrication on the size of the hole tapped or screw cut. If a screw is cut with a die using lard oil as a lubricant, the size sometimes will be from 0.007 to 0.008 inch smaller than when a soap compound is used as the lubricant.

* * *

DON'TS FOR GEAR-HOBBERS

By A. E. BOWYER-LOWE*

Don't forget to keep your hobs sharp.

Don't forget to put the key in the hob.

Don't forget to put the covers on the gears.

Don't start the cut before the pump is working.

Don't expect a fine finish if you crowd the feed.

Don't mesh the dividing or feed gears in too tightly.

Don't forget to give the table-driving worm plenty of oil.

Don't forget to pack up the blank on as large a diameter as possible.

Don't bush a large gear to fit a small mandrel; make a large mandrel.

Don't forget to see that the blank runs true before you start cutting.

Don't try to cut a spiral gear without first keying the job to the mandrel.

Don't forget to pull the machine around by hand before starting a new job.

Don't take the numbers stamped on the change gears for granted; count the teeth.

Don't try to hob a wormwheel, without first clamping the hob carriage to the column.

Don't forget to look now and again at the wire rope holding the hob carriage balance weight.

Don't omit to center a tooth of the hob; it doesn't take long, and if it does no good it certainly does no harm.

Don't try to hob steep angle spirals without knocking off the partial teeth at the leading end of the hob.

Don't forget to use both ends of the hob, in addition to the center; it saves a lot of grinding, and the hobs last longer.

Don't set the feed knock-off when hobbing spiral gears, without being at hand to stop the machine as soon as it operates.

* * *

As an example of the effect upon production, and the consequent financial results, of the use of automatic machinery, under efficient management, I cannot refrain from mentioning the Singer Sewing Machine Co., where I have reason to believe that the application of automatic machinery has reached one of the highest marks in this country. It is a recognized fact that automatic machinery, under efficient management, has been the chief cause of the tremendous financial success of this company. The original investment of this company was only $600,000. It has declared a stock dividend of $75,000,000. It has paid $440,000,000 in dividends to its stockholders, and is now paying 12 per cent dividends on a capitalization of $100,000,000. The figures are those of Mr. Robert Hearne in a statement before the Senate finance committee on the Underwood steel bill at a hearing in Washington a couple of weeks ago. Mr. Hearne also claimed in this connection that in spite of the fact that labor is about 40 per cent cheaper in Europe than in the United States, sewing machines can be and are manufactured cheaper in the United States than abroad, a fact which can be attributed largely to the use of automatic machinery, superiority of American workmanship and that American labor is more experienced and better equipped. As a proof of his statement, he pointed to the fact that the United States exports annually $9,000,000 worth of sewing machines, meeting foreign competition in its home markets.—*From an address by A. L. Valentine on "Comparison Between Industrial Conditions in the United States and Europe," before the American Society of Swedish Engineers.*

* Address: Veloce, Norton Way, Letchworth, Herts, England.

THE CARE AND REPAIR OF HYDRAULIC JACKS*

By ARTHUR J. HUMPHREY†

Many mechanics who use hydraulic jacks are unfamiliar with their construction and the methods employed in the repairing of them. Hydraulic jacks are manufactured in a variety of types and sizes, but they are all fundamentally of the same construction. For the purpose of illustration in this article, I have selected a vertical single inside pumping type of jack. More recent types of jacks are on the market, some having double pumps for light or heavy duty, but there are probably in use to-day more jacks of the type chosen than of any

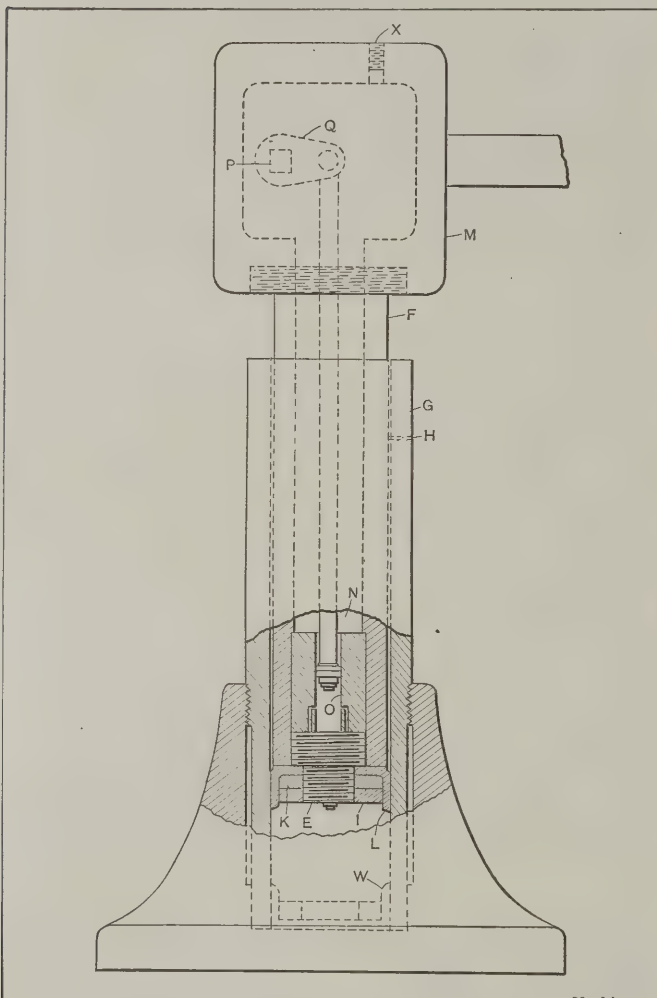


Fig. 1. Elevation of a Vertical Single Inside Pumping Type of Jack

other, and as the principle upon which all types of jacks work is the same, the following description will apply generally.

In the type of hydraulic jack illustrated in Fig. 1, the head and interior tube or ram form a reservoir in which the liquid flows to the pump. From the pump the liquid is forced by the downward stroke of the piston past the lower valve into the cylinder, and as the latter is closed at the bottom, the ram rises to allow space for the liquid. When lowering, the lower valve *A*, Fig. 2, is pressed from its seat by the end of the piston rod, and the liquid returns to the upper part of the jack by passing around the piston through small port-holes *B*.

To illustrate the proper procedure to follow in repairing a hydraulic jack, suppose that a jack has been reported as failing to work. Now the jack may fail in a number of ways and from various reasons, and the nature of the failure may indicate the location of the trouble and how to remedy it. For instance, there may not be any liquid in the jack, in which case the jack will certainly not work. To remedy this, it is only necessary to fill the jack with liquid, provided it has not been emptied long enough to dry out the leather packing on piston and ram. If the jack raises the load, but will not lower it, the bottom valve *A* is probably too short, so that the piston when clear down will not force the valve from its seat. To remedy this a longer valve is inserted, or if there is no valve available and it is necessary to use the jack before one can be secured, a small amount of solder may be dropped on the end of the valve to lengthen it. However, this is not recommended, and should only be used as a makeshift.

If the jack lifts, but will not hold a load, it is evident that the liquid, after being forced into the cylinder, must be leaking out again. By observing the jack while under pressure, and noting whether the liquid leaks around the bottom or over the top of cylinder *G*, we can determine which particular packing leather needs renewing. If no leak appears at these points, the liquid must be slowly leaking to the top of the jack through the ram valve *A*, piston valve *C* or around the piston packing *D*.

The valve seats and piston packing if only slightly cut will allow a light load to be raised quickly, but as the liquid leaks out the ram will slowly drop down again. Of course, if the seats are cut considerably, the jacks will not raise or lower at all. It is sometimes found that pieces of grit or dirt lodge on the valve seats, or the valves stick to their seats and prevent the jack from working. By giving the jack lever a firm quick jerk up and down, the dirt may be dislodged and the valve released. If when pumping or under pressure the lever rises

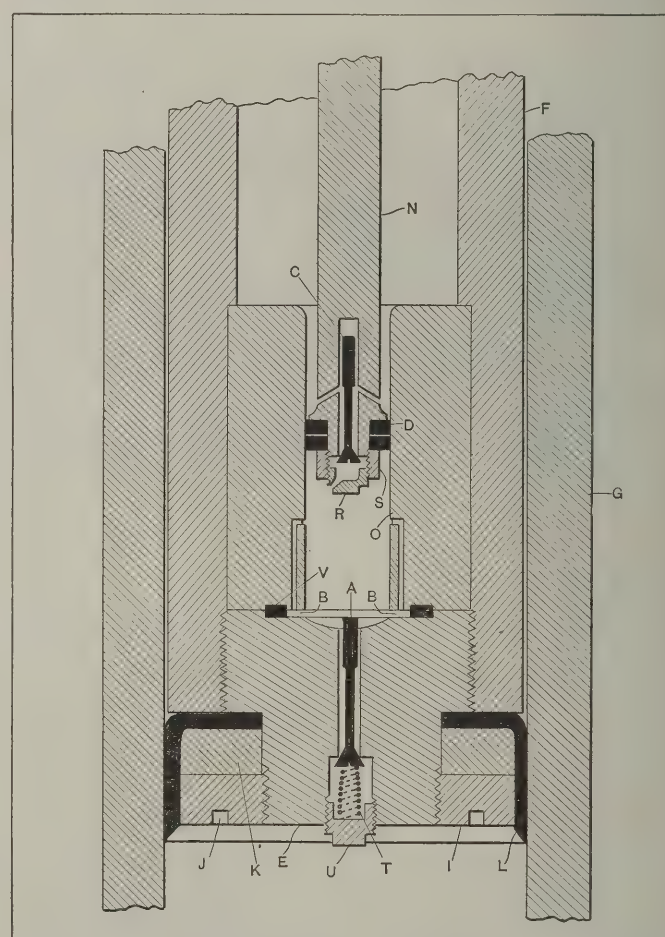


Fig. 2. View of the Principal Working Parts of the Jack shown in Fig. 1

when the hand is removed, there is something under the ram valve *A*, or the seat is cut so that the liquid returning through the pump plug *E* communicates pressure to the piston, raising it to the top of its stroke. Probably the most common jack failure is that of not raising the load due to leakage in the valves or looseness in the pump packing. Assuming that such is the case and that it is necessary to overhaul the jack, proceed as follows:

Referring to Fig. 1, remove the ram *F* from the cylinder *G* by pumping it up as far as possible and lifting it out of the cylinder. If the ram is too heavy, or the packing too tight to permit this, the ram may be entirely removed by driving a wooden plug into the small vent hole *H* in the side of the

* For additional information on hydraulic jacks and kindred subjects, see the following articles previously published in MACHINERY: "Dudgeon 'Universal' Hydraulic Jack," March, 1910; "Notes on the Manufacture of Hydraulic Machinery Gathered in the Shops of the Watson-Stillman Co.," October, 1899.

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cylinder. This vent hole limits the travel of the ram, so that when it is plugged and sufficient water is poured into the reservoir to entirely fill the cylinder, the ram can be removed. If it should so happen that the ram cannot be pumped out, it may be necessary to pull it out with a crane, or force it out with a long lever. The jack lever should be pressed down before attempting to do this.

Let the liquid stay in the jack cylinder for the present, and grip the ram in a vise, taking care not to mar it. Unscrew the nut I (see Fig. 2) with a spanner fitting in the holes J and remove the ring K and the ram packing L. Now unscrew from the ram the pump plug E, and the head M, Fig. 1. The pump piston N may now be withdrawn from the pump cylinder O. If it is desired to inspect the socket packing, this may be done by loosening the set-screw and withdrawing the socket P from the arm Q. To renew the packing, cut a washer from sole leather, making the inside of the diameter slightly smaller than the socket, and the outside diameter the same as the recess. After inserting the new packing washer, remove all small pieces of leather which have been cut off from the washer, then drive the socket in place again through the ram and tighten the set-screw.

To examine the pump cylinder O to see if it is cut, drive it out with a wooden plug. If the cylinder is badly worn it

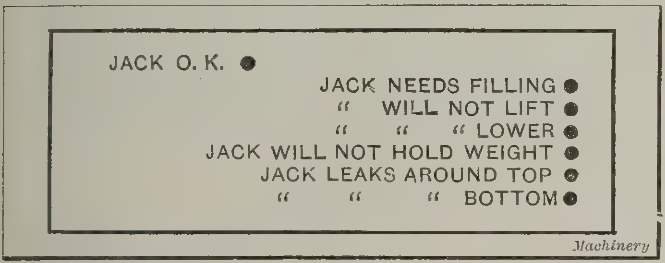


Fig. 3. Repair Report Nameplate fastened on Each Jack in Use

should be trued by reaming. Then force the cylinder over the piston and note if the piston packing is a tight fit in the cylinder. Sometimes it will be found that the piston packing is tight at the ends of the cylinder but quite loose in the middle, indicating that the cylinder has become worn where most of the travel is. If this is found to be the case, it is necessary to ream the cylinder and straighten it up, removing as little material as possible and using oil as a lubricant. After enlarging the cylinder, the piston packing must be renewed. To do this remove the brass valve bonnet R, piston packing ring S, piston packing D and valve C. Now insert a new packing leather washer on the piston, then a cup packing leather, with the cupped side facing bottom of jack; then screw up piston packing ring fairly tight, and fit the packing in the cylinder with a clean file.

Proceeding with the inspection, examine the valve C and its seat; the latter will usually be found to be all right, but if the seat is deeply cut, it should be "reset," with a set having an included angle the same as that on the valve. If the valve is much worn a new one should be put in. An old valve may be fitted, by carefully filing and then grinding it into the seat with oil and flour emery. If the ram packing L has become worn and the liquid has been leaking over the top of the cylinder or through the vent hole, place a strip of thin tin around ring K. After ascertaining that all the port holes, etc., are free from dirt and grit, assemble the ram by replacing the head, piston and then the cylinder. Before replacing the pump plug E, inspect the leather washer V to see that it makes a tight joint between the plug and cylinder. If it does not fit tightly, a new one should be inserted. Examine valve A and its seat and grind them if necessary. After the plug E is in place, the valve A should be inserted and tested, to see whether it will release the jack or not. To ascertain this, press the valve to the seat and force the piston down to the bottom of the cylinder, at the same time observing if the valve is pressed from its seat—a space of 1/8 inch is sufficient; then replace spring T, bonnet U, ram packing L, ring K and nut I, and empty the liquid from the cylinder G.

The bottom packing W, Fig. 1, seldom gives trouble, but if it should become necessary to renew it, remove the old packing and drive the new packing and ring in from the upper end of the cylinder by means of a wooden plug, which is slightly smaller than the cylinder bore. If the cylinder is badly cut and it is impossible to renew it, it can be repaired by reboring it and then forcing in a cold-drawn tube lining of the proper size.

After washing out the cylinder, wipe and oil it and then insert the ram. A handy appliance to assist in starting the packing into the cylinder, is a clamp made of thin sheet iron. This clamp encircles the packing and the ends are turned outward to receive a small bolt for tightening it. After pressing the jack lever down in order to open the valve so that the air may escape, push the ram down and strain the liquid into the jack through the filling and air plug X. The liquid recommended for use in hydraulic jacks is as follows: To one part of grain alcohol add two parts of water. This liquid is probably the best as it does not freeze in cold weather, corrode the pump, gum and clog the valve, and has not a deteriorating effect on the leather packing. Never fill a jack without straining the liquid.

After a jack has been overhauled, it is advisable to put it under pressure and let it remain so for a few hours. This will test the jack and set up the packing. If the jack has been fitted with new packing, it is well to let it remain over night before using it in order that the leather may be thoroughly soaked. If the repair has been handled in the proper manner the jack will give good service. It is essential, however, to keep it in good order, and without this precaution it is useless to expect satisfactory service from it. Most of the trouble met with in using hydraulic jacks is caused by neglect—allowing rust or foreign substances to collect, or broken and dried-up packing to remain; another precaution is not to overload the jack. The ram should be down when the jack is filled to prevent using more liquid than the reservoir will hold. If a jack is full when the ram is run out, and the cylinder under the ram is also full, it would be possible to burst the reservoir if the ram was lowered while under load and the air-hole in the reservoir had become plugged.

Always keep the ram quite down within the cylinder when not in use, otherwise the piston and ram packing may be out of the water and so become dry. For the same reason do not jack a load up to the full extent and let it remain so for several days, rather block under the load and remove the jack. Do not push the operating lever down too quickly, nor check the lowering of the load suddenly, especially under a heavy load. The sudden checking of a heavy load traveling at a high momentum, is likely to swell the cylinder to a permanent set, which will ruin it. To lower the weight, push the lever to the bottom of the stroke, then take it out and turn it with the projection upward, and with a slight pressure of the hand, the weight may be lowered as slowly as required and stopped at any point.

In large shops and round-houses where a number of hydraulic jacks are in constant use, the repairs may be made much more quickly by adopting the following system: A brass plate, Fig. 3, similar to a nameplate is attached to each jack, say on the outside of the cylinder, and a number of small holes drilled and tapped as shown, and provided with a thumb-screw to fit the hole. When the jack is sent in for immediate repair, whoever has condemned the jack, should remove the screw from the hole opposite "Jack O. K." and place it in the proper hole, designating why the jack has been sent in for repairs. Each jack is numbered and a record is kept by the man in charge of repairs; then by noting in which hole of the plate the thumb-screw has been placed, and by referring to the record book to see what repairs were made in the past, it is possible to determine very quickly just what must be done to make the jack fit for service as soon as possible. After the jack is repaired, the thumb-screw is placed in the "Jack O. K." hole again. Of course a printed report blank or card sent in with the jack would answer the same purpose as this plate, but it is difficult to get the mechanics using the jack to take the time and trouble to fill out the blank, and the thumb-screw is much handier. The plate may be cast or cut out of sheet brass and stenciled, or a printed card may be pasted on it and covered with white shellac.

NARROW VS. WIDE GUIDES FOR MACHINE TOOLS

In the January number of MACHINERY, Mr. J. S. Detrick, of the Detrick & Harvey Machine Co., explains why his firm has adopted the narrow guide for machine tools in preference to the wide, and gives the readers to understand that by reducing the ratio between the length of the guide and the width it was found that cross-winding was considerably reduced.

Theoretical considerations of the problem indicate, however, that the width of the guide has no vital influence upon the amount of cross-winding which can take place, but that the length of the guide has. This is explained in the following treatment of the case. Let $L =$ the length of the guide; $B =$ the width of the guide; and $db =$ the amount of play between the surfaces of the guide and those of the sliding part.

These conditions are indicated in the accompanying diagram in which the amount of slack or play is shown considerably exaggerated. The angle α is the angle of cross-winding of the sliding part on the guide, this angle being formed by the diagonal of the sliding part in two positions, namely, the intermediate or normal position and one of the extreme positions. Let

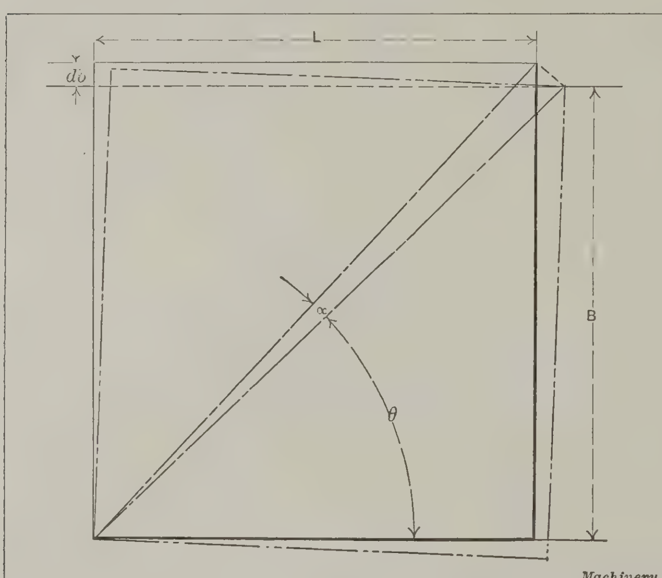


Fig. 1. Showing that the Angular Displacement for Given Clearance is nearly the Same on Wide and Narrow Guides

the length of this diagonal be denoted by x. Then, from an inspection of the diagram, it will be seen that

$$\frac{B + d\,b}{x} = \sin(\theta + \alpha) = \sin\alpha\cos\theta + \cos\alpha\sin\theta$$

Now, $\sin\theta = \dfrac{B}{x}$; $\cos\theta = \dfrac{L}{x}$ (practically); $\sin\alpha = \alpha$ (practically) because α is very small; and $\cos\alpha =$ unity for the same reason. Hence,

$$\frac{B}{x} + \frac{d\,b}{x} = \alpha \times \frac{L}{x} + 1 \times \frac{B}{x};\ \text{therefore}$$

$$d\,b = \alpha \times L,\ \text{and}$$

$$\alpha = \frac{d\,b}{L} = \frac{\text{amount of slack}}{\text{length of guide}}$$

This shows that the amount of cross-winding is inversely proportional to the length of the guide or slide, always assuming, of course, that the amount of slack or play is a very small quantity, and that the width-dimension is not a factor in this connection.

This conclusion is opposed diametrically to the conclusion Mr. Detrick arrived at as the result of practical considerations, and it would be very difficult indeed to explain the difference between them. One explanation which has occurred to the present writer is that it is much easier to machine narrow guides which are reliable and parallel than it is to machine wide guides possessing the same qualities. This appears, however, to be a point which requires the results of a series of reliable experiments for its satisfactory elucidation.

Sheffield, England GEORGE W. BURLEY

[Although it is true that the angle of deflection due to cross-winding is the same with wide and narrow guides, other conditions being the same, the lateral pressure on the sides of the guide and slide is greater on a wide guide than on a narrow guide for any given eccentric load. Referring to the diagram,

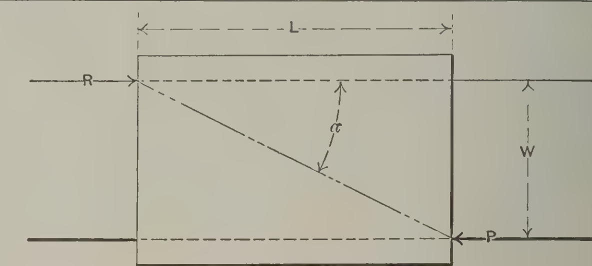


Fig. 2

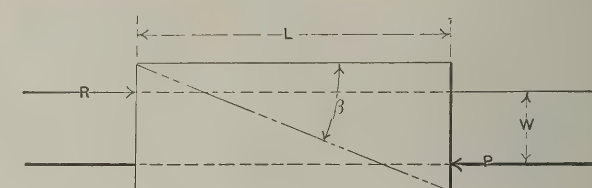


Fig. 3

Figs. 2 and 3. Showing that Lateral Friction and Wear are Greater on Wide Guides than on Narrow Ones

Fig. 2, suppose an extreme case in which the pressure required to move the slide is applied at one corner directly over the edge of the guide and the resistance to movement is all at the diagonally opposite corner, as shown at P and R. Then the turning moment is $\dfrac{P \times W}{L} = P \tan\alpha$. In the case of the narrow guide, Fig. 3, it is apparent that $P \tan\beta$ will be less than $P \tan\alpha$. Hence the greater angle α is, the greater will be the lateral pressure, approaching infinity as W becomes very wide or L very short. Therefore friction and wear are greater on wide guides than narrow ones.—EDITOR.]

POWER REQUIRED TO DRIVE REAMERS

Recently we wrote to three manufacturers of reamers and one of our prominent colleges asking if they had ever made tests to determine the difference in power consumed as between three-groove spiral chucking reamers and four- or six-lip parallel reamers. None of them had made tests or knew of any results to which they could refer us.

With so much being written on efficiency and economy in manufacturing, is it not rather curious that there should be no data on this subject?

The writer has used both kinds of reamers, and knows there is a great difference in the amount of power required to drive these reamers. The feed and speed that can be used with spiral reamers is much greater than with parallel reamers and much less care is required for the belts. In fact we can almost feel safe in saying that the saving is fifty per cent. We can get all the data necessary as to rake, clearance, etc., on lathe or planer tools, also on drills. We can get the horsepower consumed driving these tools with these various clearances and angles, but who can tell us the difference in horsepower consumed as between three-groove spiral chucking reamers and four- to six-lip parallel reamers?

Auburn, N. Y. A. A. BERTRAND

DEVICE FOR TESTING AND MEASURING GEARS

The device shown in Fig. 1 has been used for several years with very satisfactory results. Differences in diameter and eccentricity of 0.01 millimeter (0.00039 inch) can be measured by it, and the exact meshing of a couple of gears can be accurately tested. On the cast-iron base are fitted two slides, each being provided with a spindle to hold the gears to be tested. The slide to the right is moved by means of a long adjusting screw; the one to the left has only a very limited adjustment, but transfers its motion, greatly magnified, to an index placed on the front side of the base. Fig. 2 is a longitudinal section of the device; it clearly shows how the motion is transferred to the index, which measures the differences in eccentricity and the errors in mesh with great accuracy. To detect differences in eccentricity, it is most convenient to place the gear to be tested on one spindle, and to use a blank with a single tooth on the other. This tooth is meshed in succession with all the teeth of the gear under test, and by observing the different positions of the index while each tooth is measured, the eccentricity may be determined with great accuracy.

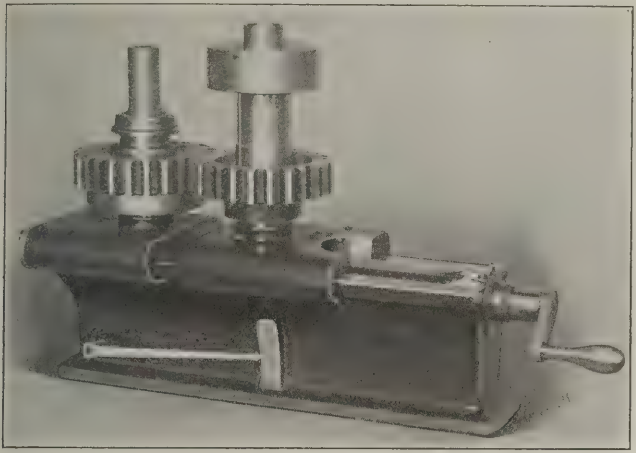


Fig. 1. Device for Testing Gears

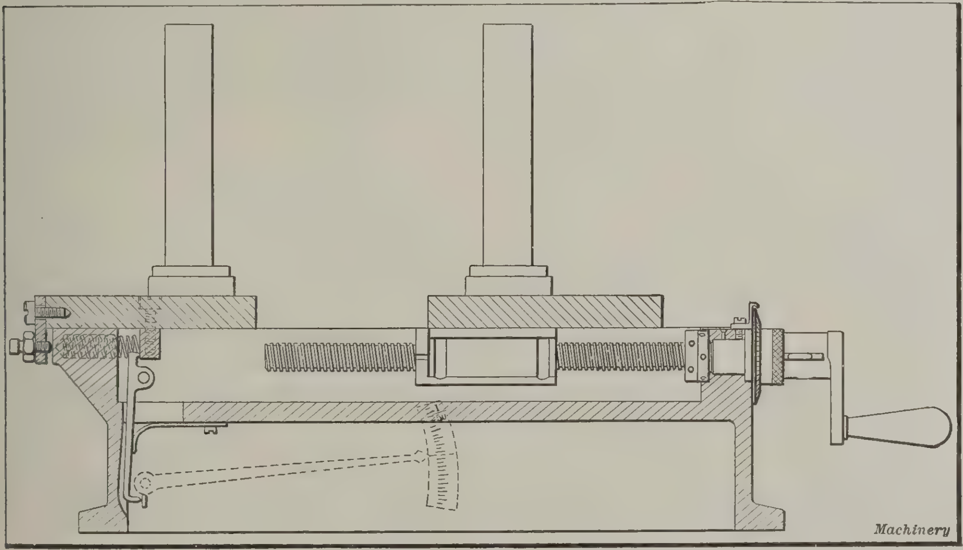


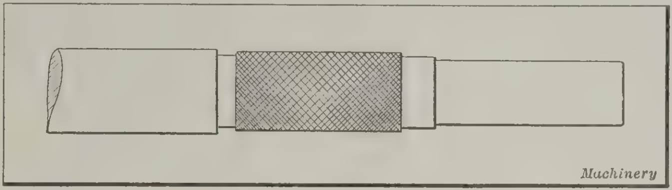
Fig. 2. Section of Device for Testing Gears

Torino, Italy. C. Boella

SAVING A SHAFT BY KNURLING

It has been common shop practice to condemn shafts, axles, etc., which have not met the allowance required for a press fit. This practice has made the manufacturer as well as the mechanic suffer for slight errors, and the junk dealer alone has profited. The manufacturers have lost thousands of dollars yearly due to small errors, such as shafts or axles being, for example, 0.0005 inch or 0.001 inch too small for the gears, pulleys, collars, flanges, etc., into which they are to go, or because commutator shells are from 0.0005 to 0.001 inch too large for a press fit.

Here is where the knurl plays a big role by rectifying even larger mistakes in a few minutes. Suppose that a commutator shell, pulley, or gear has accidentally been reamed or bored 0.001 or 0.005 inch too large. Instead of scrapping and duplicating these parts, put the shaft between the lathe centers, and knurl the seat for the press fit as shown.



Saving a Shaft by Knurling

The knurl should be coarse and can be straight, spiral or crosscut, and of any size or width, although for a small shaft a narrow knurl is required. After knurling, the shaft will be about 0.020 inch larger, depending upon the coarseness of the knurl. After this operation the shaft can be turned down again to the press fit allowance. This simple operation will prove very satisfactory in any line of work where press or shrinkage fits are used. J. E. U.

MULTIPLE-THREAD INDEXING IN THE LATHE

The following formula will be found useful to any machinist or toolmaker. The writer has had occasion to cut multiple-thread worms or spiral gears in the lathe, and in not one instance has the operator been able to do the proper indexing. It is quite simple to index for a double or triple thread, but few average workmen know what to do when the number of threads is greater than that. Therefore the writer has formulated the following rule which will cover every case:

Multiply the number of threads per inch of the lead-screw of the lathe by the lead of the spiral to be cut, and multiply this product by the number of teeth in the gear on the lead-screw; then divide that product by the number of starts or teeth in the worm or spiral. The quotient is the number of teeth the lead-screw gear will have to be turned to give the proper indexing.

For example, we want to cut a spiral gear having 8 starts or teeth, with a lead of 1½ inch in a lathe having a lead-screw with 6 threads per inch. We first figure our gearing for the lead, which gives a gear having 24 teeth for the lead-screw. According to the rule, we then have

$$\frac{6 \times 1\frac{1}{2} \times 24}{8} = 27$$

teeth, as the number of teeth the lead-screw gear must be turned. Cut the first thread, bring the lathe to a stop, mark the intermediate gear and the gear on the screw, disengage them, move the lead-screw one full turn and 3 teeth, engage the gears, and the next thread may be started. Repeat this until the gear is finished.

Of course if the product in the formula does not contain the divisor without a remainder, the gear on the lead-screw must be changed until one is obtained which will give the desired results. The ratio must, of course, be retained.

Detroit, Mich. John G. Paine

[The reason why this rule will give correct results may not immediately be apparent. It is evident that what we want to do is to move the carriage forward a distance equal to the distance from one thread to the next, that is, equal to the linear pitch of the worm; in the example given this distance is 1½ ÷ 8 inch. As the lead-screw has 6 threads per inch it makes 6 revolutions when moving the carriage one inch. Hence,

to move the carriage $1\frac{1}{2} \div 8$ inch, it will make $(1\frac{1}{2} \div 8) \times 6$ revolutions. For each revolution 24 teeth are engaged. Hence, the total movement from one thread or start to the next equals $(1\frac{1}{2} \div 8) \times 6 \times 24$, which may also be written in the form used by our correspondent.—EDITOR.]

THE PRINCIPLES OF PROJECTION

The writer believes that the general principles of projection—the reasons why the views are placed on a drawing the way they are—are not generally understood by mechanics and sometimes not even by draftsmen. In America, the method indicated in Fig. 2 appears to be universal, but in England there is really no universal way of projecting one view from another, as some use first-angle and some third-angle projection. In Fig. 2 is shown what is ordinarily termed third-angle projection, and which, undoubtedly, is the best way to show an object in a drawing. In this case the end views are placed nearest the end from which they are viewed. The plan is placed above the front elevation, and the bottom view or inverted plan is placed below the front elevation. An excellent way to demonstrate to students the reasons for showing the views in this manner, is as follows: Imagine a box having six glass sides as shown in Fig. 1. Place an object inside of the box and draw the view of each side on the face opposite it. Then open the box and the views will be presented in a plan as indicated in Fig. 2. The writer has found this to be the best way of demonstration, and the easiest way to remember.

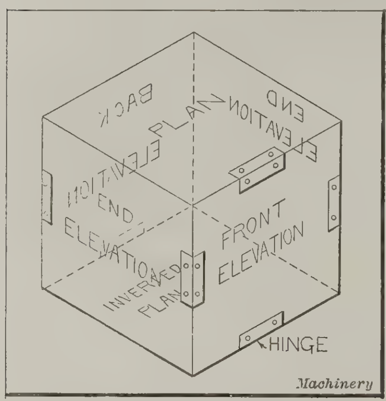


Fig. 1. The Third-angle Method of Making Projections as followed in America

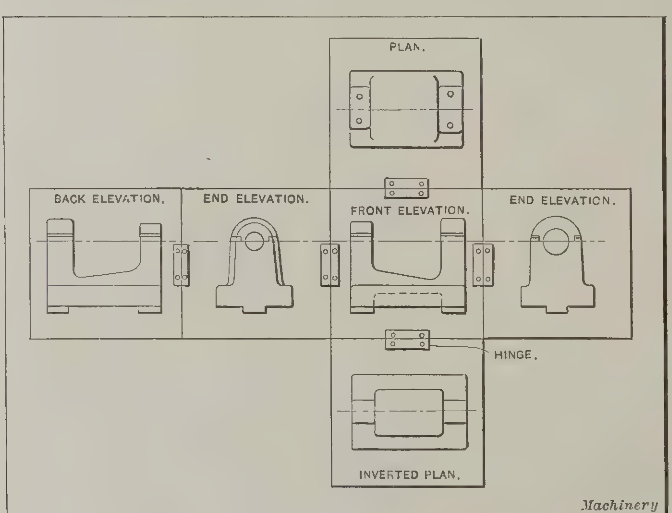


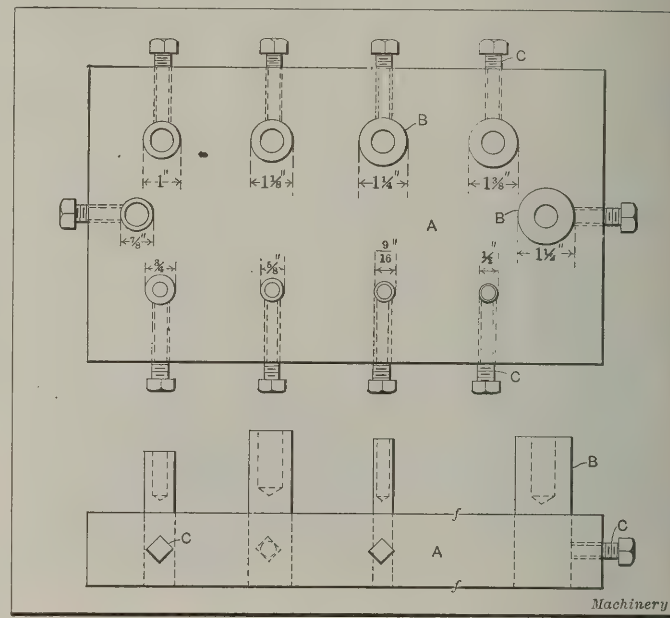
Fig. 2. A Simple Method to follow in making Correct Projections

Belvedere, Kent, England. A. W. BOASE

FIXTURE FOR HOLDING LEVERS, ETC., WHEN FACING THE BOSSES

Every mechanic knows how troublesome it is to face the bosses of levers and brackets and get the faces true or at right angles with the holes. When the lever or bracket is strapped onto the drill press table, it is liable to spring in clamping, which results in the faced surface of the boss not being true with the hole.

The fixture shown in the accompanying illustration consists of a cast-iron parallel block *A*, 14 inches long by 8 inches wide by 2 inches thick, finished on both sides. This block has ten holes drilled in it varying in diameter from ½ to 1½ inch. Of course any number of holes can be drilled and the block made of a suitable size to handle the work for which it is to be used. The holes drilled in the block *A* are made to receive the studs or pins *B* which should be made from cold-rolled steel and casehardened. These studs have a hole drilled in one end to receive the pilot of the counterbore, and are adjustable in the fixture, being held when set to the desired height by means of the set-screws *C*. In the fixture shown in the illustration, the holes in the small studs are made ⅜ inch in diameter, while the holes in the large studs are made ⅝ inch. The studs *B* should be made to fit the hole in the lever or bracket snugly so that the boss will be faced true with the hole.



A Fixture for Holding Levers or Brackets when facing the Bosses

In use, the block *A* is fastened by clamps to the drill press table and the hole in the stud *B* is set in line with the pilot of the counterbore. The lever or bracket, after the hole has been drilled, is slipped onto the stud *B* and swung around until it touches one of the other studs, which acts as a stop. Stud *B* may now be set to the desired height, so that the lever will be faced to the required distance when the counterbore touches the top face of the stud. DAVID MCINNES

Plainfield, N. J.

CHAIN CASES

In the February number of MACHINERY, Mr. J. F. Winchester defends the unprotected chain on motor trucks. It seems to be his contention that trucks operate under conditions and on roads that are worse than those under which pleasure cars operate; hence, chains should not be protected. The truth of relative road conditions alone might properly be questioned, because touring cars are usually to be found wherever there are trucks, and very often in places impossible of access by trucks; but, granting the necessity for operating trucks on poor roads, does it not make the need of a protected chain all the more urgent?

Bearings in machines that do not operate in dirty surroundings do not need protection, as, for example, in the high-speed stationary engine. We have seen them operate successfully without being enclosed, and it was only a few years ago that completely enclosed splash oil systems of lubrication were first made. Such engines are now found in the cleanest power houses built, where the enclosure can be of value for facilitating lubrication only. Where there is dust and dirt, the covering serves a double purpose; the dirtier the surroundings, the greater the value of the cover. Certainly, if trucks run on dirtier roads, they are in greater need of protection.

Chain cases do not require much space on a vehicle and need not lessen the clearance between road and sprocket more than an inch, at most. Any driver who is competent enough to negotiate a road that is full of ruts without chain cases on his car, but who would break the cases, were the same chains

covered, would be a refined driver indeed. Besides, can a sprocket and chain withstand more rough treatment than a solid braced cover?

Chain cases as ordinarily located are in a large measure protected by the wheels. Hence, they are in less danger than gear boxes, which are invariably located in the center of the rear axle and directly exposed to the point where obstructions on unpaved roads usually exist. Yet, geared drives are invariably enclosed! The writer has several times repaired gear cases broken by striking obstructions on country roads. In every case, however, the vehicle was not immediately rendered useless. The oil ran out of the gear case, to be sure, and for that reason the transmission efficiency may have been slightly impaired by the accident, but the vehicle was still operative. If the uncovered gears had struck the obstructions, would they have kept going merrily on?

It is not illogical to compare chains and gears because of the difference in construction. In the operation of each form there is sliding contact—more in the gears than in the chain, true enough—and wherever there is sliding contact, abrasion is augmented by grit and dust; everybody knows that. The figures reported in the November issue of MACHINERY show this nicely. Chain manufacturers cannot compel machine manufacturers to cover the chains they use, nor do they insist on it strongly. It might be of interest, however, to know that one of the largest manufacturers of chains is endeavoring to show the user the importance of using cases, and in many instances this chain manufacturer's suggestions have been advantageously heeded. More data such as contained in MACHINERY'S November editorial will be of much value to automobile and chain manufacturers.

New York City W. F. SCHAPHORST

MORE COMMENT ON AUTO-TRUCK TRANSMISSION CHAINS

The use of uncovered chains is certainly indefensible on motor cars—trucks or touring. Any car, to be sure, is liable to have its chain break; but when that chain becomes laden with foreign material, the chain- and sprocket-wear increases to a great extent. The life of both the chain and the sprocket is shortened, and the car is out of commission oftener while renewals are being made. It is a small matter to design a chain case that can be removed quickly; the cost is nominal, and compared to the cost, the results are phenomenal.

No doubt the makers of chains know more about them than anyone else, so let me quote from the catalogue of one of the largest manufacturers of chains: "Chains should be housed and run in oil, the same as are gears, to give best results; but as an alternative they should by all means be protected from heavy grit or mud, the deposit of which increases the base diameter of the sprocket, resulting in rapid wear and elongation of pitch of both chain and sprocket." While we all did not wear out chains and sprockets on our bicycles, it is a matter of easy recollection how much easier "she" ran after we had taken off the chain and cleaned and greased it.

C. P. W.

WHY THE SHOP DOES NOT RETAIN THE SKILLED MECHANIC

In the January number of MACHINERY I noticed an article entitled, "Why the Shop Does not Retain the Skilled Mechanic," and would like to make a few comments on the opinions there expressed. I believe that the expert machinist and toolmaker is not required to the same extent today as he has been heretofore. Different methods of management are gradually eliminating the all-around man and developing specialists in all lines of work—expert lathe hands, planer hands, etc. Young men do not wish to start in as apprentices and work for \$3.00 to \$5.00 per week for several years, when they can start in with small experience on some one machine and earn considerably more. The young man of today does not want to waste his time—he considers it waste —by acquiring knowledge that he thinks he will never need. It is to be regretted that this type of man is becoming more and more common, but this is the reason, principally, why many large firms have discontinued their apprentice systems.

In regard to placing machinists and toolmakers on the honor system, it may be said, in the first place, that in very few shops does one now find any employes, except stenographers and bookkeepers, employed on the honor system. It has been proved that this system does not "work out" with the average man. It is too easy for him to be late or absent when no record is kept of his coming or going. Time-clocks would not have been installed if it had not been found to be necessary. Consider for a moment a large manufacturing plant employing, say, one thousand men. If only a few men were making a practice of being absent all or part of each day, the routine of the work would suffer. The time-clock is necessary for the simple reason that the average man thinks of no one's convenience but his own. It is much easier to come in late than on time, and those who may mean well enough, soon become careless.

It was also mentioned that it takes more skill to become a machinist or toolmaker than to become a draftsman, and, therefore, the former man should have as much, if not more, consideration than the latter. Perhaps the writer of the article referred to, never worked as a draftsman, and in that case he is excused for the remark. Comparatively few machinists or toolmakers, when they have finished their day's work, give a thought to it until the morrow. On the other hand, most draftsmen, no matter in what line of work they may be, have to study or work out problems that have come up in their daily work, at least, say, three nights a week. A writer in a magazine recently said that "men employed in engineering work have a most confining life for that very reason." Besides this, a draftsman has to work hard many years with his books before he is able to fill his position.

I do not mean this to be direct criticism of the position taken by the former writer, for he may have found the facts as he stated them to be true in his case; but the opinion I have expressed is based on the facts as I have found them in a number of large manufacturing establishments.

Philadelphia, Pa. EDWARD R. GLENN

A SIMPLE TAPPING FIXTURE

Having occasion to tap several thousand swaged nuts of the form shown in Fig. 1, a fixture to be used on a horizontal tapping machine, as shown in Fig. 2, was designed. This fixture consists of a cast-iron angle-plate A, to the front face of

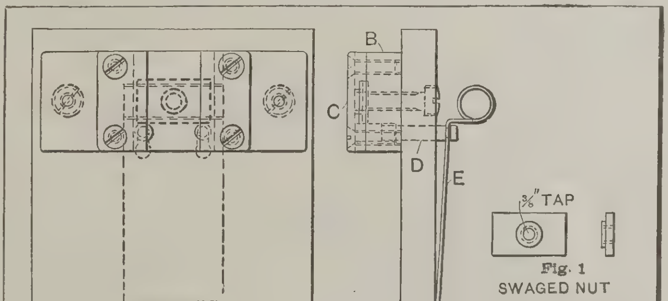


Fig. 1. The Swaged Nut. Fig. 2. The Fixture used for Holding the Nut while tapping

which is attached a soft-steel block B. Fastened to this block B are two guide strips C. Two hardened shoulder pins D which pass through the blocks A and B act as stops for the nut while being tapped. Attached to these stops and fitting over a groove turned on them, is a flat steel spring E. The holes in this spring are made keyhole-shaped, so that the spring can be inserted over the pins and then brought down into position, where it is held with the block F, a screw, and two dowel pins, as shown. The top of this spring is formed into a ring, so that it can be conveniently handled.

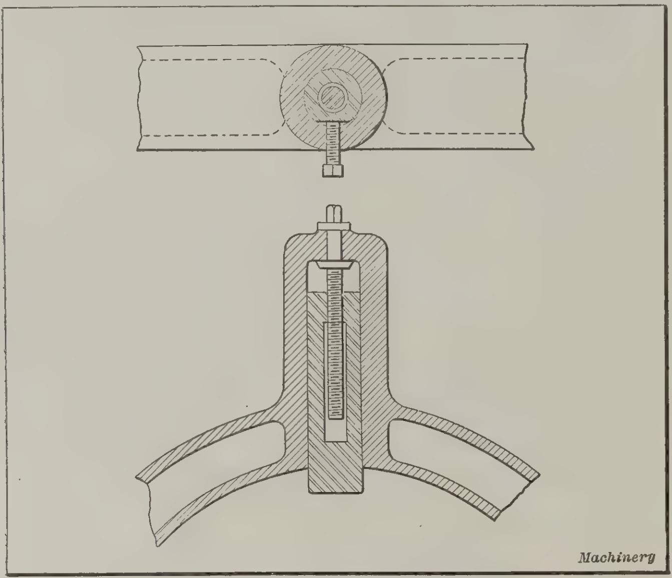
In operation, the nut shown in Fig. 1 is placed in the

guides, and rests on the pins *D*. The machine table is then moved forward, carrying the angle-plate, and the tap passed into the nut. The table is then withdrawn, and when the tap emerges, the spring *E* is pulled back, which withdraws the pins *D*, thus allowing the nut to drop into a pan placed on the table to receive it. This device can be cheaply made, but should be judged from its efficiency rather than its simplicity.

Detroit, Mich. ARON LAWRENCE

A LATHE STEADYREST OF UNCOMMON DESIGN

The accompanying illustration shows a lathe steadyrest which varies from that usually supplied by the lathe builders of today. The general outline and construction of the rest is the same, but the jaws are different. The ordinary rectangular jaw is replaced by a cylindrical piece fitting



A Lathe Steadyrest of Simple and Rigid Construction

snugly in a bored hole, as shown, which is adjusted by means of a screw. These jaws may be made of any material depending upon the work on which they are to be used. We use jaws made from steel on heavy lathes, when large cast-iron drums are turned. This construction is very rigid and is of simple design. H. TERHUNE

Plainfield, N. J.

THIS IS "ABSOLUTELY" TRUE

"Say, Bill, what was the matter with the boss and the young fellow that just left?"

"Well, you see, everybody, in the last few years, has been using the word 'absolute' in connection with the work turned out on their machines. That fellow came in and said to the boss, 'You ought to plane those plates on one of our machines; they plane absolutely true surfaces,' and I heard the old man tell him a little experience.

"'Young man,' he said, 'I want to give you a pointer. I had heard one fellow say that his machine grinds absolutely true, another that his turns absolutely true, another that his mills absolutely true, and another that his pulleys and shafting run absolutely true, for so long that I got the disease and agreed to build a machine for that old fellow down by the railroad track who hammers saws and does blacksmithing, that would grind saws absolutely true on their sides. Now I will tell you what happened to me because I did not know what the word 'absolute' meant. After I had built the machine and sent it down, and thought I had given him about enough time to pay for it, I decided to call around for the money. Now, I had seen some of the work turned out on it and had a letter from a man who had seen it wanting me to build one for him, so I felt sure everything was O. K.

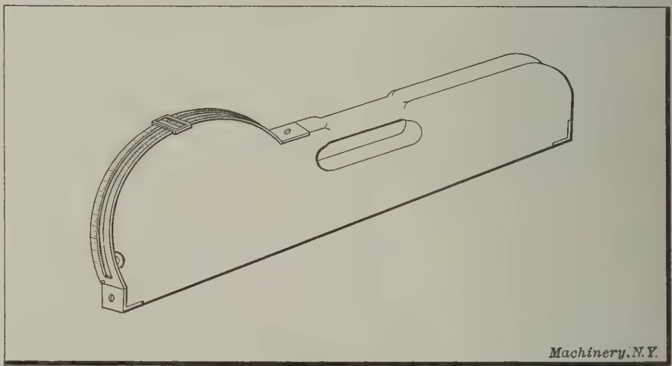
"'As I entered and stated my reason for calling, he asked me to look at some of the saws which were ground on this machine. He reached up on a shelf and got a nice new straightedge, and suspended a saw by a string hooked over the teeth and then held the straightedge against it. With the other hand he shoved the 0.004 inch blade of a feeler through, between the straightedge and the saw. Then without saying another word, he got my contract and pointed to the clause in which I agreed to produce a machine which would grind absolutely true. I requested him to put a saw in the machine and let me adjust it, and I proceeded to grind a saw. When I had it finished and the saw tallied with the straightedge, I called him over. He looked at it, and then got a surface plate about 10 inches square, and thinly covered it with lamp black and rubbed it over the surface just ground. Upon removing it, he informed me that the machine must grind absolutely true before he paid the bill.

"'Then it dawned upon me that I had used a word to convey one meaning that really meant another. I could not convince him of the injustice of his demands, and we went to law. My attorney could make no impression upon the court, which simply stated that if I agreed to build a machine to fly ten miles, the simple fact that it was impossible to do so did not entitle me to receive pay for a machine that would nearly fly. The above incident took place twenty years ago. We have since accomplished what was then considered an impossible thing, *viz.*, the flying machine, but are practically as far from producing machinery that does work absolutely true, as we were then. The only satisfaction which I got was that the machine was returned to me. I soon disposed of it, but it taught me a lesson.'" J. G. D.

GONIOMETER OR ANGLE-MEASURER

The goniometer, or angle-measurer, illustrated herewith is the invention of a German and is intended to measure the angle of an object on which it is placed without the use of any ways, screws, etc., it being merely necessary to lay the instrument on the object and read the angle off directly on the semi-circular scale at the left.

It consists essentially of a glass tube, bent into a circular form and filled with liquid; a bubble in this liquid, as in ordinary levels, tends to keep to the top. A sliding piece on a



The Goniometer, a German Instrument for Measuring Angles

circular scale is placed over the bubble and set in that position, thereby indicating the angle. This sliding piece also makes it possible to set the indicator and then remove the goniometer to a lighter place where the angle may be more easily read. In making this instrument, the one precaution necessary is to bend the glass tube containing the liquid to a perfectly circular form. ROBERT GRIMSHAW

Dresden, Germany.

A COUNTERBORING TOOL AND FIXTURE

While the automobile engineers are busy improving and perfecting their latest models, incidentally they are developing some very interesting machine and tool problems. The latest of these to come to the writer's attention was the facing and counterboring of a 5-inch diameter by 6-inch stroke cylinder. It appears that by the constant wearing of the piston rings upon the cylinder wall, a slight shoulder was formed near the extreme end of the piston ring travel in the cylinder. This shoulder however slight causes a piston knock when the piston ring reaches it. The resulting sound or knock could hardly be distinguished in the open, but as the knock occurs inside the cylinder which is closely connected with the crank case, the latter acts as a sounding box deceiving the ear to

such an extent that it is necessary to use a phonendoscope or vibracator to make sure of its location. To overcome this noise our engineer decided to relieve the cylinder bore at the upper end, so that the upper piston ring would travel about one-half its width above the counterbored recess. The tool shown in Fig. 1 was designed to perform this operation and was used in the fixture shown in Fig. 2, the fixture being held on a machine of the two-spindle vertical type which was formerly used for reaming cylinders.

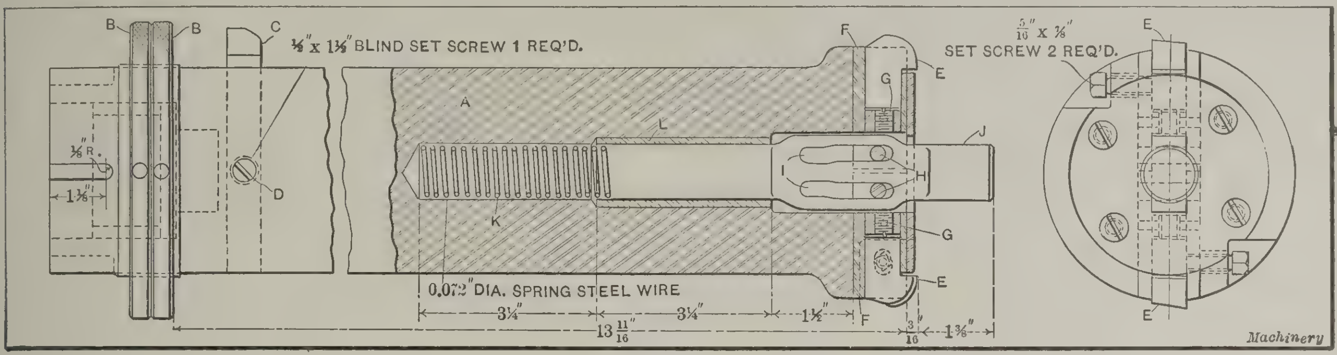


Fig. 1. Details of the Counterboring Tool

As shown in Fig. 2, the counterboring tool extends down into the cylinder to the required distance, and the tool-heads carrying the turning tools are operated by cam grooves in the central plug. The body of the tool *A* is made of machine steel, threaded in the upper end to closely fit the nose of the spindle of the machine. The total length of the body of the tool is 16 inches, and it is made of large diameter so as to afford sufficient support to the cutters to prevent chattering. The position of the counterbored recess is governed by stop collars *B*, which gage from the upper surface of the jig that holds the gas engine cylinder. Held in the body *A* by a screw *D* is a tool *C* which chamfers the open end of the cylinder to an angle of 45 degrees. The counterboring tools *E* are held in the tool-holders *F* and are adjusted by screws *G*. Driven into the tool-holders *F* are pins *H*, which operate in cam slots *I*, cut in the central plug *J*, the latter being operated upon by the spring *K*. The central plug *J* is fitted in a bronze bushing *L*, held in the body of the holder.

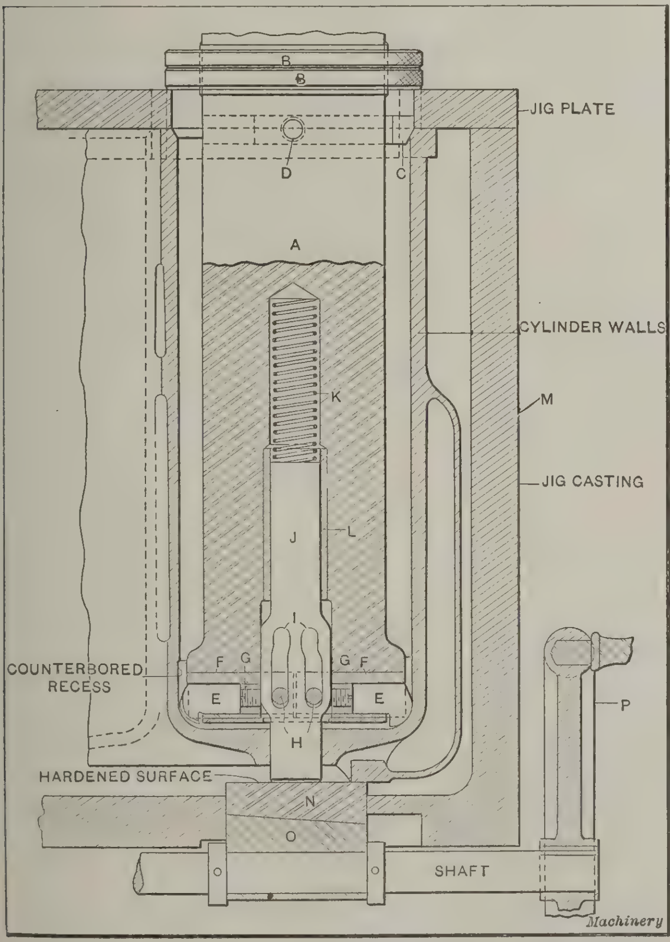


Fig. 2. Showing the Cylinder in the Fixture and the Counterbore at Work

In operation, the cylinder is clamped in the jig *M*, Fig. 2, and the body *A* inserted until the stop collars *B* come into contact with the top of the jig. At the same time the central plug *J* comes in contact with a hardened wedge *N*, which forces the former up into the body against the tension of the spring *K*—thus expanding the cutters. As the body *A* still continues in its downward movement, the cutters are kept to the same diameter by means of the straight portion of the cam slots, the extreme downward position of the cutters being governed by the washers *B* as previously mentioned. Adjustment for the central plug *J* is provided by a hardened wedge *N*, which is operated by the beveled plug *O* and handwheel *P*. The spring *K* has a very important function to fill, as the operation of the cutter depends entirely on its action. The tool-holders *F* are made from tool steel and are somewhat expensive to make, but as it is possible to hold short tools in them, a saving in steel is thus effected. The constant cutting in the hard scale and sand in the cylinder dome, requires frequent resharpening of the cutting tools, and when worn to the limit of the adjusting screws *G*, they must be replaced. The best high-speed steel obtainable is used for these cutters so that the smaller the cutter, the less the cost of maintenance will be.

Lansing, Mich. E. H. Pratt

SOME OBSERVATIONS ON GEARING

Speaking from practical observation and experience I believe that it is wrong to calculate the strength of steel gears as if they were able to continuously transmit two or more times the power transmitted by cast iron. I am not referring now to gears that run only intermittently, because with them it is more a question of strength than of wearing qualities, and I am referring only to ordinary steel forgings and castings, and not to alloy steels.

Ordinary cast iron on cast iron is a good combination so far as wear goes, while soft steel on soft steel, or on steel castings, is an exceedingly poor combination, as anybody can prove by using a steel shaft in a steel bearing. Why then should we expect steel teeth to wear as well as cast-iron teeth for the same load? And further, why should we expect them to endure under twice the load that cast iron is supposed to be able to carry? As a matter of fact, steel gears thus loaded are short-lived and uneconomical when run for eight or ten hours a day. I know of a great many instances that could be cited in support of this statement, and if any one of the readers of Machinery could name a case where steel gears will wear well when continuously transmitting anything like the loads allowed by the Lewis factors, I would be interested to know the details. I do not want it understood that I advocate cast-iron gears for I do not, but I advocate using the same factors when calculating steel gears as when calculating cast-iron gears, as far as the teeth are concerned. An ample margin for wear is just as important an economy for the purchaser of gears as it is in any other machine part. This is particularly true in the case of gears, where the labor cost is great in proportion to the cost of the material.

There is another thing that observation leads me to believe is more often done wrong than right, and that is the locating of the shaft centers for a pair of gears. I believe that they should be located enough closer than the theoretical distance,

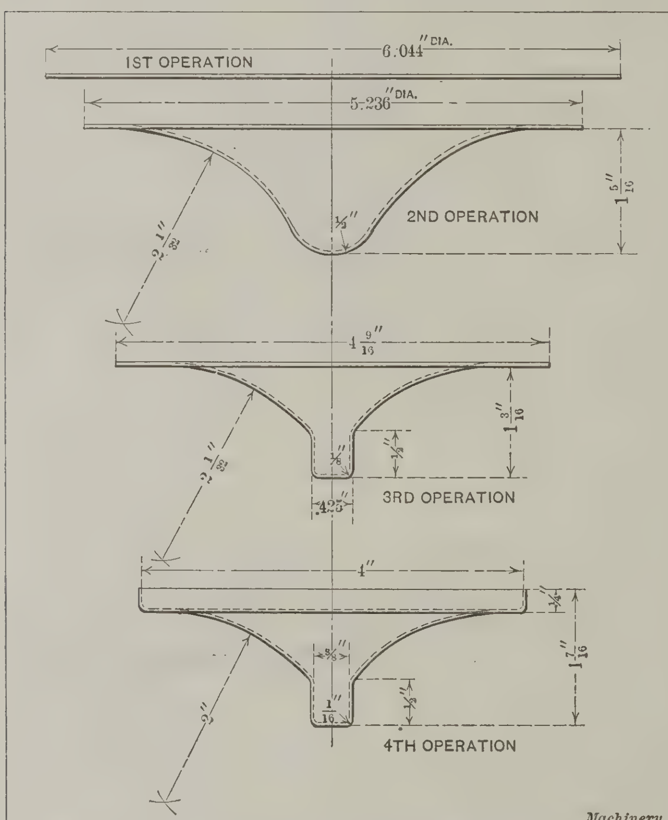
so that when the thrust of the teeth forces them apart by the amount of play there is in the bearings, they will be at the correct center distance. I believe that a great many breakdowns are due to the fact that the teeth do not mesh properly, because the centers of the gears are forced too far apart when loaded.

From a somewhat limited experience with worm-gear drives I have concluded that a well-designed worm and worm-wheel of high thread angle, made of the right materials and working well inside of the safe limits of pressure and speed, are much more satisfactory than two spur gears and two bevel gears to gain the same reduction and change of direction.

Scottdale, Pa. F. D. BUFFUM

THE DRAWING OF AN ODD-SHAPED CUP

In the February number, J. M. asks for advice relative to the drawing of an odd-shaped cup. In the writer's opinion this is a job in which considerable difficulty will be encountered. Owing to the small dimensions of the shank on this piece it does not seem feasible to do the work in less than four operations, as shown in the accompanying engraving.



Successive Operations in Drawing an Odd-shaped Cup

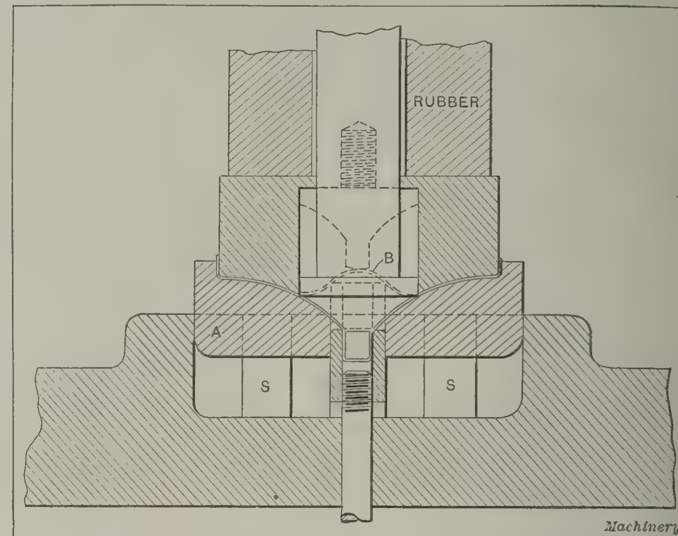
If it were attempted to do the work in a smaller number of operations, there would be considerable waste, in rejected pieces, as the metal would not flow fast enough to fill up, and the punch would break through.

As will be seen from the illustration, the metal is drawn out by easy stages until somewhat near the finished outline, before the sharp corners required are given to it. By the form of the question, the writer is led to think that J. M. is not equipped with good die-makers for making the dies. If that is the case it would be advisable to submit a sample of the piece required to some firm making a specialty of this class of work, so that this firm could bid on the dies, and decide exactly how they ought to be made and what would be the cost.

Fort Wayne, Ind. H. R. TALMAGE

DRAWING AN ODD-SHAPED CUP

In the February number of MACHINERY, J. M. asks for information regarding the tools necessary to make an odd-shaped cup. The accompanying illustration may serve as a suggestion as to the main features of the die equipment required. The dotted lines at *B* show the shape of the cup after the first operation, a combination cutting, drawing and embossing die being used for this. The dotted lines also indicate the location of the blank at the beginning of the working stroke of the second operation. With a two-inch stroke, provision must be made for the removal of the cup after forming. As a suggestion, the slots *S* are indicated, into which



Suggestion for Making Dies for Drawing an Odd-shaped Cup

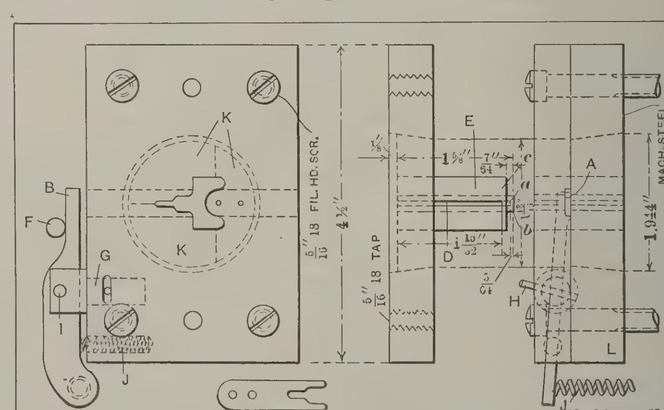
parallel wedge blocks are placed. These can be withdrawn after the stroke is completed, to allow the lower pressure ring *A* to fall and provide the required opening between the dies.

Columbus, Ohio. OTTO R. WINTER

A PIERCING AND CUTTING-OFF PUNCH AND DIE

An interesting punch and die for piercing and cutting off a typewriter part, is shown in the accompanying illustration. The stock which is a narrow strip, is fed through the channel *A* against the stop *B*, and is pierced and cut off by the punches *D* and *E*. The face of the punch *E* is made of varying heights, the forward part or face *a* and the following part or face *b* are both lower than the cutting-off face *c*, so that the slot will be cut in the blank before it is severed from the strip. The small holes in the forward end of the blank are pierced by the punches *D*, the faces of which are higher than the faces of the blanking and cutting-off punch *E*.

In operation, when the stop *B* is lifted, it swings in toward the die and rests on top of the finished blank, which is forced out of the channel when the strip is fed forward. When the blank drops out, the stop snaps down and engages the end of



Progressive Piercing and Cutting-off Punch and Die

the strip, and is forced by the latter against the pin *F*. The stop *B* rotates on the pin *G*, which is prevented from pulling out by the pin *H*. The stop *B* swings laterally on the pin *I*, and springs *J* are for actuating the stop.

The die proper is made up of three segments *K*, which are tapered and are driven into the die-block *L*. Two of these segments are symmetrical and can be milled out in one piece, then sawed apart before the taper for fitting them in the die-block is turned. To turn the taper on the die, the three pieces are soldered together and the punch is used as an arbor.

DESIGNER

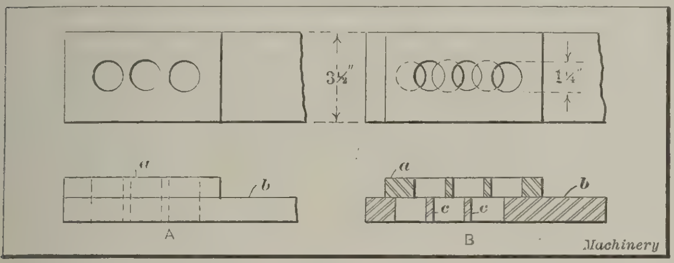
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

DRILLING ELONGATED HOLES

A simple method of drilling elongated holes is shown in the accompanying illustration. A plate *a*, which can either be made of machine steel and casehardened or furnished with hardened bushings, is clamped to the piece *b* to be drilled. The three holes, as shown at *A*, are then drilled

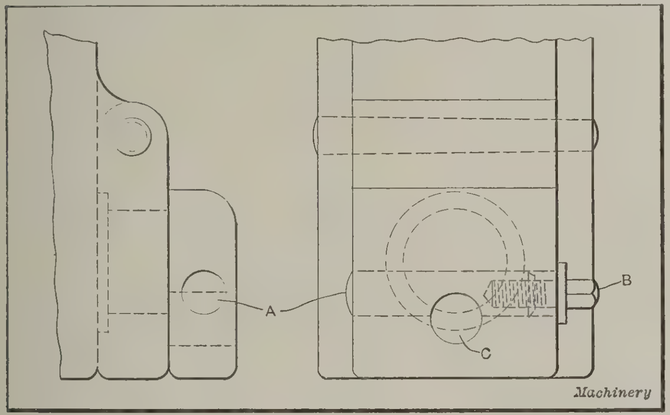


clear through, after which the block *a* is shifted to the position shown at *B*, and the remaining webs *c* are drilled out with an ordinary twist drill, ground square on the end. Preferably a high speed and light feed should be used; high-speed drills will be found to give better satisfaction than ordinary carbon drills.

SUBSCRIBER

EXTENSION TOOL-HOLDER FOR A SMALL SHAPER

In model and experimental work it frequently happens that the work to be handled in the shaper requires a tool projecting further than can be obtained with a regular tool. To meet such cases the clapper block shown in the accompanying illustration was made for the purpose of holding



an extension bar, in the end of which the cutting tool is held.

Referring to the illustration, *A* is a round rod into the end of which is tapped a hole for the screw *B*. A hole *C*, bored in the block at right angles to the rod *A*, provides an opening for the extension tool-holder. By tightening the screw *B*, after placing the tool-holder in position, the latter is held securely, the rod *A* acting as a clamp.

Hartford, Conn. F. CHARLES SCRIBNER

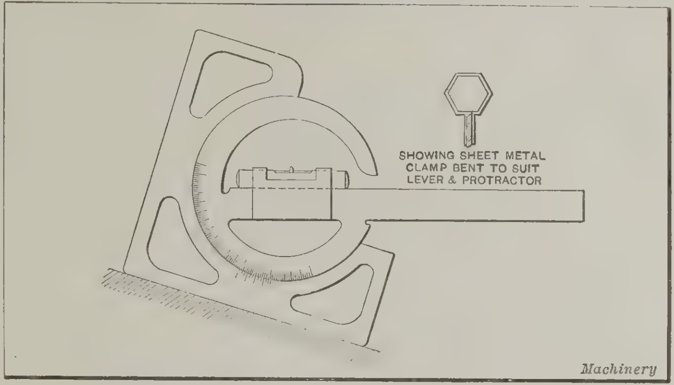
FACING WORK ON THE LATHE FACEPLATE

In facing on the lathe faceplate, it is common practice to pack up the work with tissue paper to prevent it from slipping around, and also to avoid the necessity of clamping it too tightly. Another method which is equally as good, if not better, is to deposit a thin coating of oil and fine emery between the work and the faceplate, spreading it evenly. This method allows a heavy chip to be taken when the work is clamped lightly. Still another method is to apply a thin coating of hot shellac to the faceplate, and also a thin coating to the side of the work that will be placed next to the faceplate. The faceplate is removed from the lathe and the work placed on quickly and moved around; then a weight is placed on it and left until the shellac is dry, after which the faceplate can be put on the lathe and the cut taken. This method requires no clamps at all, and was used with satisfactory results by the writer in taking a finish-facing cut from a cast-iron disk 6 inches in diameter and 1/32 inch thick.

Newark, N. J. H. E. WOOD

OBTAINING ANGULAR MEASUREMENTS WITH A B. & S. DRAFTSMAN'S PROTRACTOR

It frequently happens that a draftsman finds it necessary to measure an angular surface on a machine, but cannot do so because there is no finished surface to take the measurement from. The accompanying illustration shows how an angular measurement can be taken. This is accomplished by means of a Brown & Sharpe draftsman's protractor to which

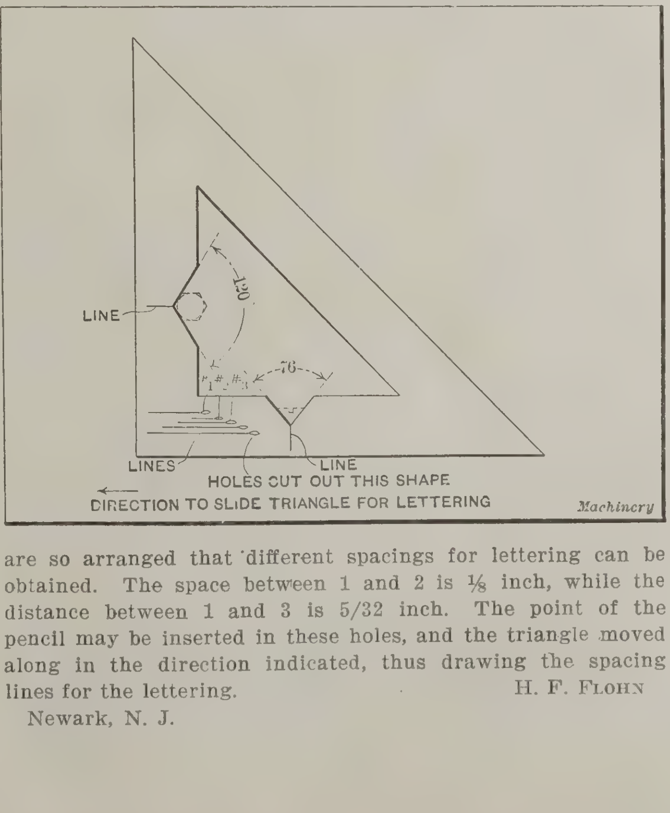


an L. S. Starrett level is attached by means of a piece of flexible material such as sheet tin, zinc or steel. The protractor can be placed on the angular face of the machine and the arm raised until the spirit level shows that the arm is in a horizontal plane, when the angle can easily be found.

F. D.

DRAFTSMAN'S TRIANGLE FOR DRAWING BOLT AND SCREW HEADS

The triangle shown in the accompanying illustration will be found convenient for drawing bolt heads, flat-head screws and laying out spacing lines for uniform lettering. Take a 45-degree triangle, preferably celluloid, and lay out the angles, as shown. The portion cut away at 120 degrees is for hexagon-head bolts, while that part cut away at 76 degrees is for flat-head screws. The small holes marked Nos. 1, 2, 3, etc.,



are so arranged that different spacings for lettering can be obtained. The space between 1 and 2 is ⅛ inch, while the distance between 1 and 3 is 5/32 inch. The point of the pencil may be inserted in these holes, and the triangle moved along in the direction indicated, thus drawing the spacing lines for the lettering.

H. F. FLOHN

Newark, N. J.

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer

METAL PAINT TO WITHSTAND ALCOHOL

S. J. B.—It is required to paint a brass vessel having a glass top with white paint which will successfully withstand the action of diluted alcohol in the proportion of 2 to 1 without the paint changing color. What mixture of paint should be used?

This question is submitted to the readers.

PROPORTIONS OF SHORT HYDRAULIC CYLINDERS

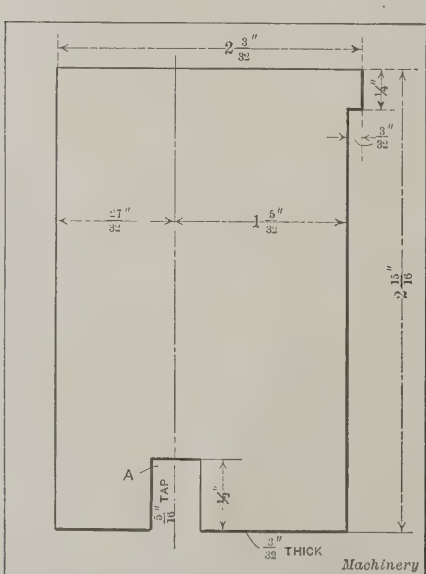
J. C. S.—The formula $\frac{R}{r} = \sqrt{\frac{S+P}{S-P}}$

in which R is the outer radius of the cylinder; r, the inner radius; S, allowable unit stress; and P, maximum pressure, gives the ratio between the outer and inner radii of thick hydraulic cylinders for given internal pressures. This formula does not apply to very short cylinders, however, because of the reinforcing effect of the thick head. The rule given by Kent for short cylinders is to make the thickness one-tenth the inner circumference for pressures of 3000 to 4000 pounds per square inch. I have to design a cylinder for 5000 pounds pressure, 8¾ inches internal diameter and 3 inches stroke. The material will be semi-steel, having a tensile strength of about 25,000 pounds per square inch of cross-section. Figured by the Kent rule an external diameter of 14¼ inches is safe for a pressure of 4000 pounds. Will a diameter of, say, 15¾ be safe for 5000 pounds? Figured by the first-mentioned formula the external diameter must be 22 inches, allowing a fiber stress of 7000 pounds per square inch.

The question is submitted to readers who are familiar with the modifications of theoretical design in such cases, enforced by commercial considerations.

BROACHING SCREW THREADS IN THIN PLATES

R. H. F.—I am building a machine in which there are 35 steel knives 3/32 inch thick which are held on a spider or knife plate with 5/16 inch—18 thread screws tapped into the slot *A*. The metal is cold-rolled steel, and the slot is 1/2 inch long. We punch the slot in a punch press and then put the knife in a small jig and tap the threads by hand. What I wish to know is, can the knives be tapped more rapidly in some other way, as our present method is slow and expensive?



A.—Inasmuch as the threads are tapped into the edge of the knife blade which is only 3/32 inch thick, the angle made by the thread is practically negligible. We suggest that the outline of the threads be broached with a suitable broach in a power press. The screw will have practically as good a hold of the knife when screwed into the broached thread shapes as though they were tapped. Of course, the bearing of the screw will not be theoretically correct, but by the time the screw is screwed home the bearing should be practically as good as is required for this class of work.

STATUS OF "PATENTED" ON MACHINES

S. J. R.—What is the law regarding the use of the word "patented" on manufactured articles; also with regard to blanket nameplates giving the dates and numbers of all patents owned by the concern making the products? I have noticed machine tools bearing nameplates on which legends similar to this appear: "Made by the Brown & Smithson Machine Tool Co., Brownsmithsonville, Ohio, operating under patents," followed by a list of all the patents owned by the company, giving the numbers and dates of issue. The machine carrying the nameplate may be a standard machine tool without a single patentable feature, yet it appears to be plastered with patents.

A.—Section 4900 of the United States Revised Statutes provides that when a patented article is not marked "patented" no damages shall be recovered by the plaintiff unless he proves that the defendant was duly notified of infringement. Section 4901 provides a penalty for marking "patented" on unpatented articles when done for the purpose of deceiving the public. So far as we can ascertain no decisions of the courts have been recorded regarding the use of blanket nameplates on machines, listing all the patents owned by the manufacturer. The practice has certain advantages for both the maker and user. It enables one style of nameplate to be used on all styles of machines produced, irrespective of their characteristics. The user is informed just what patents are owned by the company, but whether any of them apply to a particular machine is left in doubt.

JIGS AND FIXTURES—HOW DEFINED

D. T. H.—What are your definitions of "jig" and "fixture"?

A.—The answer is in the editorial under the above heading in the February, 1905, number, part of which follows: "Jig and fixture are words used interchangeably; a drilling-jig and a drilling-fixture may be one and the same thing—and they may be different, as we shall see later. Broadly, a jig is a device used in interchangeable manufacturing of machine parts for holding the work pieces and guiding cutting tools in any machining operation thereon; hence it may be used for drilling, boring, milling, planing, shaping, etc., but, we believe, it is preferably limited in general use to the first two operations, that is, drilling and boring. While fixture is a term generally used to mean the same thing, we believe that it is more comprehensive, and that it includes a lot of things which would not ordinarily be called jigs. If the device is of such a nature that it incloses and holds the work so that it can be lifted and transported as a whole, and, perhaps, has provision for a number of operations in different planes, we should surely call it a jig, but if it were the radius attachment to a planer for planing locomotive links, we should call it a fixture, although it is by no means a fixed or permanent part of the machine. A drilling vise is more of a fixture than a jig, but if it is provided with guide bushings we would term it a drill-jig or a jig-vise. Again a fixture may be one of the tools of a machine, as for example, the tools and fixtures of a turret lathe. A tool-post is an example of a fixture, but it is not a jig in the ordinary sense of the word. An "old man" for ratchet drilling is a fixture, as is also a former used on a planer as in planing relief for locomotive driving boxes, or as applied to the lathe for turning machine handles. A bending device which insures exact duplication is usually called a fixture, in preference to jig. A device for holding work pieces on the milling machine so as to insure duplication of parts is preferably called a fixture, although in many shops it would be called a jig. Hence the difficulty in assigning any definite and limiting meaning for either term. One difference that may be assumed to exist between jig and fixture is that a jig holds the work and guides the cutting tool independently of the machine supplying the driving power and feed, while the fixture is usually dependent upon the machine to guide the cutting tool or the work; one is self-contained and the other is not. We are fully aware that this distinction does not exist in actual practice, but it is one put forward as a suggestion for those shops which wish to define shop terms precisely."

STRESSES IN ELASTIC COUPLING

H. M. L.—The accompanying illustration, Fig. 1, shows a flexible coupling of the type in which a leather belt, looped around pins, transmits the power. How can the stress in the belt wound around the pins be calculated?

A.—In Fig. 2 a diagram is shown, indicating the necessary geometrical construction for finding the stress in the belt.

The radius of the outer pin circle is R and of the smaller, r. The radius of the pins is p, the number of pins is N in each pin circle, and α denotes the angle between the lines through the centers of adjoining pins. The requirement is to find the angle that line DE makes with a tangent to the outer pin circle, so that the tangential force to be transmitted can be translated into belt stress along line DE. Angle $\alpha = 360 \div 2N$. As we also know R and r, we can find the length of side BC in triangle ABC, by a simple trigonometric formula, and also the angle ABC. Then, in triangle CDF, $CF = \frac{1}{2} BC$,

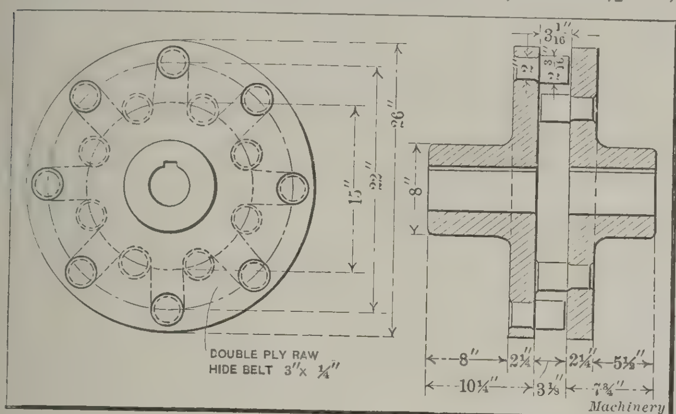


Fig. 1

$CD = p$, and angle CDF is a right angle. Hence angle CFD can be found, the sine of this angle being equal to $CD \div CF$. The angle that DE makes with AB, then, is equal to angle ABC — angle CFD, and the angle that line DE makes with a tangent through B equals 90 degrees minus this angle. The angle with the tangent will be denoted β. For the sake of simplicity, assume that the tangential force acts at the center of the pin, at B. In the force diagram, at the right, KL represents the tangential force at each pin, and KM the stress in the belt, the angle between the direction of these forces being β. Assume that P represents the total tangential force to be transmitted. If the horsepower to be transmitted is known, then $P = (33{,}000 \times \text{H. P.}) \div (2\,\pi\,R \times \text{R. P. M.})$, and the

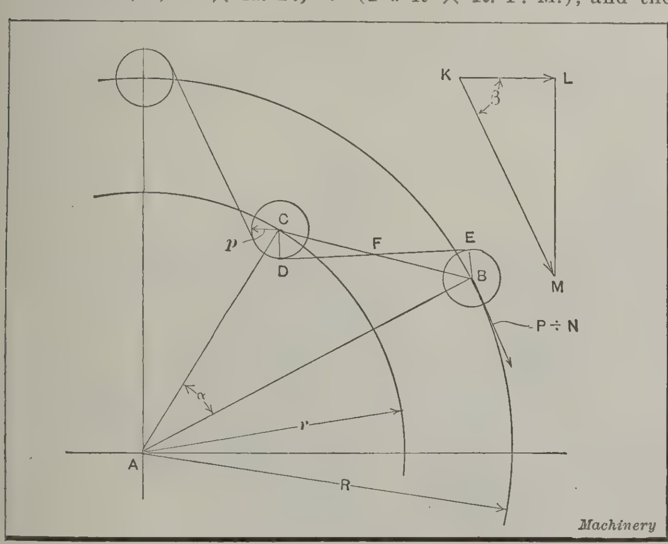


Fig. 2

force represented by $KL = P \div N$. From this we find KM, or the belt stress, is expressed as:

$$KM = \frac{P}{N} \div \cos\beta = \frac{P}{N\cos\beta}$$

Extreme refinement in this calculation is not necessary, as the relative positions of pins B and C do not remain constant, due to the elasticity of the belt, and hence the value of angle β will vary. The value found as shown, however, is the one which produces the maximum stress; with the coupling in torque, angle β will decrease, in which case the stress in the transmitting belt will decrease also. It is evident that the stress becomes very great if β is large, and as this angle depends upon the arrangement of the pins, it is advisable to make the difference in the radii of the pin circles as small as is consistent with the angular displacement required to absorb the shocks of transmission.

SPIRAL-FLUTED HOB ANGLES*

By G. H. GARDNER†

It is, of course, desirable that hobs should be fluted at right angles to the direction of the thread. Sometimes, however, it is necessary to modify this requirement to a slight degree, because the hobs cannot be relieved unless the number of teeth in one revolution, along the thread helix, is such that the relieving attachment can be properly geared to suit it. In the following it is proposed to show how an angle of flute can be selected that will make the flute come approximately at right angles to the thread, and at the same time the angle is so selected as to meet the requirements of the relieving attachment.

Let C = pitch circumference,
T = developed length of thread in one turn,
N = number of teeth in one turn along thread helix,
F = number of flutes,
α = angle of thread helix.

Then (see illustration):

$C \div F$ = length of each small division on pitch circum.

$(C \div F) \times \cos\alpha$ = length of division on developed thread.

$C \div \cos\alpha = T$.

$$\text{Hence } \frac{T}{(C \div F)\cos\alpha} = N = \frac{F}{\cos^2\alpha}$$

Now, if $\alpha = 30$ degrees, $N = 1\,1/3\,F$,
$\alpha = 45$ degrees, $N = 2\,F$,
$\alpha = 60$ degrees, $N = 4\,F$.

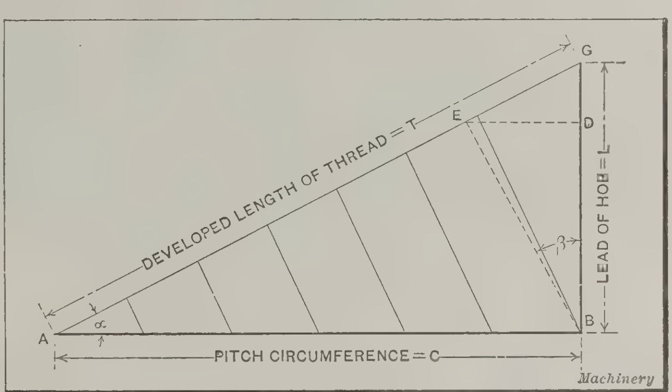


Diagram for Derivation of Formula for Spirally Fluted Hobs

In most cases, however, such simple relations are not obtained. Suppose for example that $F = 7$, and $\alpha = 35$ degrees. Then $N = 10.432$, and no gears could be selected that would relieve this hob. By a very slight change in the spiral angle of the flute, however, we can change N to 10 or 10½; in either case we can find suitable gears for the relieving attachment.

The rule for finding the modified spiral lead of the flute is: *Multiply the lead of the hob by F, and divide the product by the difference between the desired value of N and F.*

Hence, the lead of flute required to make $N = 10$ is:
Lead of hob $\times$ $(7 \div 3)$.

To make $N = 10\frac{1}{2}$, we have:
Lead of flute = lead of hob $\times$ $(7 \div 3.5)$.

From this the angle of the flute can easily be found.

That the rule given is correct will be understood from the following consideration. Change the angle of the flute helix β so that AG contains the required number of parts N desired. Then EG contains $N - F$ parts. But $\cot\beta = BD \div ED$, and by the law of similar triangles,

$$BD = \frac{F}{N} \times BG, \text{ and } ED = \frac{N-F}{N}\,C$$

The lead of the spiral of the flute, however, is $C \times \cot\beta$.

Hence, the required lead of spiral of the flute:

$$C \times \cot\beta = \frac{F}{N-F}\,L$$

This simple formula makes it possible always to flute hobs so that they can be conveniently relieved, and at the same time have the flutes at approximately right angles to the thread.

* See also MACHINERY, December, 1910, engineering edition, "Gashing Spiral Fluted Hobs."
† Address: 101 Eustis St., Revere, Mass.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BROWN & SHARPE INTERNAL GRINDING MACHINE

The Brown & Sharpe Mfg. Co., Providence, R. I., has recently placed on the market an internal grinder that is designed for general internal grinding operations. This machine has a capacity for grinding holes varying from 2½ to 12 inches in diameter and 8 inches deep, and the machine will swing 18 inches. By using a special spindle, holes less than 2 inches in diameter, but not exceeding 12 inches deep, can be ground. This machine is especially adapted for grinding holes in hardened steel gears, cutters, collets, bushings and similar work. Taper holes can also be ground as easily and accurately as those that are straight, and such work as facing recesses in automobile gears to obtain a bearing true with the hole can be done without removing the piece from the machine.

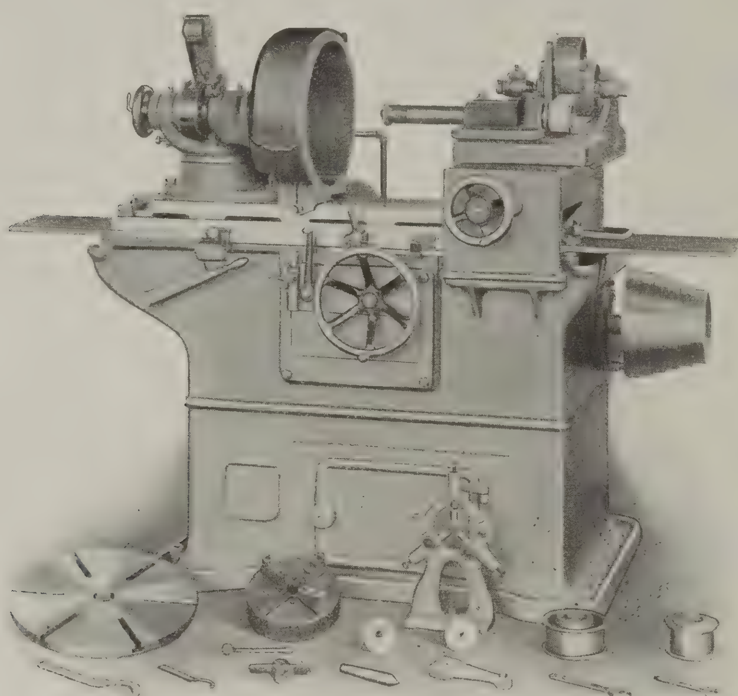


Fig. 1. Brown & Sharpe No. 22 Internal Grinding Machine

The design and construction of this machine, front and rear views of which are shown in Figs. 1 and 2, respectively, gives evidence of a careful study of the requirements for a grinder of this type. The general operation of the machine is as follows: The work to be ground is fastened either in a chuck or on a faceplate mounted upon the work spindle, which is driven from the overhead works. The headstock carrying the work spindle is fastened to the table of the machine, and the latter has an automatic, reversing, longitudinal movement similar to that of universal and plain grinding machines. The grinding-wheel stand and slide are mounted on a heavy bridge, which is bolted to the right-hand end of the machine bed and spans the work table. The grinding-wheel spindle is driven by a web belt from an intermediate shaft mounted at the back of the wheel-stand as shown, and this intermediate shaft, in turn, is belted to the over-head works.

The work speeds and table feeds of this machine are independent, the same as with the universal and plain grinders built by this firm. This arrangement makes it possible to obtain a correct table feed for any work speed. For example, when it is desired to remove stock rapidly, a slow speed and fast feed are available. Both work and table feeds are started and stopped by a single lever located on the front of the machine.

All wearing surfaces throughout are adequately protected from grit. The ways of the bed are always covered and the oil holes are protected from grit and dust. All screws, bolts and nuts requiring frequent adjustment are hardened. The handwheels and levers for controlling the various movements of the machine are all placed at the front.

Wheel Spindle, Stand and Slide

The wheel-spindle is of hardened tool steel and is enclosed in a heavy sleeve that extends practically its full length. The spindle and sleeve form a separate unit, which can be removed easily and quickly in case another spindle and sleeve of smaller size is to be used. At the front end of the spindle and close to the wheel there is a phosphor-bronze box in the sleeve, and at the pulley end an annular ball bearing is provided to take the pull of the belt and reduce friction to a minimum. The different grinding wheels used are mounted on a sleeve, which has a taper hole that fits the end of the spindle.

An ample range of independent spindle speeds is obtained by the use of interchangeable split pulleys on the intermediate shaft at the back of the wheel-stand. An idler pulley is provided to keep an even tension on the belt and take up the slack resulting from the use of pulleys of different diameters. Three split pulleys are furnished providing for speeds varying from 3990 to 7300 revolutions per minute.

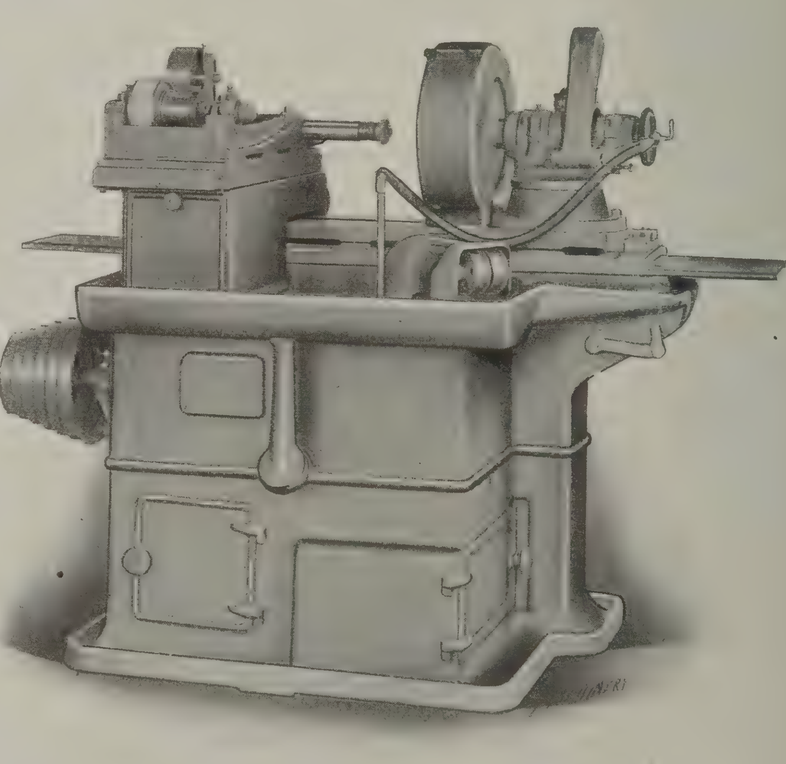


Fig. 2. Rear View of Brown & Sharpe Internal Grinder

The wheel-stand and slide are both of heavy, rigid construction, capable of resisting vibrations which would cause inac-

curacy in the work. The wheel-stand swivels, thus permitting the spindle to be set at an angle when grinding the faces of cutters or automobile gears. This feature is also convenient when a hole has been ground, and it is desired to grind the face of the work before removing it from the machine. The ways of the wheel-stand slide are long to insure alignment, and are amply proportioned to resist vibrations. A transverse movement of the slide is obtained through a worm and wheel, actuated by a handwheel at the front of the machine. When it is desired, an automatic cross-feeding mechanism, similar to that found on all Brown & Sharpe universal and plain grinding machines, can be furnished.

Headstock

The headstock is of a rigid design and is firmly fastened to the swivel table by means of bolts that slide in a T-slot. It swivels and can be set at any required angle, the amount of adjustment being indicated by graduations on the base. The spindle is hollow and runs in bronze boxes provided with means of compensation for wear. It can be locked in position when removing the faceplate, chuck, or an attachment. Over the spindle pulley there is a belt tightening device consisting of a small pulley mounted on a bracket that can be drawn forward or pushed back by means of the handle shown. The forward adjustment puts the driving belt in tension and causes the spindle to revolve and drive the work. When the idler is swung back, the spindle can be quickly brought to a stop for changing the work, or it can be revolved easily by hand when centering a piece. A range of twelve work speeds, varying from 40 to 340 revolutions per minute are provided.

Sliding Table

The sliding table is of rigid construction and its bearing surfaces are scraped to fit the ways on the bed which are aligned with master straightedges. The travel of the table is automatic and entirely independent of the speeds of the work and wheel. It is controlled by adjustable dogs on the front of the table that operate against a reversing lever in the usual manner. The dogs can be raised and the table run beyond the reversing points without disturbing the adjustment, which is a valuable feature when withdrawing the work from the wheel. When the work is finished the trip dog nearest the wheel is raised; the table then moves to the left until the power feed automatically disengages. The table can then be moved farther away by the large handwheel shown. After a new piece of work is inserted, the table is moved up by means of this handwheel until the work nearly reaches the grinding wheel, when the power feed automatically engages again.

Provision for Wet Grinding

The soda water for wet grinding is pumped from a tank located in the bed and is fed to the wheel through the hollow work-spindle. The pump consists of a simple fan, revolving in a case, and, as it is immersed at all times, no packing is required. The tank is readily accessible for cleaning. The hood or water guard shown on the machine is furnished for covering the work.

In other details, the construction of this machine differs but little from that of the Brown & Sharpe universal grinding machines. The swivel table, however, pivots on a stud located beneath the headstock. This gives a long leverage from that point to the end, thus enabling very fine adjustments to be made when setting to grind straight or when adjusting to an exact angle for taper work, after the headstock has been set as closely as possible by the graduations on its base. There are six changes of table feed, varying from 15 inches to 48 inches per minute. The equipment furnished with the machine is shown about the base in Fig. 1. The overhead works, which are not shown, are also included in the equipment.

WALKER SURFACE GRINDER

The Walker Grinder Co., Worcester, Mass., is building an improved design of "single-stroke" surface grinder which is adapted for grinding concave as well as flat surfaces. This machine is of the cup-wheel type and has a heavy column on which are mounted upper and lower vertical slides. The upper slide carries the grinding wheel, and the lower slide has a rotary magnetic chuck on which the work is mounted. When the machine is in operation, the wheel is fed down against the work until the latter is finished to the required thickness. The wheel slide is fed against a positive stop and the thickness of the work is varied by adjusting the lower slide which is equipped with a vertical feed-screw. This screw is operated by the large handwheel (seen at the left of the slide) which is graduated in thousandths of an inch. When this adjustment of the lower slide is once made, it is not changed for successive operations except to compensate for wheel wear. The feeding movement of the grinding wheel is effected by the hand lever seen at the right of the wheel slide. This same lever also controls the starting and stopping of the work spindle, the switching on or off of the magnetizing current for the chuck, and it also controls the de-magnetizing current for neutralizing the residual magnetism always found in a magnetic chuck after the electric current has been switched off.

All of the power movements for this machine are derived from a horizontal shaft at the rear on which are mounted

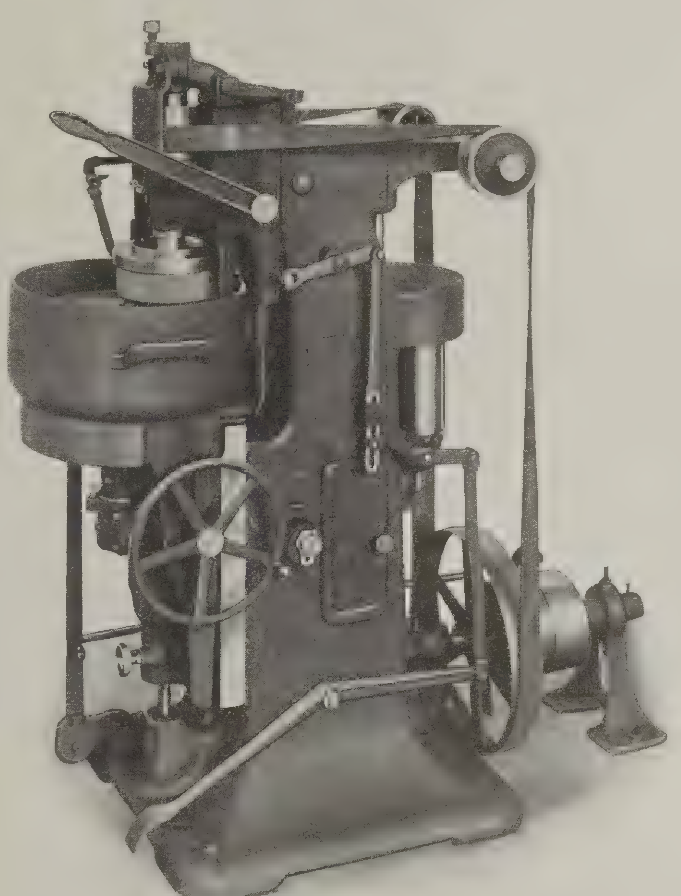


Fig. 1. Walker Surface Grinder

tight and loose pulleys. The wheel spindle is driven independently by a quarter-turn belt which passes over idlers as shown. The spindle pulley is wide enough to permit the required vertical movement of the slide. The work table is driven from the drum pulley seen at the rear of the column. This pulley receives its motion through gearing from an intermediate vertical shaft which, in turn, is driven by a quarter-turn belt connecting with the inner end of the horizontal driving shaft. The drum pulley is also wide enough to permit the necessary vertical movement of the lower slide. The wheel slide is counterbalanced by a weight inside the column, so that when the operating lever is thrown back, the slide returns to its upper position, thus leaving plenty of room under the wheel for placing or removing work. The link and lever connections seen at the side of the column, connect the wheel slide with a jaw clutch inside the work-table driving drum, and disconnect the latter from the shaft on which it is mount-

ed, when the wheel slide is in the upper position. By this means, the work spindle is automatically stopped whenever the wheel is raised from the work. It is sometimes advisable to clean the chuck face while in motion and, in such a case, the drum-clutch operating mechanism may be disengaged, thus giving an independent control of the work spindle through the foot lever seen at the base of the machine.

When this machine is to be used for concave grinding, the knee supporting the work table is tilted to the required angle. The knee is separate from the slide and has an overlapping ledge at the top, on the outer corners of which are set-screws. These set-screws provide means of correct alignment in one direction and form pivoting points. The tilting movement is effected by the knurled screw seen near the lower end of the knee. The latter is held against the slide by four cap-screws which have located quite near them, four adjusting set-screws. These set-screws are permanently set for aligning the knee, but can be re-adjusted at any time if necessary. The knee has an adjustment of two degrees and can be quickly reset in a level position without re-aligning.

Work having a concave surface is not held directly against the magnetic chuck, but on an auxiliary plate. The magnetic power of the main chuck is transmitted through this auxiliary plate, the upper surface of which is shaped to suit the work. The use of the auxiliary plate in connection with the grinding of a milling saw is illustrated in Fig. 2. After the saw is ground concave on one side it is held for grinding the opposite side on a plate having a convex face. If the saw were held for grinding the last side, against the flat face of the regular chuck, it would be pulled down in the middle, thus making it impracticable to concave both sides alike. Fig. 3 shows the method of grinding such work as dies, disks, etc., and Fig. 4 illustrates how piston-rings or similar parts are held. Fig. 5 shows how a number of small washers can be ground at one setting. These washers are separated by a perforated iron or brass disk, which acts as a retainer and holds the parts in the required position over the poles of the magnetic chuck. Fig. 6 illustrates how parts can be located on a chuck for multiple grinding, so that they support each other, thus making it unnecessary to use stays. These different views are shown to indicate, in a general way, how various kinds of work is ground on a machine of this type.

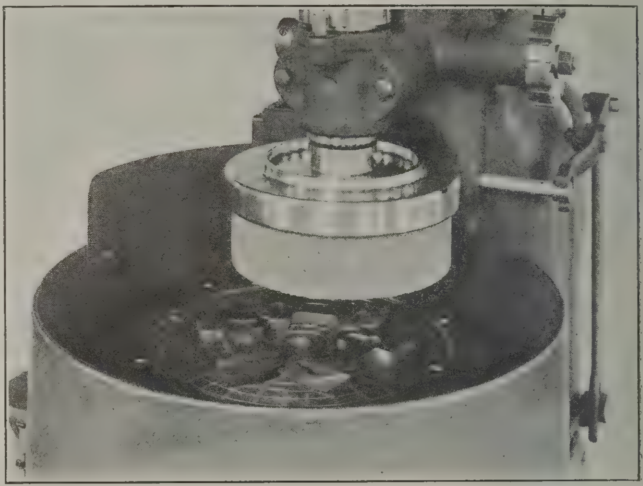


Fig. 6. Small Parts placed on Chuck so as to support Each Other

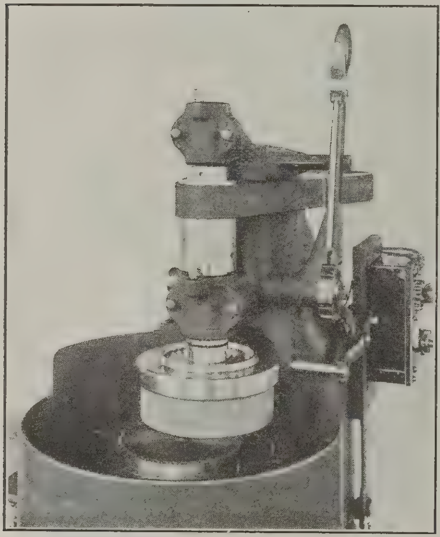


Fig. 2. Grinding a Concave Saw

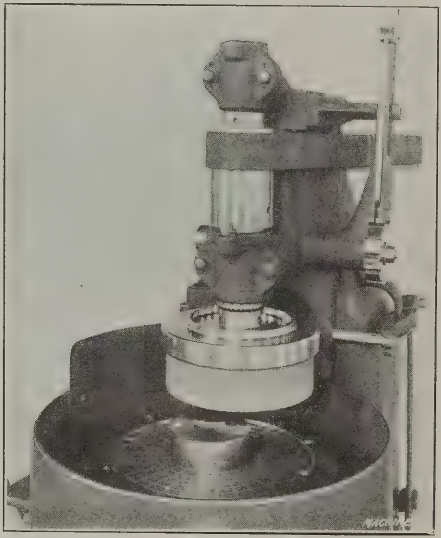


Fig. 3. Grinding a Die

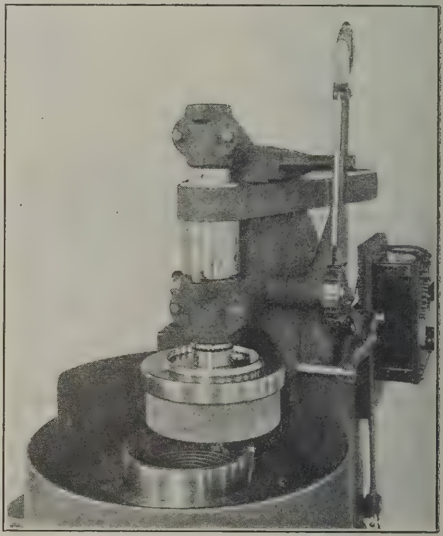


Fig. 4. Method of Holding Piston-ring

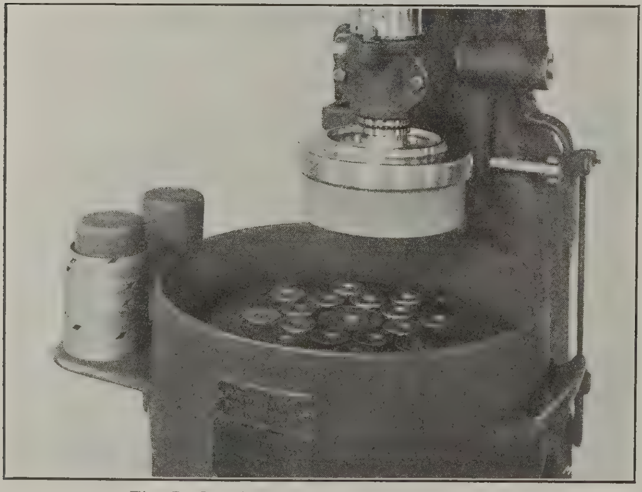


Fig. 5. Multiple Grinding of Small Washers

BAKER BROTHERS AUTOMATIC DRILLING MACHINE

Baker Bros., of Toledo, Ohio, have brought out a new type of drilling machine designed to reduce the idle or non-productive period connected with drilling operations. The maximum time required for drilling many classes of work is not consumed while the drill is passing through the material, but while the operator is placing the work in position, advancing the tool to the work through the jig bushing or clearance space, engaging the feed, withdrawing the tool and removing the work. After considerable study and experimenting, this company has developed a machine to perform these operations automatically—as far as the movement of the drill-spindle is concerned—and in a minimum of time. This machine, which is illustrated in Figs. 1 and 2, is so simple in construction that changes for different classes of work can be made quickly. The spindle is fed to the proper depth and returned by means of a cam which gives a powerful feed and a quick return movement. The feed also has a dwell at the end of the downward movement, which adapts the machine for accurate facing operations.

Either a plain work-table or one having an automatic index-

ing movement is provided. The automatic table is intended for work which is comparatively small, thus permitting a number of parts to be held in a suitable fixture around the periphery of the table, as shown in Fig. 2. As the forward and return movements of the drill spindle are automatic, the operator simply inserts new blanks and removes those that are drilled. The automatic indexing motion takes place as soon as the spindle is withdrawn and rotates the table to the next position, thus bringing a new piece of work under the drill or other tool. The period required for withdrawing the tool and indexing the table varies from two to three seconds. Change-gears are provided for indexing the table any required number of divisions from five to eighty. As the table can be adjusted in or out, holes can be drilled on circles of any radius within the capacity of the machine, by providing the proper change-gears for the indexing movement. The standard machine will drill holes in circles varying from four to twenty inches in diameter. A scale is provided which shows the diameter of circle on which the drill is set for any position of the table. When this machine is used for chuck work, the table usually has from six to eight chucks, and all the workman has to do is to insert and remove the work, as the machine itself requires no attention other than to see that the tools are kept sharp. If a drill should break, the machine can be stopped instantly.

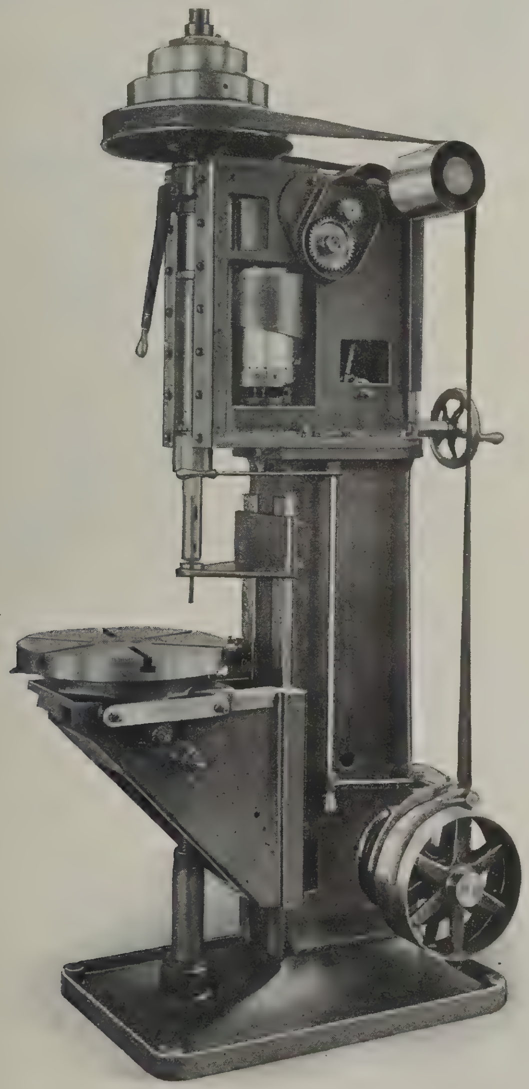


Fig. 1. Baker Bros. Automatic Drilling Machine

In case it should be desirable, the machine can be made to skip any number of chucks when indexing.

When a plain table is used, the operator places the work under the drill-spindle and trips the machine by a foot-lever, the same as he would a punch press. The spindle then advances and the drill passes through the work, after which the spindle returns quickly to its upper position. The operator then removes the finished piece of work, places another blank in position and trips the foot-lever as before, which causes the spindle again to feed down and return automatically. As the machine is entirely controlled by the foot-lever, the operator can use both hands for inserting and removing the work, thereby securing a very rapid production. The plain table is used for work which, because of its shape or size, could not be handled on a machine of the automatic indexing type, such as is shown in the accompanying illustrations.

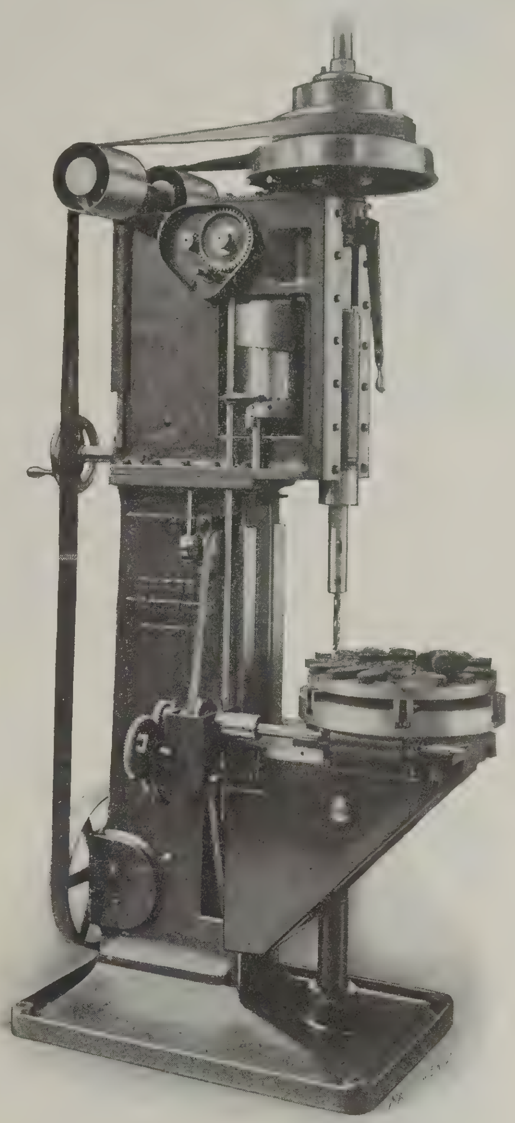


Fig. 2. View of Baker Bros. Drilling Machine showing Table Indexing Mechanism

This machine has a capacity for drilling 1-inch holes in steel when using high-speed drills. The automatic indexing type will drill ¾-inch holes through a piece of cast iron ¾ inch thick, at the rate of eight holes per minute. The spindle is mounted in a bronze-bushed slide which operates on carefully scraped ways. The revolving cam-drum, which imparts a feeding movement to the spindle, acts against a roll attached to the spindle saddle. This cam, in addition to "slip" change-gears, gives the required feed variations. One cam is provided with each machine.

The spindle has a vertical movement of 6 inches. It is made of high-carbon, hammered crucible steel and has a minimum section of 1¾ inch. The end is bored to a No. 3 or 4 Morse taper. There are six spindle speeds ranging from 200 to 800 revolutions per minute, the changes being obtained by means of the three-step cone pulley shown, and a two-speed countershaft. The idler pulleys at the rear are mounted on a vertical slide which can be adjusted to align the pulleys with different steps on the spindle cone, by means of the handwheel seen at the rear. The spindle is driven by a 2-inch belt and the distance from the center of the spindle to the frame is 8 inches. All the running bearings of this machine are equipped with ball bearings. The machine can be arranged for either motor or belt drive.

NEW BRITAIN SCRAPING STAND

The stand shown in the accompanying illustrations is used for holding work while scraping the bearing surfaces. This stand is especially useful in connection with the scraping and fitting of dovetail ways or bearing surfaces which are at an angle with the face of the work. The table to which the parts are clamped can be adjusted to hold the work in a horizontal position, or it may be tilted to locate the surface being scraped in a more convenient position for the workman, as indicated in Fig. 2.

Fig. 1. New Britain Scraping Stand

The table is locked in position by means of hinged clamping levers which are permanently attached to the stand. The table may be inclined to any angle up to 90 degrees. The face of the table is 16 by 30 inches. The work is held in position by means of bolts that engage T-slots cut in the table face. The height of the table can be varied from 28½ inches to 34½ inches. This adjustment is effected by means of a "quick-pitch" screw located within the column. After the table is raised to its extreme height, it still

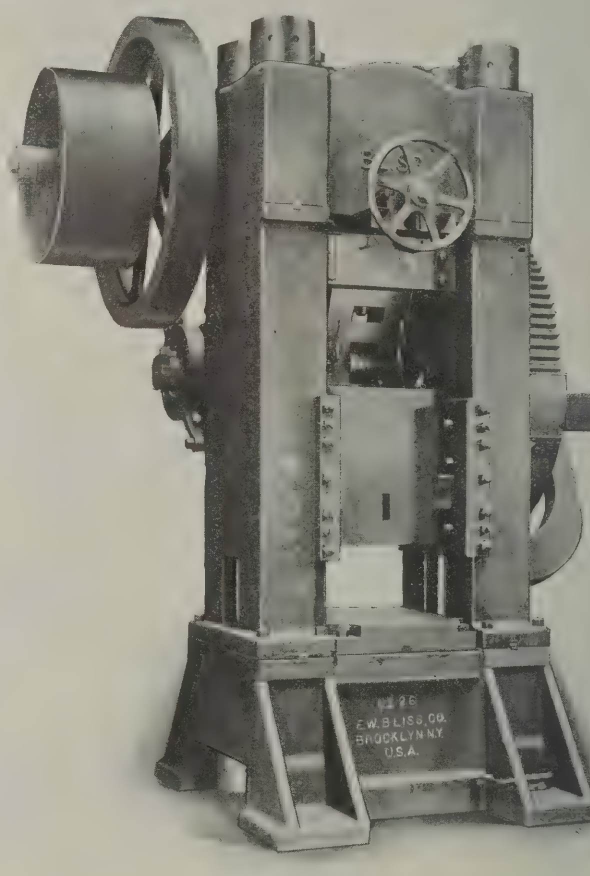
Fig. 2. Stand set for Scraping Angular Surfaces

has a bearing on the column so that it cannot be accidentally turned out of the base. The vertical adjustment permits the work to be held at the most convenient height for the workman. This scraping stand is made by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn.

BLISS "KNUCKLE-JOINT" PRESS

Power presses of large proportions and great capacities are being used increasingly in connection with many manufacturing operations, owing to the fact that many articles can be produced more economically and uniformly in a press than by the methods formerly employed. The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., is now building a new line of knuckle-joint presses, one size of which is shown herewith. These presses are used for heavy stamping and embossing operations on steel, brass, copper, silver, Britannia, etc., and they are particularly adapted for embossing operations in the manufacture of medals, coins, jewelry, etc. The toggle-joint gives a powerful movement to the slide at the end of the stroke when the work is being done. A comparatively slow movement is also obtained at the end of the stroke which is desirable when it is necessary to have the metal flow while under pressure, as in embossing.

This machine is capable of exerting a pressure of 800 tons. The toggle links are placed above the slide in the same position as the pitmans of an ordinary crank press, and they are operated by a crankshaft in the rear of the press. This construction permits the use of positive knockout attachments in the bed and cross-bar knockouts in the slide. The powerful



Large Toggle-joint Embossing Press

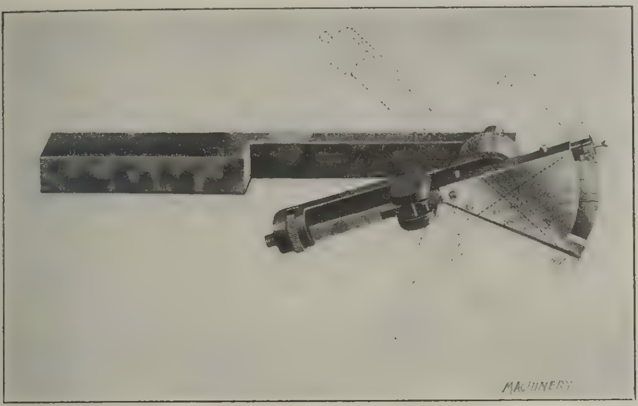
jaw clutch on this machine has three engaging points and is operated by the foot-treadle seen at the right. The necessary adjustment for dies and pressure is obtained by a taper wedge adjustment. The position of this wedge is changed by means of a screw, which, in turn, is operated by the handwheel shown.

This press is of the tie-rod construction, the bed and crown-piece each being separate castings. The side housings, which take any side strain and provide bearing surfaces for the slide and crankshaft, are also separate and of box section. Four large tie-rods pass through the side housings and take the entire strain when the press is at work. This construction not only prevents breaking the frame, but also provides a means for releasing the press should it become stalled on its center, as the tie-rods may be heated and expanded through suitable openings provided. The distance between the uprights of the press is 28 inches; the stroke of the slide is 2 inches, and the total weight of the machine is 45,000 pounds.

TEST INDICATOR

A new type of test indicator recently developed for use on a lathe, milling machine or in connection with tool-room work, is shown in the illustration. The instrument proper is very light and sensitive and has a scale with graduations reading to 0.0005 inch. Since these graduations are spaced ⅛ inch apart, a reading of 0.0001 inch can be obtained. As the tool is

mounted on an adjustable holder, it can be set in any direction as indicated by the lines. The position with relation to the work can be varied by an adjusting nut at the end of the tool, and there is an elevating nut for raising or lowering the indicator to bring it in alignment with the center line of the lathe. This indicator, when arranged as illustrated, can be used in an ordinary toolpost, and when the holder is removed, the stem fits the toolpost of any bench lathe or it can be clamped to the spindle of a surface gage in place of the scratch awl or scriber. Direct contact is made with work by



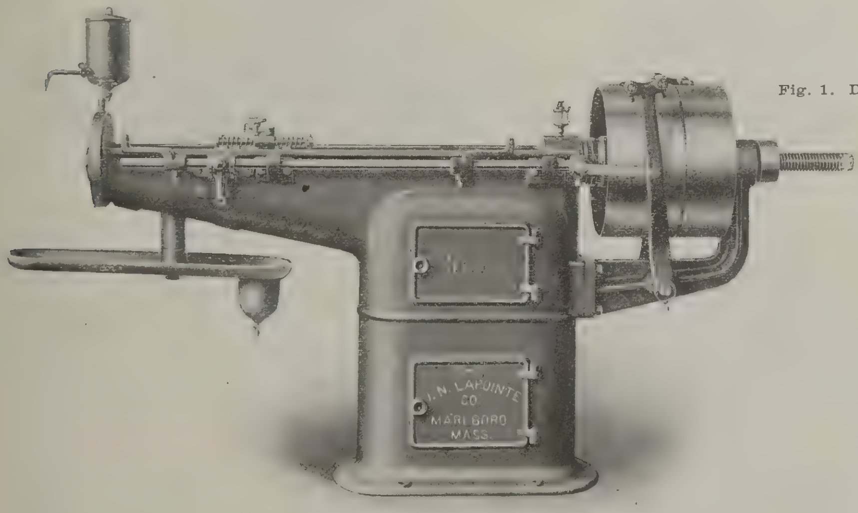
Test Indicator made by American Watch Tool Co.

a small ball point, which, through a system of levers, gives a reading on the scale that is multiplied about two hundred times. The contact point is removable and can be replaced by finer ball points, flats or any special shape required. The working parts of the indicator are all carefully protected from injury by a metal shield. This indicator has been placed on the market by the American Watch Tool Co. of Waltham, Mass. It is an accurate and inexpensive instrument for use in machine shops or laboratories.

LAPOINTE BROACHING MACHINE

A light type of broaching machine has been designed by the J. N. Lapointe Co., Marlboro, Mass., for keyseating comparatively small parts, such as the change- or feed-gears used on various types of machines. This machine is said to cut keyways in work of this kind at the rate of from 150 to 200 pieces per hour. It has a capacity for broaching keyways up to 3/8 inch in width, and usually from two to four parts can be broached simultaneously.

The construction of this machine is very simple. There is a sliding head having a stroke of 40 inches, which is actuated by a 2-inch non-revolving screw. This screw passes through a revolving bronze nut which is inserted in the hub of the driving pulley. Two loose pulleys are mounted on the hub of the tight pulley, this hub acting as a bearing for the driving mechanism. This combination of pulleys and also the belt shifting device, is similar to the arrangement used on planers. The driving belts can be shifted by hand, or automatically by means of adjustable dogs. The rod which carries the stop-dogs, is connected with two swiveling belt-forks which are mounted on a shaft passing through the bracket shown. When the sliding head comes in contact with one of the stop-dogs, either the forward or return belt is shifted onto the tight pulley, thus reversing the movement.



Lapointe No. 1 Broaching Machine

The stroke of the sliding head is varied according to the length of the broaching tools used, by simply changing the position of the stop-dogs. The driving nut is so arranged that it can be removed quickly for replacement, when necessary, by unscrewing a cap at the end of the driving pulley hub. This machine has a ball bearing thrust to eliminate excessive friction and wear on the nut and screw, especially when heavy broaching is being done. The ball bearing reduces the power required for operating the machine. This machine is also adapted for broaching square holes up to 5/8 inch.

DWIGHT SLATE AUTOMATIC DRILLING MACHINES

The multiple-spindle machines illustrated in Figs. 1 and 2 are automatic in that the feeding and return movements of

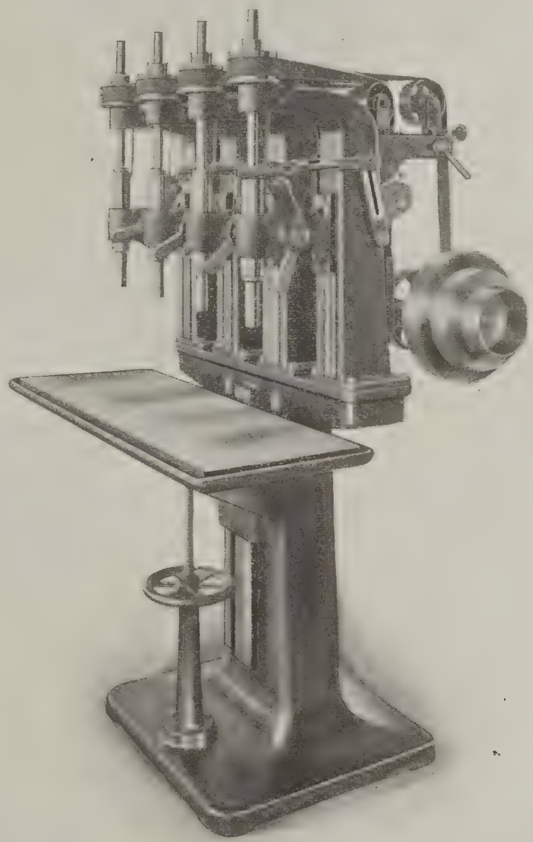


Fig. 1. Dwight Slate Cam-feed Automatic Drilling Machine

the drill spindles are obtained from cams. These cams are mounted on a shaft at the rear and are spaced at equal angles, thus giving the same intervals of time between the movements of each spindle. For example, the cams of a four-spindle machine are 90 degrees apart, whereas the cams of a six-spindle type are 60 degrees apart. When the machine is in operation, the various spindles move progressively and continuously, and the workman's entire time is utilized in loading jigs and removing the drilled parts, so that a very rapid production is obtained.

These machines are of an improved design now being manufactured by the Dwight Slate Machine Co., Hartford, Conn. The machine shown in Fig. 1 has four spindles, and Fig. 2 is a rear view of a six-spindle type. Any number of spindles ranging from two to eight can be furnished. The number that

one man can operate depends, of course, on the time required for drilling the work. The end view, Fig. 3, shows the arrangement of the cam feed. The required movement for each spindle is obtained from an independent cam *C* which engages a roller on slotted arm *A*. The latter is connected to the pinion shaft by rod *B* and the lever shown.

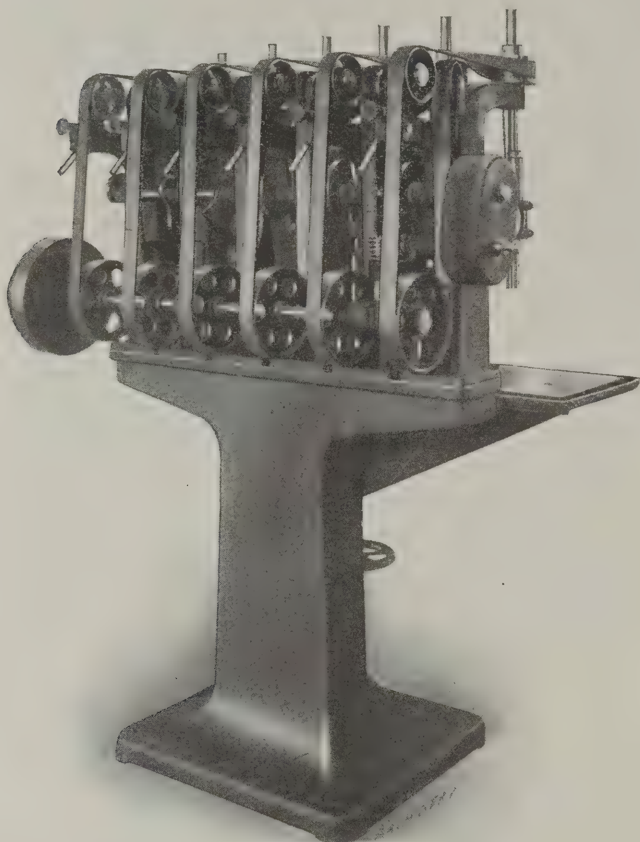


Fig. 2. Rear View of Six-spindle Cam-feed Drilling Machine

The stroke of the spindles is varied for drilling holes of different depths, by adjusting nut *a* on the slotted arm. The position of each spindle can also be adjusted independently for leveling the drill points, by loosening nut *D* and turning the

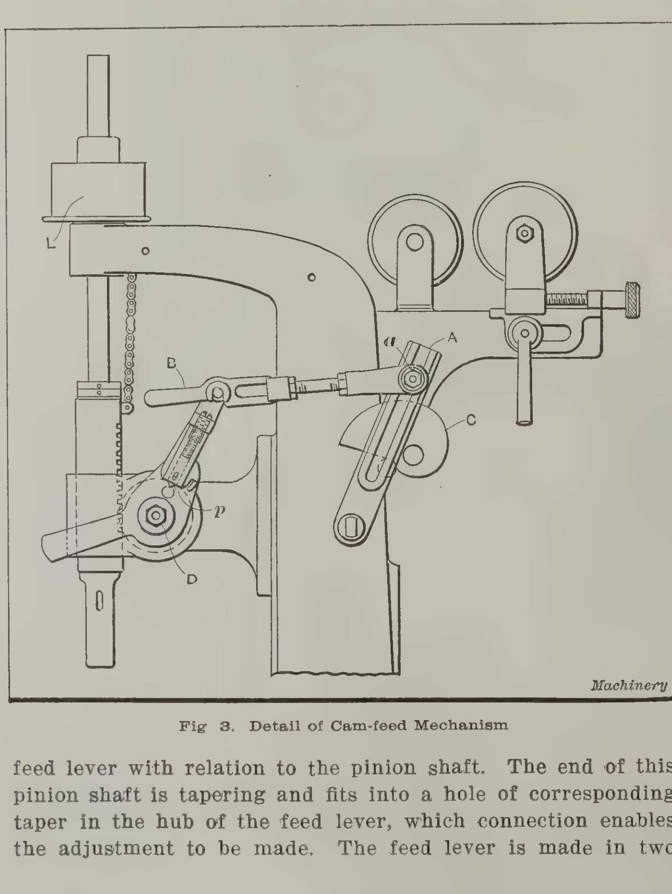


Fig 3. Detail of Cam-feed Mechanism

feed lever with relation to the pinion shaft. The end of this pinion shaft is tapering and fits into a hole of corresponding taper in the hub of the feed lever, which connection enables the adjustment to be made. The feed lever is made in two parts and is equipped with a safety device for stopping the feed in case of an overload at the drill point. The safety stop consists of a hardened, adjustable spring-plunger *p* which is inserted in the upper half of the feed lever and engages a notched stud attached to the lower half. If an overload occurs, plunger *p* is disengaged from the stud, thereby protecting the feed mechanism and preventing the breaking of drills to a large extent. The tension on this plunger can be varied for drills of different diameters. In case it is desired to feed one of the drill spindles by hand, this can be done by disengaging link *B*.

As the amount of feeding movement is limited to the throw of the feed lever, this machine is restricted to the drilling of holes not exceeding 1½ inch in depth. The cam-shaft is driven from the main shaft through worm gearing and the feed change mechanism seen to the right of the machine in Fig. 2. This gear box gives three feed changes which are obtained by shifting a small pull-pin. There are also three spindle speeds obtained by the three-step driving cone pulley. The spindle driving belts have adjustable idlers at the rear for varying the tension, and the spindle belt pulleys are equipped with oil reservoirs and an ingenious method of providing continuous lubrication.

The work table of this machine is securely locked to the column by a narrow gib located on one side of the central

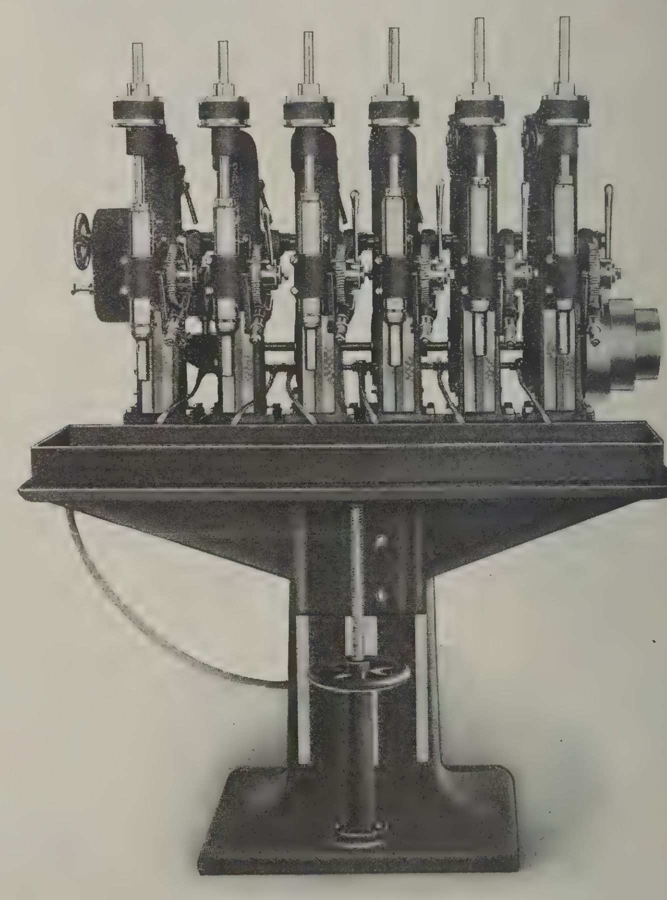


Fig. 4. Automatic Drilling Machine with Worm Feed

dovetailed way seen in Fig. 1. When this gib is drawn outward by a stud passing through the saddle, the table is clamped tightly against the outer bearing surfaces shown, and it is also securely locked to the central dovetailed way. The elevation of the table is effected by the screw and handwheel shown. This machine is especially adapted for drilling small duplicate parts such as are used in the manufacture of locks, light hardware, small tools and similar parts.

Fig. 4 shows another multiple-spindle machine of the same type but equipped with a different feeding mechanism. The arrangement of this feed is shown in Fig. 5. The feed movement is derived from a back shaft *U*, which is driven from the main shaft through a change-gear box, the same as with the cam-feed design. The feed worm *F* is supported and held in engagement with worm-gear *R*, by a latch-arm *A* which nor-

mally engages a supporting stud *I*. The adjustment of the automatic feed trip for drilling holes of any depth between 0 and 5¼ inches, is obtained by setting the adjustable ring *B* in the proper relation with the pinion shaft. This ring has a projecting lug, as shown, which disengages latch-arm *A* and throws out the feed. The distance that the projection on ring *B* travels before disengaging the latch, determines, of course, the depth of the hole drilled. The screw *N* and shoe *K* provide convenient means for securely locking ring *B* to pinion shaft *L*. The stop-pin *P* determines the maximum adjustment of ring *B*.

This machine also has an automatic safety release in case of an overload, which operates as follows: Worm *F* is keyed to rotate with its shaft, but is free to slide longitudinally. Under a normal load this worm is held in the operative position with respect to worm-gear *R*, by means of a ring *C* and compression spring *D*. When overload occurs, the worm moves longitudinally against the tension of compression spring *D*, and as the

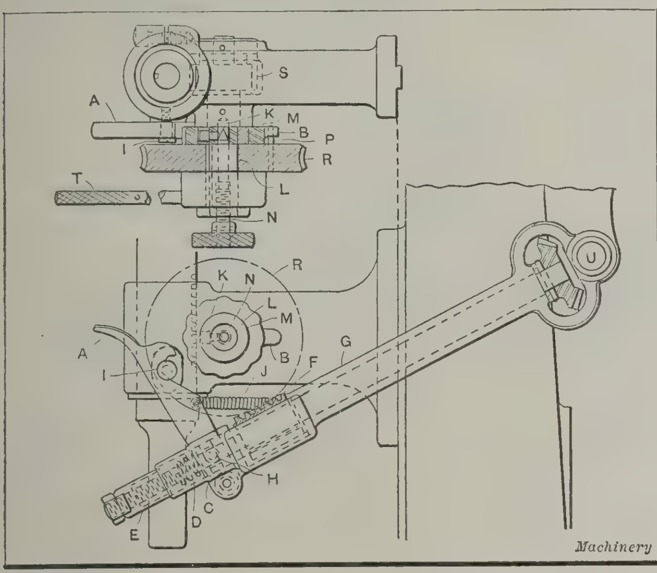


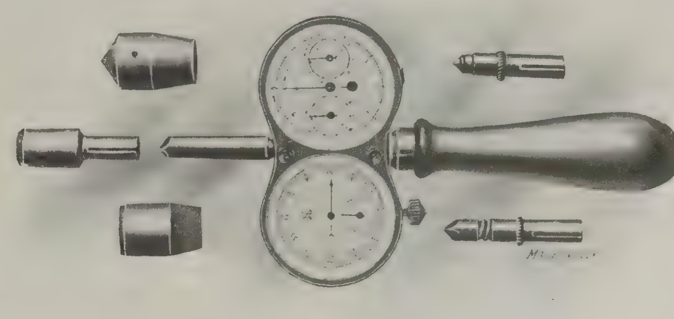
Fig. 5. Feed Mechanism of Machine illustrated in Fig. 4

worm is connected to latch *A* through the ring *C* and pin *H*, this longitudinal movement results in disengaging the feed. The tension of spring *D* can be varied for drills of different diameter, by cap *E* and the locking nut shown. The feed can be stopped at any time by throwing out latch *A*, and it is engaged by simply lifting the worm-shaft supporting arm *G*, which causes the latch to hook over stud *I*.

A multiple-spindle machine equipped with the worm feed, is recommended when the drilling is comparatively deep, and, especially, for work which cannot be quickly inserted in or removed from the jigs. On the other hand, the cam-feed machine is adapted to that class of work which is quickly drilled and easily jigged.

SCHUCHARDT & SCHUTTE TACHOSCOPE

The instrument shown herewith is known as a "Tachoscope" and consists of a revolution counter and a non-magnetic, precision stop-watch, which are so connected that they operate simultaneously the moment a slight pressure is applied to the center spindle. As soon as the pressure is released, both the revolution counter and watch stop at the same time, thus indicating on the dials shown, the number of revolutions made

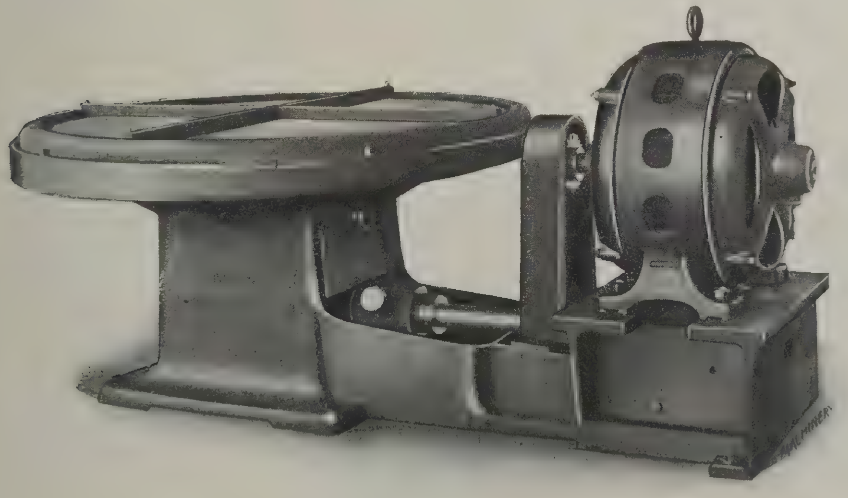


Combined Revolution Counter and Stop-watch

by whatever is being tested, and also the time elapsed. The small pointer on the watch dial records up to thirty minutes and then repeats, and the duration of the test is indicated in minutes, seconds and fractions thereof. The revolution counter has three pointers which indicate from 1 to 100, 100 to 1000 and 1000 to 10,000 revolutions per minute, respectively. This instrument can be used for right- or left-hand rotation and no adjustment or setting is required. The appearance of either a red or black disk on the counter dial, indicates whether right or left rotations are being counted, and the figures on the dials which correspond in color with this disk, are the proper ones to use. The counter and also the stop-watch, can be set back to the zero position instantly. The movements of the stop-watch and counter are said to equal in precision those used in high-grade time pieces. This instrument, which has been placed on the market by Schuchardt & Schutte, Cedar and West Sts., New York, is especially recommended for testing rapidly revolving parts and it can be used for speeds up to 30,000 revolutions per minute.

GARDNER MOTOR-DRIVEN DISK GRINDER

The large vertical spindle type of disk grinder which is built by the Gardner Machine Co. of Beloit, Wis., and was described in detail in the September, 1911, number of MACHINERY, is now equipped with a motor drive. The motor is mounted on an extension of the base and forms an integral part of the machine, as shown by the accompanying view. A 15-horsepower motor is used, and connection is made with the main shaft of the grinder by a silent chain. This main shaft, in turn, drives the disk wheel spindle through bevel gears which are fully enclosed and run immersed in oil. A guard covers the chain and gears as shown. The starting box for the motor is attached to the rear of the base and does not show in the illustration. The pedestal for the motor is made to accommodate any standard make that is specified.

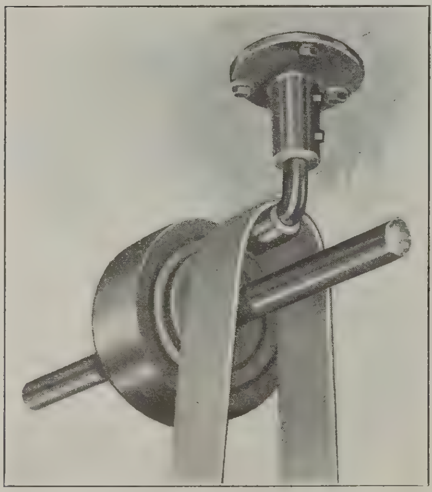


Gardner Vertical-spindle Motor-driven Disk Grinder

When these machines are installed in plants having no dust exhaust system, an exhaust blower is furnished. The pulley for driving this blower is attached to the main driving shaft, midway between the shaft collar and the silent chain gear. The disk wheel is driven at 500 revolutions per minute, and is 53 inches in diameter. This type of grinder is also made for a belt drive, from either overhead or underneath. The motor-driven type is often more convenient when it is desired to place the machine under a hoist or crane-way. The complete weight of the machine is 4500 pounds.

SAFETY BELT-HANGER

The Universal Stamping Co., 47 Poultney St., Buffalo, N. Y., is now manufacturing a safety belt-hanger which is designed to prevent the accidents caused by belts winding up on the shaft when they are thrown on or off the pulleys. This hanger consists of a cast-iron bracket which is fastened to the ceiling or shaft-hanger support, by three lag-screws or bolts. The hanger proper is made of steel tubing bent at right angles on the lower end. The horizontal part thus formed carries a roller which is held in place by a small casting driven in the end of the tube. The hanger is located over the center of the shaft, and on whichever side of the pulley the belt is usually thrown off. The supporting roller should be about one-half inch below the rim of the pulley. The end of the roller should also be close to the side of the pulley. When a belt is thrown off it runs onto the roller, and, if the other end of the belt is also thrown off the driven pulley, the belt will hang free from the shaft, as shown in the illustration. When a belt is being placed on the revolving pulley, it is first engaged with the stationary driven pulley, after which it is slipped onto the driving pulley by using an ordinary belt pole. As the belt is held close to the pulley rim by this hanger, it can be put on easily. This belt-hanger is made in three sizes for belts up to 6 inches in width.



Safety Belt-hanger

CHAMPION MOTOR-DRIVEN LATHES

The method of applying a motor drive to the 12-, 14-, 16, and 18-inch lathes built by the Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, Ohio, is shown in Figs. 1 and 2.

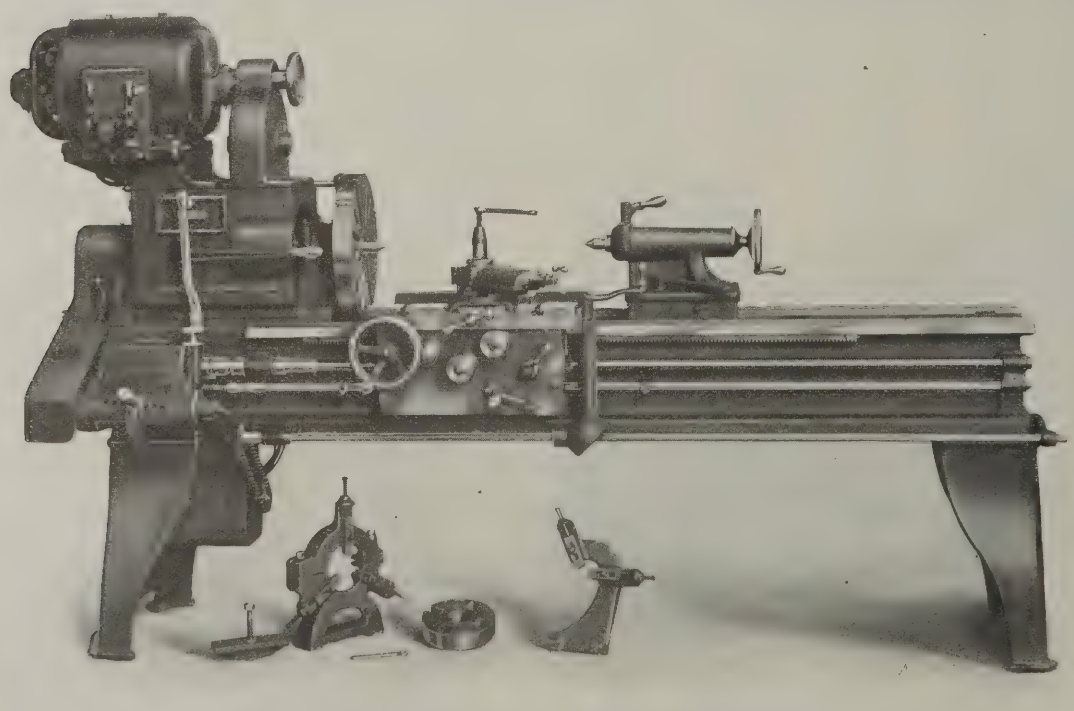


Fig. 1. Motor-driven Lathe built by the Champion Tool Works Co.

The power is transmitted from the motor to the lathe spindle as follows: A steel pinion mounted on the motor shaft, meshes with a raw-hide intermediate gear which makes the drive practically noiseless. This raw-hide gear drives a friction gear which runs freely on the spindle sleeve. Keyed to this sleeve there is a friction controlled by the horizontal lever seen in front of the headstock, and by means of this lever, the lathe can be stopped or started at will, independently of the motor. The drive from this point to the spindle is either direct through the face gear to which the friction can be connected by means of a locking pin, or through either one of the positive-clutch, double back-gears which are controlled by the vertical lever shown. These three mechanical changes in the headstock, in addition to those obtained by the three to one variable-speed direct-current motor, give a wide range of progressive spindle speeds. The spindle speeds vary (approximately) from 12 to 400 revolutions per minute, and the convenience of the control enables these changes to be obtained quickly and with little effort on the part of the operator.

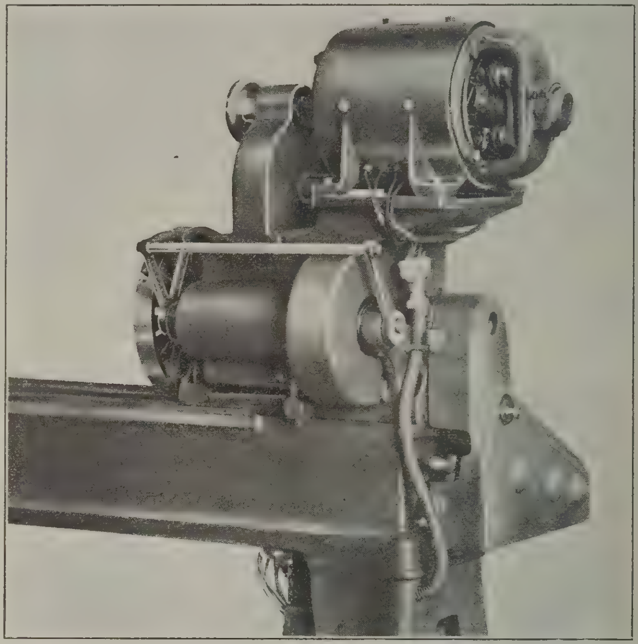


Fig. 2. Rear View showing Headstock End of Motor-driven Lathe

The speed of the motor is regulated by a drum-type controller located under the headstock end of the lathe. This controller is operated by the crank handle seen at the right of the apron. The connection between this handle and the controller is made through bevel gears, a splined rod and the chain and sprocket wheels shown. A handwheel on the outer end of the motor shaft, enables the operator to revolve the lathe spindle by hand, when this is necessary in connection with the chucking or inspection of work. Any standard make of motor having a speed variation of from 500 to 1500 R.P.M., can be used and the following sizes are recommended: For a 12-inch lathe, 1 horsepower; 14-inch lathe, 1 horsepower for medium duty, and 2 horsepower for heavy duty; 16-inch lathe, 2 horsepower; 18-inch lathe, 3 horsepower. These lathes can also be furnished for motors of the alternating current type.

The back-gears on this machine are so arranged that a change from the single to the double back-gear can be made without stopping the lathe. As previously stated, this change is effected by the vertical lever seen in front of the headstock. These gears have a positive internal key clutch, and the change

from fast to slow or *vice versa*, can be made quickly without shock or jar. The feeding movement of the lathe can be reversed either from the apron or headstock, and the longitudinal feed can be disengaged at any predetermined point by automatic stops. There is a chasing dial for thread cutting and an interlocking device to prevent engaging the screw and rod feed simultaneously. The quick change gear box gives forty changes for feeding and threading without removing any gears. Eight of these changes are obtained by a single lever, and one movement of a push-pin varies the entire range. All the gears are carefully guarded as will be seen by referring to the rear view, Fig. 2.

The 16-inch lathe has a swing of 17⅛ inches over the bed and a swing of 11⅝ inches over the carriage bridge. It has a capacity for cutting screws having from 2 to 56 threads per inch, including 11½ pipe thread. The ratio of the double back-gears is 8 1/3 to 1 and 3 to 1, respectively. A double friction countershaft, large and small faceplates, steady- and follow-rests, wrenches, etc., are included in the equipment. A taper attachment, chucks, chuck-plates, a draw-in attachment, spring collets, oil pan, pump, turrets for the carriage or bed, and similar equipment, can be furnished extra if desired.

SLOCOMB INSIDE MICROMETER SETS

The J. T. Slocomb Co., Providence, R. I., has recently placed on the market inside micrometer calipers in sets, contained in morocco-covered velvet-lined cases. Some of these sets contain only inside micrometers, and others have, in addition, regular outside micrometers, as shown in the accompanying illustrations. The set seen in Fig. 1 contains two inside micrometer handles, with two points for each handle for measuring diameters from ½ to 2 inches by thousandths of an inch. The set shown in Fig. 2 has one inside micrometer handle with two points for measuring from ½ to 1 inch, and it also contains a 1-inch outside micrometer. There are six sets, in all, which differ in the combination and number of tools they contain.

The form of the inside micrometer permits it to be used for measuring throughout the depth of any hole within its capacity and it is adapted for either tool-room or general machine shop work. This micrometer is a direct-reading instrument and can be set to given dimensions without using an outside micrometer. The inside micrometer is made in two sizes and each size has two measuring screws which are fitted with individual nuts graduated to read to thousandths of an inch. Adjustments for different diameters are obtained by turning these graduated nuts and the caliper is locked in any position by simply turning the knurled handle. The adjusting screw is prevented from turning with the nut by V-grooves engaged by a V-pointed spindle at the side, which is tightened by the handle and forms the lock. The V-groove has 1/10 inch graduations, which appear above the nut after every fourth revolution, thus giving a direct and continuous reading in addition to that obtained by finer graduations on the periphery of the nut.

Fig. 1. Inside Micrometer Set with Capacity for measuring from 1-2 to 2 Inches

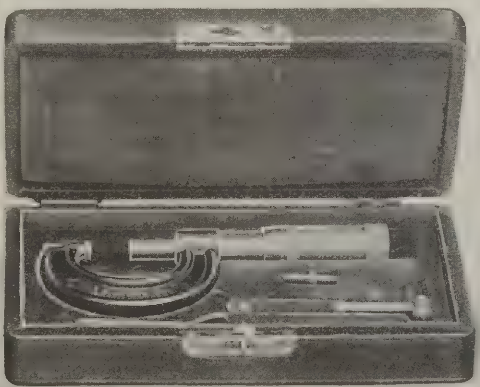
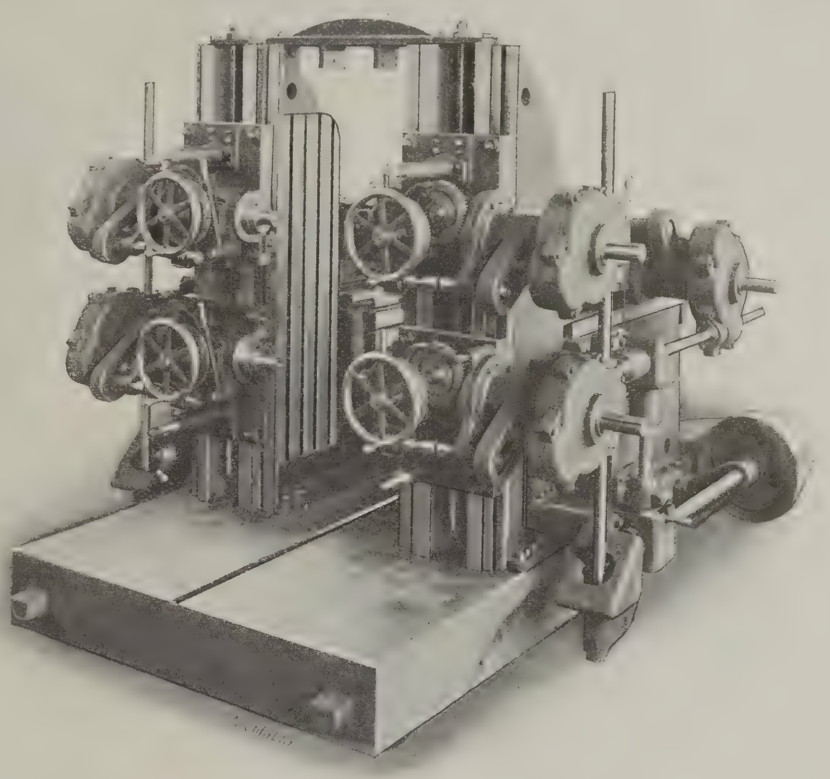


Fig. 2. Combination Set containing Inside and Outside Micrometer

BEAMAN & SMITH SIX-SPINDLE BORING MACHINE

The boring machine illustrated herewith is a special design built by the Beaman & Smith Co., Providence, R. I., for boring and reaming heater sections. This machine has a heavy base or platen upon which are mounted two uprights. On the front face of each upright, there are two adjustable saddles, each of which carries a horizontal spindle. At the rear of the upright, there are horizontal beds and each bed also has a saddle and horizontal spindle, making six spindles in all. The work is held in a jig and it is bored or reamed simultaneously from both sides, by the different spindles, thus giving a rapid production.



Beaman & Smith Special Six-spindle Boring and Reaming Machine

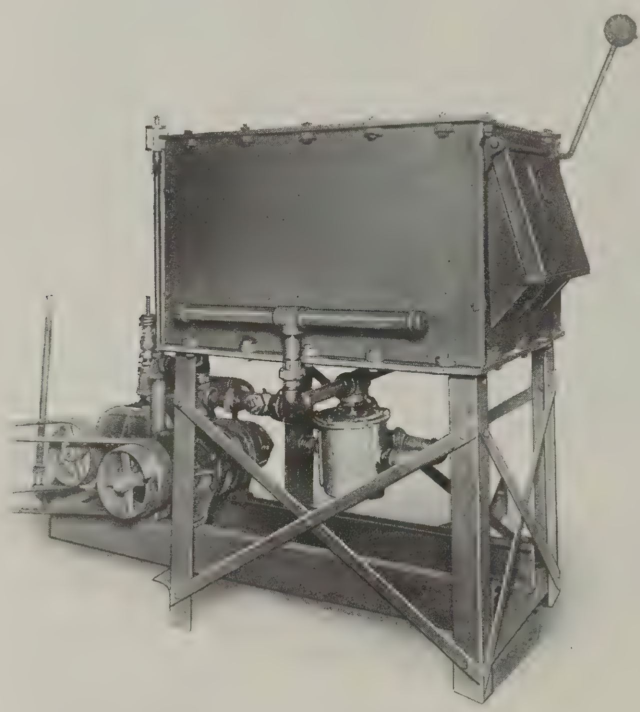
The platen is provided with a track on which a jig holding the work is rolled into position. Two jigs are required, so that one can be loaded or unloaded, while the other is in the machine. The spindles in each upright are driven in unison, and those on the beds at the rear are independent. All the spindles have a horizontal movement of 11 inches in their respective heads. There are four speeds ranging from 15½ to 32 revolutions per minute. The feeds for the spindles are automatic and vary from 1/64 to 1/16 inch per revolution. Variations of feed are obtained by change gears. Each side of the machine is driven independently by 5-inch belts which operate on four-step cone pulleys at the rear. The driving gears have a ratio of 14 to 1.

The spindles are all crucible steel and run in hard bronze boxes. The inner ends of the spindles are fitted to the particular form of cutter required. The platen of this machine is

6 feet wide and 10 feet long. The distance between the uprights is 23½ inches. The minimum distance between the centers of the front spindles is 18 inches and the maximum distance, 49 inches. The minimum and maximum distances between the ends of opposed spindles, are ¾ inch and 22¾ inches, respectively. The greatest distance between the front and rear spindles is 62 inches. The weight of this machine is approximately 31,000 pounds.

CASEHARDENING AND ANNEALING FURNACE

The casehardening and annealing furnace shown herewith is manufactured by the Wisconsin Foundry & Machine Co., Madison, Wis. The principal features claimed for this furnace are: high temperatures with a minimum amount of gas, ease of heat regulation for constant temperatures, and simplicity of operation. The furnace proper has a fire-brick heating chamber, 15 inches wide, 11 inches high, and 30 inches



Casehardening and Annealing Furnace

long. This chamber is thoroughly insulated from the iron shell by air spaces and asbestos board strips. The insulation is said to be so effective that the furnace chamber remains hot after the fire has been out about fifteen hours. The furnace door is easily opened or closed, owing to the ball counterweight provided. Each installation is supplied with two positive-pressure blowers of sufficient size to produce the best results. The air and gas enter, separately and under pressure, a mixer which is seen under the furnace. Here the gas and air are thoroughly mixed, and this mixture passes to the furnace through a single pipe. It is claimed that a temperature of 2500 degrees can be easily obtained. The installation illustrated is equipped with a gasoline priming system which is used to advantage in starting the furnace, or for enriching a poor quality of gas, in order to get the desired heat. This furnace can also be supplied in sizes varying from 15 by 15 inches to 15 by 36 inches.

SHUSTER STOCK STRAIGHTENER AND CUTTER

The machine shown herewith is designed to automatically straighten and cut to accurate lengths either square, hexagon or flat stock. It has a capacity for ¾ inch squares or hexagons and it will also handle flat stock 1¼ inch wide by ¼ inch thick. A maximum length of 20 feet can be cut, but

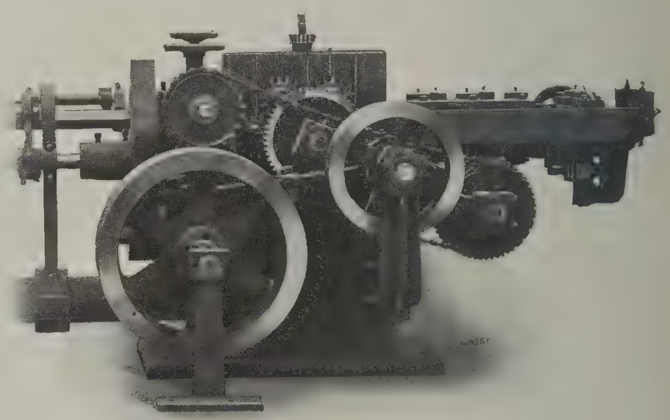


Fig. 1. Rear View of Shuster Stock Straightener

only part of the extension of the machine is shown in the illustration.

The machine is driven by a balance wheel (see Fig. 1), which connects with a train of gears operating the horizontal and vertical straightening rolls and feed rolls. There are five vertical and five horizontal rolls, all of which are gear driven. These rolls have grooves corresponding to the shape of the material they are to handle. The upper horizontal rolls and the rear vertical rolls are adjusted, by means of suitable screws, to suit the size of the material. The front feed rolls are adjusted by the handwheel shown above them, and they are driven in unison with the back feed rolls, by the chain and sprockets, seen in Fig. 1. The back feed rolls (at the left end of the machine) are also adjusted by a handwheel.

The extension consists of a guide-bar having a suitable groove for the shape of material being handled, and a cover or apron. There is an adjustable stop-gage which is set for the length to be cut. The coil of stock should be mounted on a suitable reel located at the end of the machine. The stock first passes through a guide and then enters the rear feed rolls. The straightening rolls are next encountered and then the front feed rolls. After passing the latter, the stock moves through a bush die, past the cutter knife and into the guide-bar until it strikes the stop gage previously referred to. Then

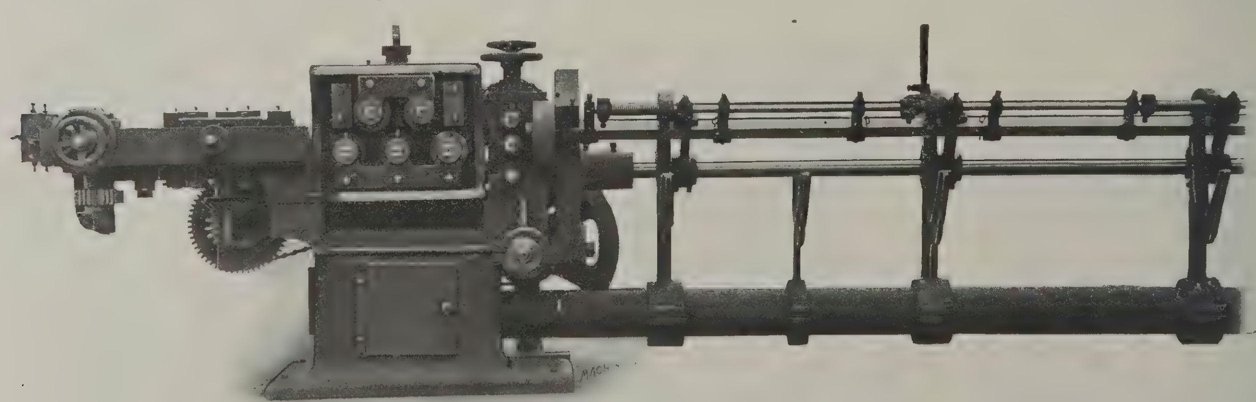
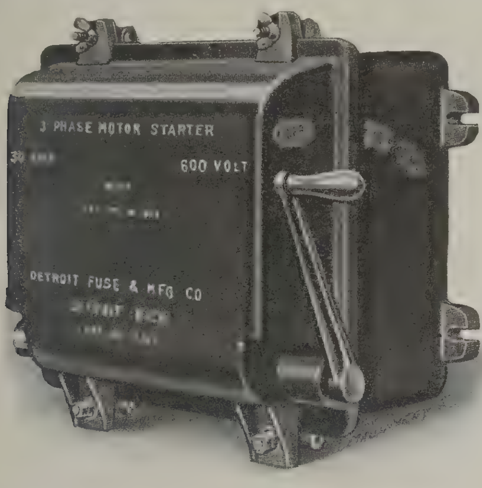


Fig. 2. Side View of Shuster Geared-roll Stock Straightener and Cutter

the cutting mechanism is automatically set in motion and the knife severs the piece, after which the guide-bar cover is thrown open and the cut rod drops out into the forked holders or brackets shown. As soon as the stock strikes the stop-gage, a clutch mechanism is thrown in, which releases the feed rolls and causes them to remain stationary while the cutting operation takes place. This machine is built by the F. B. Shuster Co., New Haven, Conn.

DETROIT THREE-PHASE MOTOR STARTER

A new type of three-phase motor starter is now being manufactured by the Detroit Fuse & Mfg. Co., 1400 Rivard St., Detroit, Mich. This starter makes it unnecessary to "fuse" a three-phase motor for the starting current, and it automatically protects the motor from injury, as well as the operator. The size shown in the illustration, has a capacity of 30 amperes at 400 to 600 volts, and it is especially adapted



Detroit Three-phase Motor Starter

for motor-driven machinery using alternating-current motors with any voltage above 250 and not exceeding 600.

The starter is of very substantial construction, and all the mechanical or moving parts are enclosed in a cast-iron box. The switch is operated by the hand lever seen at the side of the box. To start a three-phase motor, this lever is moved to the "start" position. This closes the circuit and places the fuses in the circuit, but "parallels" them with a solid copper bar which takes care of the starting load. It is necessary for the operator to hold the lever in the starting position until the motor reaches its normal speed; he then removes his hand from the lever and the parallel bars are thrown out of the circuit without opening it. This leaves the fuses completely protecting the motor at its running load, without at any time breaking the contact, as is done when a double-throw knife-switch is used for this purpose. There are no flimsy or complicated parts connected with this starter, and in its operation there is no possibility of accidental contact with "live" parts The three-phase starter is also made in a 200 to 250 volt size.

NEW MACHINERY AND TOOLS NOTES

Chuck Closer: Stark Tool Co., Waltham, Mass. Hand-operated chuck closer for bench lathes which enables the work to be released or clamped while the lathe is in motion. This chuck is operated by a lever at the left of the headstock.

Band Saw: Houghton & Richards, 26 N. Clinton St., Chicago, Ill. Tilting band saw designed for cutting metal. The saw is operated by gravity feed and the band wheels are mounted on a tilting arm which swings forward over the table and gives a continuous feeding movement.

Lathe Center: Stark Tool Co., Waltham, Mass. Self oiling lathe center which can be oiled without withdrawing it from the work. The hole through which the oil is inserted, is normally kept closed by an adjustable brass collar. This collar retains the lubricant and excludes dust or dirt.

Tapping Machine: Evans Stamping & Plating Co., Taunton, Mass. Vertical tapping machine having an automatic stop mechanism for tapping to any predetermined depth. This machine is built for either hand lever or foot lever operation. It has a capacity up to ¼ inch, and the work table is 11½ inches in diameter.

Drilling Machine: Richmond Stay-Bolt Drilling Machine Mfg. Co., 11 E. Broad St., Richmond, Va. Machine for drilling the tell-tale holes in boiler stay-bolts. The bolts are dropped into slots in a revolving carrier, and then all the operations are performed automatically. The carrier may be easily adjusted to accommodate bolts of different lengths.

Emery Wheel Guard: Challenge Machine Co., Inc., Philadelphia, Pa. Emery wheel protector and dust guard. The guard proper is made of four heavy steel bands which have great strength. At the ends of the guards in front, there are adjustable shields which deflect the grindings and protect the eyes of the workmen. The guard is attached to the machine by a heavy arm.

Pipe Threading Machine: The Loew Mfg. Co., Cleveland, Ohio. Pipe threading machine which will not only cut off and thread pipe, but also cut off and thread nipples without the use of a nipple chuck. This machine is a lathe bed type. The die-head is self-locking and self-releasing. There are two changes of speed obtained by shifting gears, and no countershaft is required, as tight and loose pulleys are provided on the machine itself.

Die-Sinking Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Die-sinking machine designed to eliminate the use of special angular cutters by having a swiveling knee upon which the work table is mounted. By means of this angular adjustment of the work table, both internal and external clearances can be milled with straight cutters. The machine is equipped with both vertical and horizontal spindles and the latter is supported by an overhanging arm.

Speed Changing Mechanism: Burke Electric Co., Erie, Pa. Arrangement for changing the constant speed of alternating or direct-current motor, in connection with machine tool drives. It consists of a frame which supports a jack-shaft and the necessary pulleys for the speed adjustments. In the case of a lathe, the frame is attached to the headstock, and the jack-shaft is located above the main cone pulley, whereas the driving motor is mounted on an extension base at the rear.

Safety Device: J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Safety device for drop-hammers, designed to automatically prevent accidents to the operator when inserting work by hand. The device is used in connection with work which has to be "restruck" after the "flash" or excess metal has been removed. A spring steel guard is clamped to the guide or upright, and when the ram descends, the guard swings outward, thus forcing the hand of the operator away from the danger zone.

Gear Testing Machine: Peerless Gear Tester Mfg. Co., 602 Schofield Bldg., Cleveland, O. Gear tester for determining the concentricity, pitch diameter and variation in the tooth thickness of spur and bevel gears. The machine consists of a horizontal base, having a stationary and a movable block carrying hardened and ground studs for holding the master gear and the gear to be tested. There is also the necessary mechanism for transmitting the motion caused by inaccuracy in the gear being tested to pointers swinging over graduated dials.

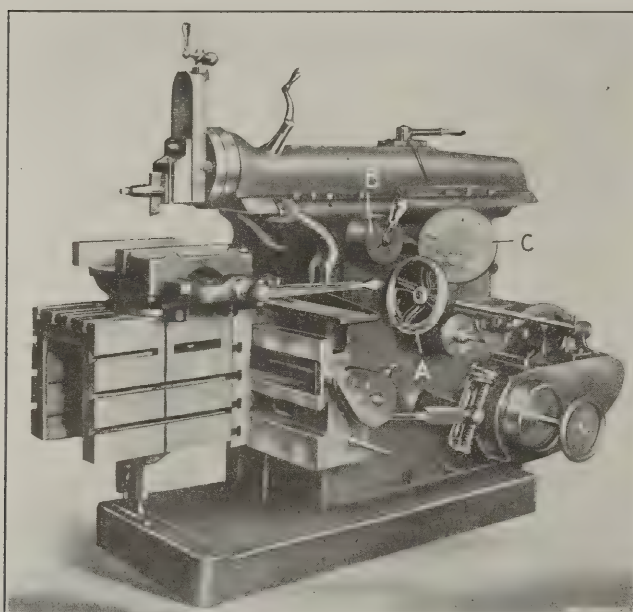
Surface Grinder: Northampton Emery Wheel Co., Leeds, Mass. Grinder for surfacing dies, chucks, straightedges, surface-plates, typewriter parts and all similar work within the capacity of the machine. This grinder is of the column-and-knee type and the table can be operated either by hand or automatically. The vertical feed is shown by a dial graduated in thousandths of an inch. Three sizes are built, the smallest of which has a table measuring 10 by 24 inches and the largest, 10 by 36 inches. A 12-inch wheel is used, and the side feed can be varied from 1/64 to 1/8 inch per stroke.

Motor Drive for Lathes: South Bend Machine Tool Co., South Bend, Ind. Double-belt reversible motor drive for lathes, consisting of a cast-iron bracket pivoted to a casting attached to the rear of the bed and carrying both the countershaft and motor. The motor is mounted on the lower end of this bracket and is connected to the countershaft at the upper end by open and cross belts. A cone pulley on the countershaft is belted to the headstock pulley, and the proper tension for this driving belt is obtained by simply adjusting the rear bracket by means of a screw in front of the lathe. The forward and reverse movements are controlled by a horizontal shifter rod which extends along the lathe bed and is within convenient reach.

The Periodograph: Gisholt Machine Co., Madison, Wis. Recorder for keeping accurate record of time required by workmen on various jobs. Each man is supplied with a card on which the recorder registers the time at which a piece of work is started. When the job is completed, the card is again placed in the recorder and the finishing time is automatically registered just above the starting time. By simply subtracting the lower figure from the upper, the net time is obtained. Spaces are provided on the card for several starts and stops, and by carrying the net periods to the right, it is easy to sum up the total time. The stamp automatically locates the card, so that the recorder can be operated by the workmen without chance of error.

SHAPER HAVING AUTOMATIC STARTING CONTROL AND SPEED DIAL

A motor-driven crank-shaper equipped with an automatic starting control and a speed dial for obtaining any desired cutting speed, is illustrated herewith. This is a Gould & Eberhardt machine and it is driven by a 5 horsepower Reliance adjustable-speed motor having a speed range of from 300 to 1500 revolutions per minute. The speed adjustments are obtained by mechanically shifting the motor armature by handwheel *A*. When the speed is properly set for a given operation, the motor can be stopped and started as often as desired, without further attention to the speed adjustment. This is due to the fact that the starting and stopping is entirely separate from the speed regulation and is controlled by an automatic



Motor-driven Crank Shaper equipped with Automatic Starting Control and Speed Dial

starter through the drum switch *B*. This switch has three positions, namely, the "start," "off," and "break" positions. To start the motor, it is simply necessary to throw the switch to the starting position. When the switch is moved to the "off" position, the power is shut off, and the time then required for the machine to stop will depend upon the time required for friction to overcome the momentum of the moving parts. When the switch is thrown to the "brake" position, the motor is automatically brought to a stop almost instantly. This simple method of stopping eliminates the necessity of a clutch, and the motor is never running idle, thus unnecessarily wasting power. The starter, which is mounted on a nearby post, is of the series control type and automatically takes care of all starting conditions. All wircs are carried in a conduit which is tapped directly in the drum switch, so that there is no exposed wiring.

The speed dial *C* is a device used with the Reliance adjustable-speed motors to enable the motor speed to be quickly regulated for obtaining any required cutting speed of the tool. This device is in the nature of a circular slide rule, and, in the case of a shaper, it takes into account all the variable factors, such as the ratio of the drive and the length of the stroke. The method of using this dial was described in the March number of MACHINERY. It is the product of the Reliance Electric & Engineering Co., Cleveland, Ohio.

* * *

PERSONALS

Henry L. Gantt spoke on "Scientific Management" before the American Society of Swedish Engineers, Brooklyn, N. Y., Saturday evening, March 23.

William H. Holland, of the Sibley Machine Tool Co., South Bend, Ind., has succeeded Mr. Walter A. Sibley as president and general manager.

E. H. Pratt, Lansing, Mich., has been promoted from the position of toolroom foreman to that of tool engineer of the Olds Motor Works of Lansing.

Frank P. Judge, formerly head of the mechanical department of the Wells Bros. Co., Greenfield, Mass., has been appointed general superintendent of the company's bolt cutter and gage shops.

George V. Rottweiler has resigned as chief engineer and factory manager of the Falls Machine Co., Sheboygan Falls, Wis. Mr. Rottweiler designed the line of gasoline motors built by the motor department of the company.

E. E. Barney of Syracuse, N. Y., the present manager of the Smith Premier Typewriter Works of Syracuse, has been appointed manager of the Remington Typewriter Works of Ilion, N. Y., to succeed Mr. John Calder, whose resignation takes effect May 15.

Albert G. Lea, who for the past five years was president of the Lea Equipment Co., New York and Philadelphia, has disposed of his interest in the company to Philadelphia parties, and has resigned as president. Mr. Lea will not enter active business for the present.

John Calder, who for several years has been manager of the Remington Typewriter Works, Ilion, N. Y., has resigned his position, effective May 15, to take a position with the Cadillac Motor Car Co., Detroit, Mich., where he will be associated with the management.

D. De Vries, manager of the well-known firm of dealers, R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland, is in this country, where he arrived February 20. Mr. De Vries expects to remain for about eight weeks, visiting the principal machine tool concerns throughout the country.

George Langen, works manager of the Cincinnati Planer Co., Cincinnati, Ohio, sailed March 18 for Europe, where he will make a trip covering the entire continent. Mr. Langen expects to be gone four or five months. The trip is taken principally in the interests of his company.

Walter B. Snow, publicity engineer, 170 Summer St., Boston, has increased his organization by the addition of Mr. Charles L. Mulligan, late of the editorial staff of the Brooklyn *Standard-Union*, and for a considerable period associated with the publicity department of the Western Electric Co.

Howard D. Penney, for several years foreman for the Knox Automobile Co., Springfield, Mass., and for the past two years with the Parker Transmission & Appliance Co., of the same city, has taken a foreman's position with the Hendee Mfg. Co., manufacturers of the Indian motorcycle, of Springfield.

C. F. Barker of the firm of Gilbert & Barker Mfg. Co., Hartford, Conn., retired from the firm on January 1, 1912, having reached the age where he felt that he had earned a well-deserved rest. Shortly before retiring, his associates in the office presented him with a clock as a token of their esteem and good wishes.

Frank D. Chase, associate member of the American Society of Civil Engineers and architect of the Western Electric Co., has opened offices in the Peoples Gas Bldg., Chicago, Ill., for the practice of architecture and industrial engineering. Mr. Chase will make a specialty of manufacturing plants and mercantile buildings.

Allen D. Risteen, who for the past twenty-three years has been assistant editor and editor of *The Locomotive*, Hartford, Conn., has resigned to become connected with the Travelers' Insurance Co., of the same city. Dr. Risteen has contributed many valuable articles on steam boiler inspection and practice to the technical press.

Arthur B. Tilton, assistant advertising manager of Hoskins Mfg. Co., Detroit, Mich., has been made advertising manager, succeeding Mr. H. Ralph Badger, resigned. Mr. Badger, who had been with the Hoskins Mfg. Co. for three years as publicity manager and assistant manager of sales, will for the present confine his attention to personal interests.

H. E. Harris has been appointed general superintendent of the Wells Bros. Co.'s tap and die plant. He was formerly the company's assistant superintendent and production engineer and came to them from the Western Electric Co., with which he had been master mechanic and methods engineer. Mr. Harris read the paper "Taps and Tapping," presented before the monthly meeting of the A. S. M. E., March 12.

George J. Henry, Jr., who has had eighteen years' experience with the Pelton Water Wheel Co., San Francisco and New York, ten years of which were spent as the company's chief engineer, and the past six years as chief engineer and sales manager, has resigned, and opened an engineering office at No. 737 Rialto Building, San Francisco, Cal. Mr. Henry will specialize on hydraulic machinery and hydraulic installations.

George H. Graves, treasurer, and George T. Coppins, secretary, of the Walworth Mfg. Co., Boston, Mass., were recently presented with loving cups by twenty employes of the company, only two of whom have been in the company's service less than twenty years. The average term of service of the givers of the cups is thirty-one years. Mr. Graves has been with the company forty-seven years, and Mr. Coppins thirty years.

H. R. Setz, who has been chief engineer of the Struthers Wells Co., Warren, Pa., for the past two years, has taken the

position of chief engineer with the Otto Gas Engine Works of Philadelphia. Mr. Setz was formerly connected with several of the leading European and American gas and oil engine manufacturers. His attention will be chiefly directed toward the development of a complete line of Otto-Diesel engines of the horizontal type.

C. C. Owens was recently placed in charge of the Detroit sales office of the Westinghouse Electric & Mfg. Co., with the title of district manager. Mr. Owens was born in 1877 and graduated from Columbian University, Washington, D. C. He entered the employ of the Westinghouse Electric & Mfg. Co. in 1896, taking the apprenticeship course for three years in the engineering department, specializing on switchboards and controllers. For the past eight years he has been connected with the New York sales office.

William R. Wherry, a Pennsylvania R. R. passenger conductor, was retired March 22, at the age of sixty-seven, after fifty years of active service. In this period he was never suspended or disciplined in any manner. Mr. Wherry was born in Cambria County, Pa., and when seventeen years old was employed by the Pennsylvania R. R. Co. as a freight brakeman. One promotion followed another until he was made a passenger conductor on the Pittsburg Division, where he is employed at the present time. The record of this passenger conductor, who is the type of man the company puts in charge of its trains, is given in a letter written by him to his superintendent: "I have now been running a passenger train for almost forty-six years and in that time have never had a serious accident, never had a passenger seriously injured or killed, have never been fined or suspended, always got along well with the traveling public, was never reported by a passenger that I heard of, and never was the cause of any lawsuits, which, when you consider the number of people of all kinds I have handled, is a wonder. It has always been my aim to do everything in my power to take my train over the division safely, and I have always held the company's interests first and have been loyal to it. I have never been seriously injured, but have had some very narrow escapes, having fallen between freight cars, and been knocked down by an engine and squeezed between cars."

* * *

OBITUARIES

Henry W. Spangler, Whitney professor of dynamical engineering, University of Pennsylvania, Pa., died March 17.

Alanson H. Merriman, a manufacturer of drop presses for the past forty years, died in Hartford, Conn., March 4, aged eighty-four years.

Frank E. Eggleton, superintendent of the molding department of the Waterbury Farrel Foundry & Machine Co., died March 5, at his home in Waterbury, of pneumonia, aged forty-six years.

John H. O'Donnell, regarded as an authority on wire drawing machinery, died at his home in Waterbury, Conn., February 27, aged forty-eight years. He was the inventor of the diamond wire-drawing die, and was prominently identified with various concerns in Waterbury and Seymour, Conn., and Worcester, Mass.

Charles Hart, president of the Hart Mfg. Co., Cleveland, Ohio, died February 9, aged sixty-two years. He was a lifelong resident of Cleveland and established the company of which he was president and treasurer, thirty years ago. He is survived by a widow, daughter and son, Mr. Louis F. Hart, vice-president and secretary of the company.

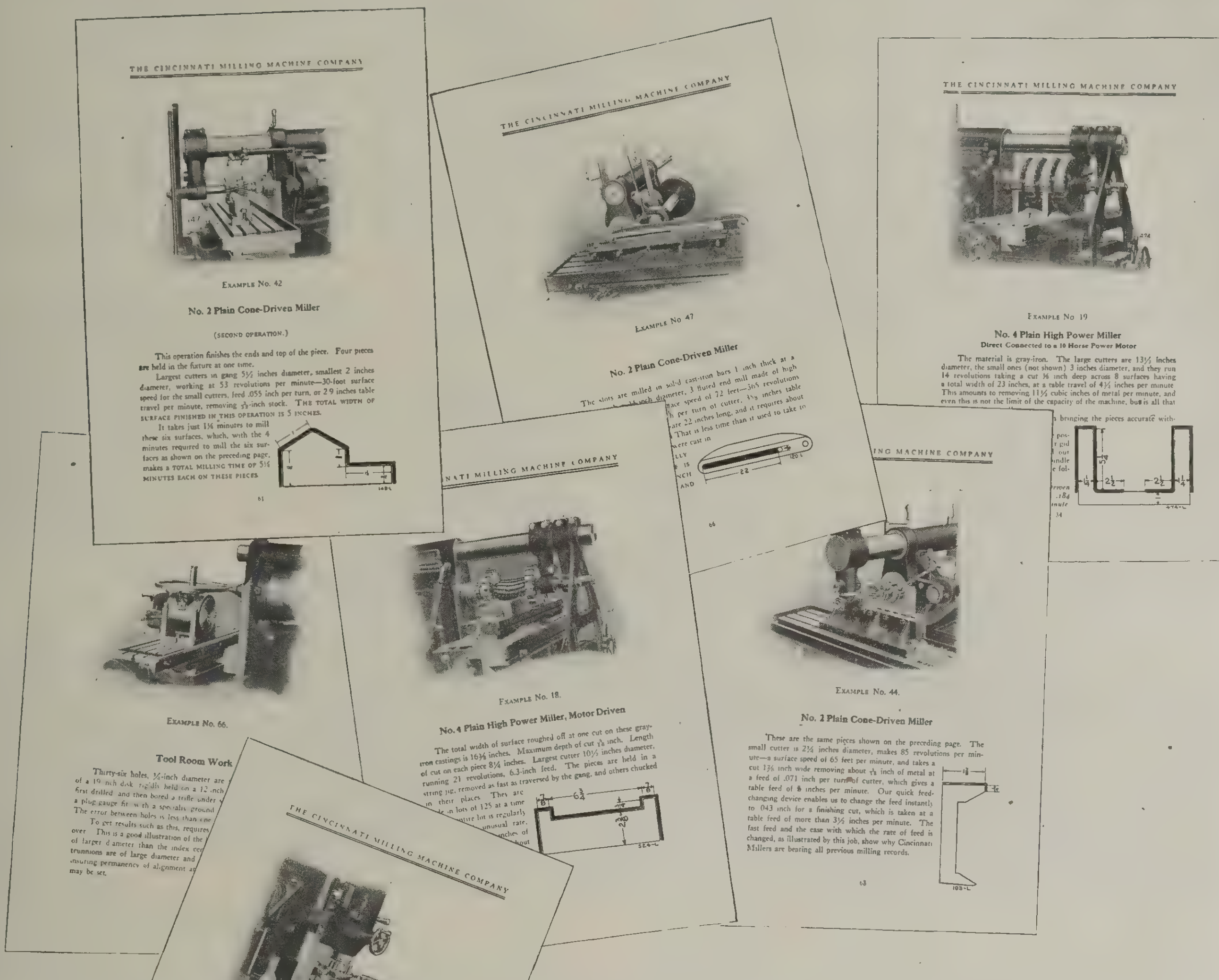
Elias G. Heller, president of the Heller Bros. Co., Newark, N. J., prominent steel and file makers, died at his home in the Forest Hill section of that city, March 22, of pneumonia, following apoplexy, in his seventy-fifth year. The firm of Heller Bros. was established in 1865 by the three brothers, Elias, Peter and Lewis, and a factory was built in the following year. The business soon outgrew the capacity of the building and a much larger plant was built in 1872. Lewis Heller withdrew from the firm in 1870 and Peter Heller in 1880, in which year the brothers George and John Heller were made members of the firm. Mr. Heller is survived by a widow and three sons, Paul E., Arnaud G., and R. Arthur Heller.

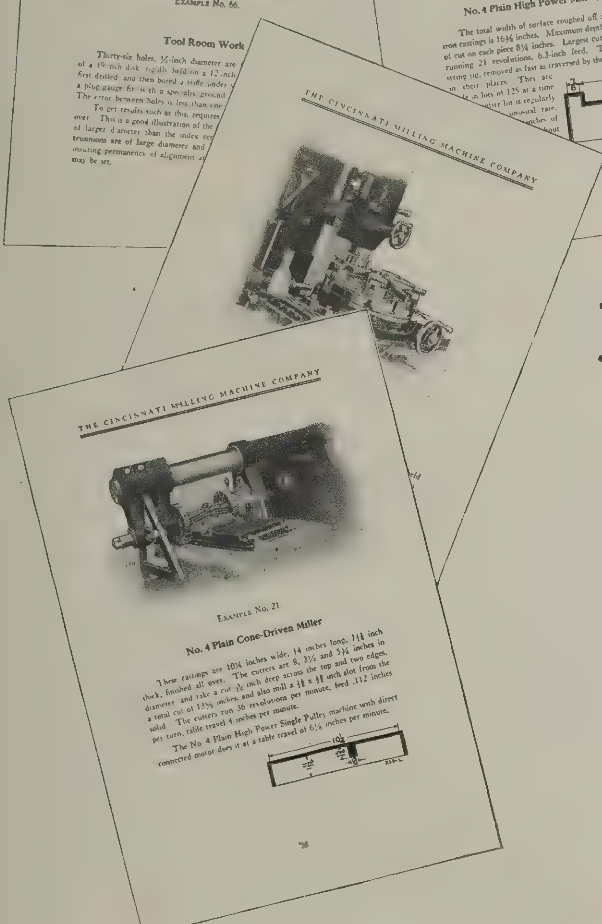
Rear-Admiral George W. Melville, formerly engineer-in-chief of the U. S. Navy, and world-famous as an engineer, inventor scientist and Arctic explorer, died at his home in Philadelphia, March 17 of paralysis, aged seventy-one years. At the outbreak of the Civil War, Melville, then twenty years old, entered the U. S. Navy and became an officer of the engineer corps. He saw much active service during the war and at its close was attached to the *Tacony*, with which vessel he served in the Gulf of Mexico during the occupation and evacuation of Mexico by the French. Melville's career as an Arctic explorer began with a trip to the North in 1873, when as assistant officer of the small sealing steamer *Tigress* he assisted in the search for the remaining members of the crew of the *Polaris*. Later he was the engineer officer of the ill-fated *Jeannette* expedition, and returned from this terrible experience in 1882. In the spring of 1884 he again went into the frozen North with the squadron dispatched to the relief of the Greeley expedition, the survivors of which were rescued in 1884. He was appointed engineer-in-chief of the Navy in 1887 for a term of four years and was reappointed four times successively, his retirement taking place in 1903. During this long period in the naval service one-hundred-and-twenty vessels were constructed, aggregating 700,000 horsepower. Rear-Admiral Melville was elected vice-president of the American Society of Mechanical Engineers 1895-97, president of the society in 1899, and in 1910 he was made an honorary member. Some years after his retirement from the Navy he and John Macalpine were associated in Philadelphia as a firm of consulting engineers and naval architects. During this association the Melville-Macalpine reducing gear was successfully developed for coupling steam turbines to marine propellers for the efficient propulsion of ships.

Milton Prince Higgins

MILTON PRINCE HIGGINS

Milton Prince Higgins, president of the Norton Co., and Norton Grinding Co., died Friday, March 8, at his home in Worcester, Mass., aged sixty-nine years. Mr. Higgins was born December 7, 1842 in Standish, Maine. He was the descendent of an old Cape Cod family which originally came from England in 1633. At the age of seventeen years he left home to serve an apprenticeship in the shops of the Amoskeag Mfg. Co., Manchester, N. H. While serving his time he studied evenings and saved enough money to enable him to go through Dartmouth College, from which he graduated in 1868. After his graduation he entered the employ of the Washburn & Moen Mfg. Co., under the late Mr. Charles Hill Morgan and later took a position as superintendent of the Washburn Shops of the then newly organized Worcester Polytechnic Institute, where he remained for twenty-eight years. In 1903 he was appointed a trustee of the Institute, which position he held until his death. Mr. Higgins took an active interest in the establishment of trade schools for mechanics, and his influence in industrial education has been wide-spread. During his association with the Worcester Polytechnic Institute he obtained a year's leave of absence to organize the shops of the Georgia School of Technology at Alabama. He also planned the shops of the Miller Manual Labor School of Virginia. In 1899, he presented a paper before the American Society of Mechanical Engineers on the education of machinists, foremen and mechanical engineers, thus being the first to introduce to the public the "half-time" school proposition. He was appointed a member of the state board of education by Governor Douglas of Massachusetts, and his vigorous efforts in this connection led to the establishment of the Worcester Trade School in 1908. While at the Washburn Shops, Mr. Higgins became interested in a small emery wheel business which he acquired in company with Prof. Alden. Under their management this business grew into the well-known firm of the Norton Emery Wheel Co., which later became the Norton Grinding Co. In 1896, the Worcester Polytechnic Institute sold its hydraulic elevator business to Mr. Higgins and Prof. Alden, who had been instrumental in building it up. Thus the Plunger Elevator Co. was established and carried on successfully until its absorption a few years ago by the Otis Elevator Co. In 1904, Mr. Higgins acquired an interest in the Worcester Ferrule & Mfg. Co., which in a few years greatly increased its business and was reorganized as the Worcester Pressed Steel Co. He was also president of the Manchester Supply Co., Manchester, N. H., and of the Sanford Riley Stoker Co., Providence, R. I. Mr. Higgins was a member and past vice-president of the American Society of Me-





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chanical Engineers and a charter member of the Society for the Promotion of Engineering Education. He leaves a widow, two sons and two daughters. One of his sons, Alden C. Higgins, is with the Norton Co., and the other, John W. Higgins, is manager of the Worcester Pressed Steel Co.

* * *

COMING EVENTS

April 10-11.—Fourteenth annual convention of the National Metal Trades Association in New York, Hotel Astor headquarters. Robert Wuest, commissioner, New England Bldg., Cleveland.

May 13-15.—Triple convention of the American Supply and Machinery Manufacturers' Association, National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association, at Norfolk, Va., Monticello Hotel, headquarters. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 13-25.—Newark industrial exposition under the auspices of the Board of Trade of Newark, N. J., in the First Regiment Armory. It is claimed that one hundred thousand different articles are manufactured in the three thousand shops of the Newark industrial district, the diversity being proportionately greater than that of any other manufacturing district in the country. William G. Rose, manager, Newark, N. J.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Building, Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

May 16-17.—Semi-annual convention of the National Machine Tool Builders' Association at Atlantic City, N. J., Hotel Chalfonte headquarters. E. P. Bullard, Jr., president, Bridgeport, Conn.; James H. Herron, secretary, Cleveland, Ohio.

May 20-22.—Railway Storekeepers Association's convention in Buffalo, N. Y. Hotel Statler, headquarters. Wm. E. Kelley, secretary-treasurer, 825 Wabash Ave., Chicago, Ill.

May 28-31.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Hotel Hollenden, headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

MANUFACTURERS' ASSOCIATION OF HARTFORD COUNTY, Hartford, Conn. Circular on a cooperative continuation course for shop boys offered by the Hartford Public Schools, which has been provided to fill the need of more efficient training for shop men, long felt by the manufacturers of Hartford. Charles B. Cook, manager of the Royal Typewriter Co., is chairman of the industrial educational committee of the Association.

FRANKLIN INSTITUTE, acting through its Committee on Science and the Arts, recently awarded the Elliott Cresson gold medal, the highest in the gift of the Institute, to the following gentlemen: Alexander Graham Bell, of Washington, D. C.; Samuel Wesley Stratton, of Washington, D. C.; Albert A. Michelson, of Chicago, Ill.; Alfred Noble of New York City; Elihu Thomson, of Swampscott Mass.; Edward Williams Morley, of West Hartford, Conn.; Johann Friedrich Adolph von Baeyer, of Munich, Germany; Sir William Crookes of London, England, and Sir Henry Enfield Roscoe, of London, England.

OSCAR E. PERRIGO, 6 Beacon St., Boston, Mass., has made an advance in the methods of correspondence school work whereby the courses of instruction are reduced in average cost and made of greater practical value to students. A special course is arranged for each individual to fit individual needs, and the tuition rates are made proportional to the requirements of the individual. The student is not required to spend time necessary to go over matter already well known, and he pays only for those parts of the course in which he needs specific instruction. The advantages of the system are obvious. Theory, practice and system for clerks, mechanics, engineers, accountants, manufacturers and other men connected with industrial work are taught.

NEW BOOKS AND PAMPHLETS

MECHANICAL STRESSES IN TRANSMISSION LINES. By A. GUELL. 31 pages, 6 by 9 inches. 10 illustrations. Price, 20 cents. 5 tables. Published by the University of Illinois, Urbana, Ill.

INDUCTANCE OF COILS. By Morgan Brooks and H. M. Turner. 72 pages, 6 by 9 inches. 25 illustrations and charts and 12 tables. Price, 40 cents. Published by the University of Illinois, Urbana, Ill.

BULLETIN OF SYRACUSE UNIVERSITY, Syracuse, N. Y. 509 pages, 5½ by 8½ inches. Contains general information on admission, courses, examinations, and list of students. Published by the University, Syracuse, N. Y.

ANNUAL REPORT OF THE DIRECTORS OF AMERICAN TELEPHONE AND TELEGRAPH CO. to the Stockholders, for the year ending December 31, 1911. 51 pages, 6 by 9 inches. Published by the American Telephone & Telegraph Co., New York.

FIFTY YEARS OF THE ARKWRIGHT MUTUAL FIRE INSURANCE COMPANY. By Edward V. French. 123 pages, 6 by 9 inches. Numerous illustrations, maps and charts. Published by the Arkwright Mutual Fire Insurance Co., Boston, Mass.

This book contains a history of the development of, and work done by the Factory Mutual Fire Insurance Companies during the past seventy-five years, and deals especially with that part of the work done by the Arkwright company in inducing manufacturers to cooperate for the prevention of fires in their plants, and for obtaining insurance at cost. The book is distributed to engineers, architects, manufacturers and others connected with and interested in fire prevention engineering. It gives a great deal of technical information, and should be very valuable to any one on whom it devolves to take precautionary measures against fire.

PRACTICAL PROBLEMS FOR VEHICLE DRAFTSMEN AND MECHANICS. By R. B. Birge and Hugh M. Sargent. 80 pages, 12 by 9 inches. Published by Ware Bros. Co., Philadelphia, Pa. Price $2.00.

This work is the outgrowth of practical experience in the classroom. The authors state that while intimately connected with the vehicle industry, they, in 1909, conducted an evening class in carriage drafting, and that the results of the first year were so encouraging that the work was continued through another year; the many problems which came up for discussion and solution in relation to the highly technical work of carriage body drafting were collected, and have formed the basis of the present treatise. The work contains first a number of geometrical definitions, followed by specific problems of particular interest to the carriage-maker. It is profusely illustrated, and contains not less than thirty-one full page plates with problems, and drawings of carriage bodies. The typographical execution of the book and the paper on which it is printed are of the best, making the intricate drawings extremely sharp and clear, and leaving nothing to be desired as regards distinctness in the execution of the design.

ENGINEERING AS A VOCATION. By Ernest McCullough. 201 pages, 5½ by 8 inches. Published by David Williams Co., New York. Price $1.00.

The subject matter of this work has been re-arranged from a number of addresses presented before technical schools, and is especially published for the information of parents in order that they may form a correct judgment in advising a career for their sons. In his preface the author states—certainly with considerable truth—that semi-technical periodicals and daily newspapers are the bureaus of information frequently consulted in matters of this kind, and perhaps more than one-half the students now in the technical schools are there because of the advice obtained from such sources. The book deals with the work of the engineer, the education of the engineer, and home study course. One chapter is entitled "How to Hunt and Hold a Job," and another, "Does it Pay to Study Engineering?" The work contains exact information on many subjects on which the prospective engineer should be informed, and will undoubtedly prove of value to anyone who is planning an engineering education for himself or for others.

WOOD-WORKING SAFEGUARDS. By David van Schaack. 217 pages, 6¾ by 9¾ inches. 320 illustrations. Published by Aetna Life Insurance Co., Hartford, Conn. Price $1.00.

This book offers a great number of practical suggestions for safeguarding workmen engaged in the lumbering and wood-working industries. It confines itself chiefly to machines, operations and conditions which are more or less common, but the suggestions contained should impress manufacturers with the possibilities in safeguarding, which, with some variation, will be applicable to many of the special machines used which it has not been possible to touch upon in a work of limited extent. The book is profusely illustrated, so as to clearly show the suggested safeguards. Different sections of the book are devoted to logging, saw mills, planing mills, circular saws, band saws, jointers, shapers, sanders, etc., and to the various wood-working industries. Special attention is also given to power generation and transmission, grinding wheels, and elevators. A carefully compiled index is an important feature of the book. It deserves a place on the desk of the executive of any industrial establishment employing wood-working machinery.

MARINE STEAM TURBINES. By G. Bauer and O. Lasche, assisted by E. Ludwig and H. Vogel. Translated from the German and edited by M. G. S. Swallow. 214 pages, 6 by 9 inches. 103 illustrations. 18 tables. Published by Norman W. Henley & Son, New York. Price $3.50.

The use of steam turbines for the propulsion of naval vessels has increased to a considerable extent during the last few years. The present book will therefore be welcomed by many engineers who are especially interested in this subject. The book is the work of men engaged in practical pursuits, and while it contains the necessary theory, yet the theoretical discussions have been presented in such a way as to be useful to any engineer with enough fundamental training to enter successfully upon the subject of the theory of steam turbines. The book is divided into ten parts headed as follows: Introduction; General Remarks on the Design of a Turbine Installation; The Calculation of Steam Turbines; The Turbine Design; Shafting and Propellers; Condensing Plant; Arrangement of Turbines; General Remarks on the Arrangement of Steam Turbines in Steamers; Turbine-driven Auxiliaries; and Tables. Being partly the work of an author who has already made himself favorably known to the steam engineering profession by his "Marine Engines and Boilers," it is safe to predict that the present book will be well received by engineers.

APPLIED METHODS OF SCIENTIFIC MANAGEMENT. By Frederic A. Parkhurst. 325 pages, 6 by 9 inches. 48 illustrations and 9 folding plates. Published by John Wiley & Sons, New York. Price, $2.00.

This book is based on a series of articles published by the author in *Industrial Engineering*, during 1911. A considerable amount of new matter, not contained in the original articles, is, however, included. The book does not deal with mere principles, but shows the actual application of these principles to every-day practice. As a concrete example, the history of the application of scientific management to the works of the Ferracute Machine Co., at Bridgeton, N. J., is recorded. The system adopted, closely follows the lines laid down by Fred W. Taylor, and is particularly suited to businesses employing one hundred people or more. The book is logically arranged, and commends itself particularly to the manager or superintendent on account of the practical, precise and detailed manner in which it has been written. The "glittering generalities" with which books and articles on scientific management have often been filled, are here reduced to distinct rules and descriptions of definite methods. The appendix, which contains most of the new matter not included in the original publication, and which covers over one hundred pages of the book, is especially profuse in definite information relating to the duties of the various officers and men in the shop, with instructions for each. The thoroughness of the treatment in this respect may be judged from the fact that instructions are included for the duties of the shop drawing boy, the night watchman, the janitor, the crane boss, etc. Altogether, it seems that this is the very kind of a book which persons who have looked for really practical and definite information on scientific management will welcome.

NEW CATALOGUES AND CIRCULARS

GENERAL ELECTRIC CO., Schenectady, N. Y. Booklet No. 4930 on electrically driven refrigerating machinery.

GISHOLT MACHINE CO., Madison, Wis. Leaf illustrating Gisholt 36-inch boring mill equipment for finishing flywheels in one chucking.

MAX AMS MACHINE CO., Mt. Vernon, N. Y. Circular of the Ams power presses, showing a few of the recent designs and additions to the line.

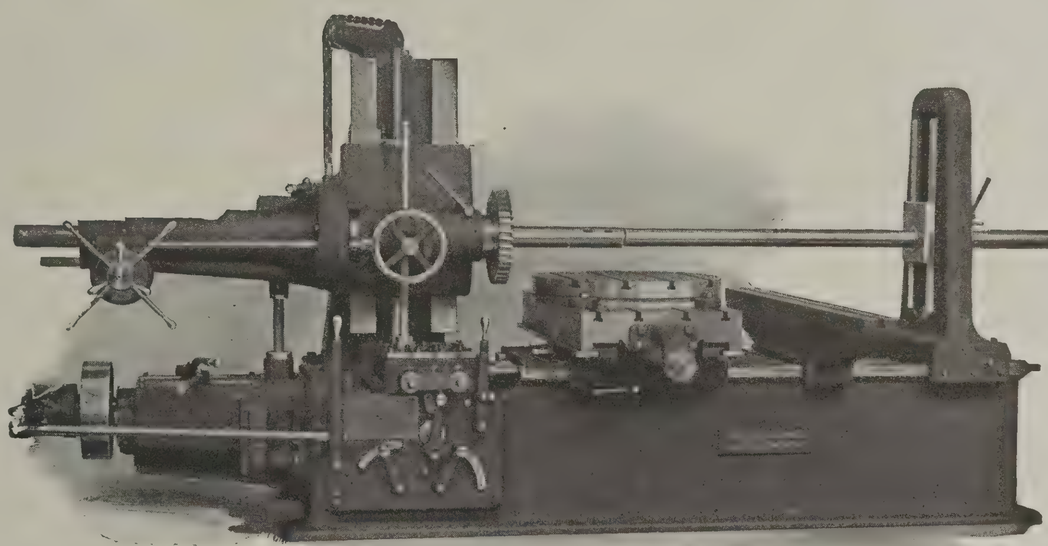
CHALLENGE MACHINE CO., INC., Philadelphia, Pa. Circular of the Challenge emery wheel protector and dust guard for the protection of workmen.

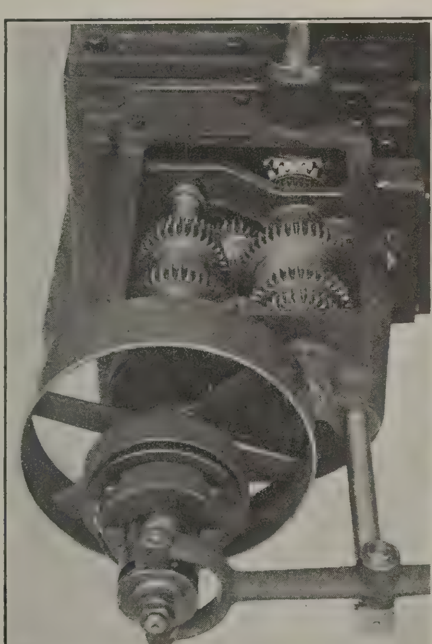
BLOOD BROS. MACHINE CO., Kalamazoo, Mich. Circular of universal

THIS IS THE

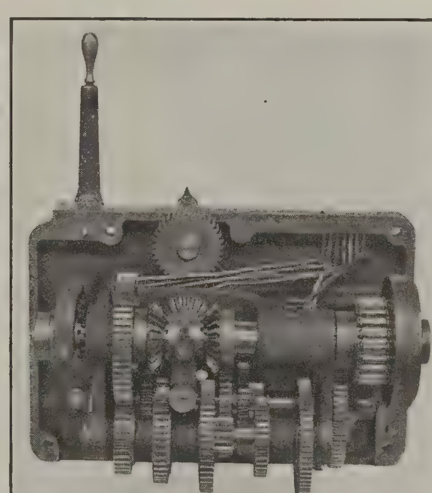
"PRECISION"

BORING, DRILLING AND MILLING MACHINE





THE SPEED BOX



THE FEED BOX

These boxes are shown approximately under the positions they occupy on the machine. Note that they are UNITS, each complete in itself, and involved in no way with each other, hence, **SIMPLICITY.**

Note also the **large size** of the boxes by comparing them with the bed, as shown in position on the machine, giving room for gears of **large diameter,** hence, **STRENGTH.**

These are two good things about the "PRECISION"—everything else about it has had the same careful attention in designing. The ACCURACY alone of the "PRECISION" would make it, as it is, the favorite of those who require something **RELIABLE.**

Lucas Machine Tool Co., NOW AND ALWAYS OF Cleveland, O., U.S.A.

AGENTS—C. W. Burton, Griffiths & Co , London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

joints which are made in over one-hundred patterns, encased and open, single and double forms.

FORT WAYNE ELECTRIC WORKS OF THE GENERAL ELECTRIC CO., 1616 Broadway, Fort Wayne, Ind. Catalogue of electric fans; and bulletin No. 1134 on direct-current electric motors.

S. A. WOODS MACHINE CO., Boston, Mass. Booklet on inside wood molders, illustrating Nos. 107 and 107-B machines and details; also a universal side-head grinder and automatic knife grinder.

BROWN HOISTING MACHINERY CO., Cleveland, Ohio. Circular on "Brownhoist" rapid freight handling equipment, showing freight handling trolleys, roller bearing freight trucks, lumber trolleys, etc.

GILBERT & BARKER MFG. CO., Springfield, Mass. Catalogue A on oil storage systems for factory store-rooms, paint stores, hardware and commissary stores and mines, designed for handling heavy lubricating and non-lubricating "gummy" oils.

HOLUB-DUSHA CO., 93d St., and First Ave., New York. Catalogue of button machinery, comprising cutting lathes, blank splitters, thickness gages, emery stands, backing machines, button grinding machines, facing and turning lathes, drilling machines, etc.

GARWOOD ELECTRIC CO., Garwood, N. J. Leaflet illustrating a 5-horsepower "C & C" motor which has been running twenty-two years, driving the presses of the Hartfield Telegraphic Code Publishing Co. The motor is still in good condition and is in daily use.

CLING-SURFACE CO., 1018 Niagara St., Buffalo, N. Y. has issued Bulletin No. 321, a neat folder showing eleven noteworthy installations in Pennsylvania where "Cling-Surface" is profitably used on belts. Each illustration is accompanied by data concerning the belts shown.

GENERAL ELECTRIC CO., Schenectady, N. Y. Booklet No. 4927 on feeder voltage regulators, illustrating the various processes of manufacture and showing the facilities possessed by the company at its Pittsfield works for the manufacture of this type of apparatus.

SKF BALL BEARING CO., 50 Church St., New York. Bulletin No. 2 on SKF single- and double-thrust ball bearings, illustrating the self-aligning feature provided for both types; also single-thrust bearings, without self-aligning seats, capacities and sizes of all forms are listed.

E. G. SMITH CO., Columbia, Pa. Catalogue of "Columbia" beam calipers graduated in inches and metric measure, with and without verniers. The catalogue also lists and illustrates "Which Way" pocket levels, the "Columbia" spherometers, spring gages and other machinists' tools.

SUPERIOR MACHINE TOOL CO., Kokomo, Ind. Leaflet on sensitive vertical drilling machine equipped with high-duty roller bearing bushings, and having the features of constant drive, constant power factor, geared speed change box, unit spindle construction, and front control of all speeds.

FAIRBANKS CO., 416-422 Broome St., New York. Circular of the Osgood oil-groove cutting machine which cuts continuous spiral grooves in interior bushings or on the exterior of shafts, journals or studs. The capacity of the machine is from ⅝ inch to 7¾ inches in diameter and from 1½ inch to 20 inches long.

FALLS MACHINE CO., Sheboygan Falls, Wis. Catalogue of Falls gasoline motors of the tandem four-cylinder automobile type in three models of 40–45, 30–35 and 30–40 horsepower, respectively. The company also furnishes unit power plants in two models with or without foot pedals, control levers and transmission brake.

VEEDER MFG. CO., 39 Sargeant St., Hartford, Conn. Catalogue of Veeder products, comprising odometers for automobiles, tachodometer (a speed indicator or tacometer combined with an odometer) odometers for carriages, cyclometers, revolution counters, speed counters, mileage recorders for elevators, and die-castings.

NATIONAL-ACME MFG. CO., Cleveland, Ohio. Booklet on the adjustable screw-cutting spring dies which are carried in stock by the company. The advantages of spring dies are enumerated, as are also the special advantages of the "Namco" form, which are perfect rake and clearance for the teeth, ample chip room and correct temper.

CELFOR TOOL CO., Buchanan, Ill., Catalogue No. 11 on drills, reamers, flue-cutters, countersinks, chucks, sockets, tool-holders, tool-bits, and boring tools. The catalogue concludes with a table of feeds and speeds for cast iron, medium steel and hard or very tough steel, and a table of decimal equivalents comprising both English and metric measure up to 76 millimeters and 3 inches.

PERMANENT MANUFACTURERS EXHIBIT RAILWAY SUPPLIES AND EQUIPMENT, Karpen Bldg., 900 S. Michigan Blvd., Chicago. Pamphlet on scope and purpose, exhibition hall and equipment, division and allotment of space, power for working machinery, character of exhibits, and other matters of interest to manufacturers desiring to reach the buyers of railway supplies. The exhibition opened March 16.

NORTON CO., Worcester, Mass. February number of *Grits and Grinds* containing an account of the award of the *Scientific American* medal to the Norton Co. for grinding-wheel protective devices, description of the American Museum of Safety, New York, and an article on the safety movement in America and abroad. The protection hoods for grinding wheels made by the Norton Co. are also illustrated and described.

PEERLESS RUBBER MFG. CO., 16 Warren St., New York. Catalogue No. 100 of mechanical rubber goods comprising "Rainbow" sheet packings, "Peerless" piston and valve rod packings, combination packing, gaskets, rubber belting, elevator and conveyor belts, water and steam hose, air-brake hose, pneumatic tool hose, acid hose, pump valves, car vestibule diaphragms, gas engine bags, rubber cement, rubber matting, sheet rubber tiling, etc.

UNITED STATES BUREAU OF MINES has just issued Technical Paper No. 8, by Frederick M. Stanton and Arno C. Fieldner, in order to suppy the constantly increasing demands for information relating to the methods used by the Bureau of Mines in analyzing coal and coke. This technical paper describes the methods in use at the laboratories of the bureau for analyzing coal and coke and determining the heating value of these fuels. Copies may be obtained by writing to the Director of the Bureau of Mines, Washington, D. C.

HEALD MACHINE CO., 20 New Bond St., Worcester, Mass. Booklet giving the personnel of the company and its history. The business of the Heald Machine Co. was established by Stephen Heald in the year 1830, in Barre, Mass., and at first comprised the making of woodworking machinery and agricultural implements. In 1903 Mr. James N. Heald bought out his father's interest and moved the plant to Worcester, where it was organized under the name of Heald Machine Co. The plant now covers 50,000 square feet and employs 160 persons.

TAFT-PEIRCE MFG. CO., Woonsocket, R. I. Illustrated booklet showing the various departments and equipment of the plant, which is one of the largest and finest in the world devoted exclusively to the handling of light high-grade machine work on the contract basis. The company specializes on making equipment for manufacturing, comprising jigs, fixtures, dies, tools, etc., required for the economical manufacture of interchangeable machine parts. The toolroom equipment illustrated is without parallel in the United States. The booklet will be found of unusual interest to all concerned with toolmaking and high-grade machine production.

WESTINGHOUSE ELECTRIC & MFG. CO., E. Pittsburg, Pa. Special publication R. L. 57, entitled "Synchronous Motors for Power Factor Correction." This booklet, which has an art cover, contains some of the most valuable common-sense data on the phenomena of power factor and on the bad effects of low power factor and power factor correction with synchronous motors, that has been published. The publication gives much more specific data on synchronous motor installations, including curves and diagrams by means of which anyone can determine, with a few simple calculations, the capacity of a synchronous motor necessary to corrrect a given load from and to given power factors. The booklet is sent free to any address on request.

LUCAS MACHINE TOOL CO., Cleveland, Ohio. Circular of new model No. 33 precision horizontal boring, drilling and milling machine; and leaflet on the vertical milling attachment which is now furnished for the Nos. 32 and 33 machines. The No. 33 machine, like the intermediate model No. 32, has constant-speed quick power movements to all parts, having feeds so arranged that no matter what feed is used the quick return for that feed is obtained by simply moving the feed and quick-return lever in the reverse direction. The vertical milling attachment is of the bridge form of construction with both ends supported and rigidly tied by the uprights. The attachment can be quickly removed, leaving the machine unencumbered for use as a regular horizontal boring and milling machine.

J. T. SLOCOMB, Providence, R. I. Catalogue No. 13 of machinists' tools, comprising external micrometers up to 18 inches capacity, internal micrometers, standard end measures, standard reference disks, screw thread micrometers, special micrometers, centering tools, combination center drills, etc. The new catalogue is bound in a red waterproof cover, printed in black and gold. The size is 5⅞ by 7⅝ inches, which is more convenient for the pocket than the common catalogue size, 6 by 9 inches. The tools illustrated and listed are fully described, a feature that is appreciated by intending buyers. A number of valuable tables for machinists which apply particularly in the use of these tools is included. Copies of the new catalogue will be sent to any address upon receipt of request.

GEOMETRIC TOOL CO., New Haven, Conn. Book entitled "Special Threading Tools," illustrating and describing the "Geometric" screw cutting die heads of the self-opening and adjustable type made in styles D, C, and DD; "Geometric" solid adjustable die head for use on automatic screw machines where the direction of rotation of the piece is reversed on the completion of the thread; "Geometric" adjustable collapsing taps; "Geometric" adjustable hollow milling tools; "Geometric" chaser or die grinder; "Geometric threading machine." The book is virtually a treatise on the special threading tools, showing their form and component parts with fine halftone views, and giving valuable information for users of modern threading equipment. It contains several pages of valuable data useful to makers of bolts, screws, nuts and other threaded work.

DODGE MFG. CO., Mishawaka, Ind. Catalogue C-12 containing 413 pages, beautifully illustrated and printed, is being distributed to the trade. The first pages are devoted to interior views of Dodge foundries, machine shops, power plant and branch houses; then follow tables for laying out shafting, horsepower of steel shafting, dimensions, etc. Every product of the company—a complete line of power transmission machinery and appliances, elevating and conveying equipment, rope driving system, and water softener apparatus—is completely described and listed. Considerable space is devoted to the Dodge friction clutch as an accident prevention device. The concluding pages give a little history of the transmission of power by Manila rope with illustrations of a number of striking installations, heavy engineering work, etc. The business was established in 1878 by Wallace H. Dodge, inventor of the split wood pulley with interchangeable bushings which effected a revolution in the pulley art. At that time, the plant occupied only a few acres of ground in Mishawaka. To-day there are 63 acres of ground space and over 21 acres of floor space.

TRADE NOTES

DOEHLER DIE-CASTING CO., Court & 9th Sts., Brooklyn, N. Y., is about to erect a reinforced concrete addition to its present plant, consisting of seven floors, 50 by 100 feet.

LANSING CO., Lansing, Mich., recently purchased the entire hoist building plant of the Butcher & Gage Co., Jackson, Mich., and in the future will manufacture the Wolverine contractors' hoist in Lansing.

FAVOR, RUHL & CO., 49 Barclay St., New York, have taken the sales agency for the "Tec" line of drafting-room supplies for New York City and vicinity, controlled by the Technical Supply Co., Scranton, Pa.

EDGAR ALLEN & CO., LTD., 86 John St., New York, agents for Allen's high-grade tool steel are now located at the foregoing address. A complete stock of steel is carried, and all requirements of customers can be promptly met.

HAUCK MFG. CO., 149 Livingston St., Brooklyn, N. Y., had a small fire in the office March 5. The fire destroyed some furniture, unimportant records and papers, but in no way affected the manufacturing facilities. There will be no delay in handling orders.

METALLIC SHELL & TUBE CO., has removed from Pawtucket, R. I., to a large three-story building at 129 Valley St., East Providence, R. I. The change of quarters was made necessary by the rapidly increasing growth of the business. The company is installing new machines and equipment, and will be in a better position than ever to take care of seamless tube wants.

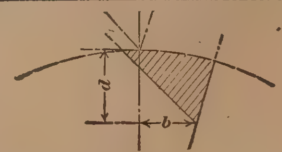
BLOOD BROS. MACHINE CO., Kalamazoo, Mich., manufacturer of universal joints, is running its factory with full force night and day. Although new buildings and equipment have been added during the past four months, nearly doubling the original capacity, the company is still barely able to keep up with orders. The entire factory is at present devoted to the manufacture of universal joints.

PARKER TRANSMISSION & APPLIANCE CO., has moved from Springfield, Mass., to Fulton, N. Y., where it will continue the manufacture of the Parker "all-in-mesh" transmission gears for automobiles. The company will also develop several of Mr. Parker's inventions. The capitalization was recently increased from $250,000 to $1,000,000, and plans have been made for pushing the business aggressively.

E. L. ESSLEY MACHINERY CO., Chicago, Ill., had a fire in its store at 555-557 Washington Blvd., March 7, which completely destroyed its office records. The large warehouse, 817 Washington Blvd., containing 10,000 square feet of floor space was untouched by the fire however, and the company's offices are temporarily located at this address. The warehouse is filled with new and second-hand machinery, and the fire will not seriously interrupt the business.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., has just put on the market a new chain graphite, especially intended for lubricating the chains of motor trucks and pleasure cars. This preparation is put up in cylindrical sticks, 2 by 8 inches, encased in a neat cardboard carton and weighing about one pound each. This convenient chain lubricant can be carried ready for use at any time, and is simply applied by rubbing the bar against the sprocket side of the chain. Unlike oils and greases, graphite does not rapidly collect dust and dirt.

SETTING DOUBLE-ANGLE FLUTING CUTTERS—I



Elevation Formula:
$d = R_1 - x R$
R_1 = radius of blank,
R = radius of finished cutter,
d, see illustration; x, see table.

Cross-movement Formula:
$b = y R$
R = radius of finished cutter,
b, see illustration; y, see table.
In table, W = width of land.

Number of Teeth in Cutter	$\frac{W}{R} = \frac{\text{Land}}{\text{Rad.}}$	Value of x for "Elevation" Formula						Value of y for "Cross-movement" Formula					
		$\alpha = 12°$ $\beta = 52°$	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
6	0.020	......	......	0.0235	0.1125	0.2328	0.3536	......	......	0.0050	0.0238	0.0497	0.0948
	0.040	......	......	0.0489	0.1344	0.2540	0.3719	......	......	0.0098	0.0285	0.0540	0.0997
	0.060	......	......	0.0685	0.1563	0.2736	0.3902	......	......	0.0146	0.0332	0.0582	0.1046
	0.080	......	......	0.0910	0.1782	0.2934	0.4085	......	......	0.0190	0.0379	0.0624	0.1095
	0.100	......	......	0.1133	0.2001	0.3130	0.4269	......	......	0.0239	0.0425	0.0666	0.1144
	0.120	......	......	0.1359	0.2220	0.3326	0.4453	......	......	0.0288	0.0471	0.0708	0.1193
8	0.020	0.1770	0.2300	0.3159	0.3912	0.4861	0.5795	0.0375	0.0488	0.0671	0.0831	0.1034	0.1553
	0.040	0.2010	0.2529	0.3368	0.4118	0.5041	0.5934	0.0426	0.0542	0.0715	0.0873	0.1071	0.1590
	0.060	0.2251	0.2758	0.3580	0.4308	0.5212	0.6073	0.0479	0.0595	0.0779	0.0915	0.1108	0.1627
	0.080	0.2491	0.2987	0.3791	0.4500	0.5383	0.6210	0.0531	0.0644	0.0803	0.0957	0.1145	0.1664
	0.100	0.2732	0.3216	0.4000	0.4698	0.5555	0.6352	0.0582	0.0689	0.0847	0.0999	0.1182	0.1701
	0.120	0.2973	0.3445	0.4196	0.4890	0.5726	0.6495	0.0632	0.0730	0.0891	0.1040	0.1219	0.1738
10	0.020	0.3648	0.4108	0.4793	0.5421	0.6192	0.6950	0.0767	0.0872	0.1019	0.1152	0.1318	0.1861
	0.040	0.3880	0.4328	0.5000	0.5602	0.6350	0.7081	0.0821	0.0920	0.1062	0.1190	0.1352	0.1896
	0.060	0.4121	0.4548	0.5202	0.5783	0.6511	0.7212	0.0874	0.0969	0.1105	0.1228	0.1386	0.1931
	0.080	0.4351	0.4768	0.5401	0.5964	0.6673	0.7343	0.0926	0.1015	0.1148	0.1266	0.1420	0.1966
	0.100	0.4582	0.4988	0.5598	0.6145	0.6831	0.7474	0.0977	0.1062	0.1191	0.1304	0.1454	0.2001
	0.120	0.4822	0.5213	0.5790	0.6326	0.6992	0.7605	0.1027	0.1110	0.1234	0.1342	0.1488	0.2036
12	0.020	0.4871	0.5243	0.5839	0.6340	0.7011	0.7621	0.1035	0.1116	0.1240	0.1350	0.1493	0.2045
	0.040	0.5089	0.5462	0.6031	0.6521	0.7160	0.7741	0.1081	0.1160	0.1280	0.1386	0.1525	0.2076
	0.060	0.5317	0.5681	0.6220	0.6692	0.7312	0.7862	0.1127	0.1205	0.1320	0.1422	0.1557	0.2107
	0.080	0.5540	0.5900	0.6412	0.6863	0.7463	0.7980	0.1173	0.1251	0.1360	0.1458	0.1589	0.2138
	0.100	0.5768	0.6120	0.6601	0.7032	0.7612	0.8100	0.1220	0.1297	0.1400	0.1494	0.1621	0.2169
	0.120	0.5986	0.6309	0.6778	0.7200	0.7761	0.8221	0.1265	0.1340	0.1440	0.1529	0.1653	0.2200
14	0.020	0.5732	0.6045	0.6540	0.6993	0.7581	0.8084	0.1220	0.1288	0.1391	0.1486	0.1610	0.2162
	0.040	0.5949	0.6251	0.6731	0.7150	0.7712	0.8195	0.1265	0.1325	0.1430	0.1520	0.1639	0.2191
	0.060	0.6167	0.6450	0.6912	0.7311	0.7841	0.8302	0.1310	0.1375	0.1469	0.1554	0.1668	0.2220
	0.080	0.6385	0.6660	0.7089	0.7472	0.7973	0.8400	0.1355	0.1418	0.1508	0.1588	0.1697	0.2249
	0.100	0.6590	0.6861	0.7267	0.7636	0.8100	0.8506	0.1400	0.1464	0.1546	0.1622	0.1726	0.2278
	0.120	0.6788	0.7062	0.7443	0.7798	0.8232	0.8609	0.1445	0.1500	0.1584	0.1656	0.1756	0.2307

Contributed by George W. Burley

SETTING DOUBLE-ANGLE FLUTING CUTTERS—II

Number of Teeth in Cutter	$\frac{W}{R} = \frac{\text{Land}}{\text{Rad.}}$	Value of x for "Elevation" Formula						Value of y for "Cross-movement" Formula					
		$\alpha = 12°$ $\beta = 52°$	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
16	0.020	0.6328	0.6624	0.7062	0.7465	0.7972	0.8360	0.1345	0.1410	0.1501	0.1581	0.1691	0.2234
	0.040	0.6536	0.6812	0.7229	0.7600	0.8091	0.8461	0.1395	0.1450	0.1537	0.1611	0.1717	0.2260
	0.060	0.6745	0.7000	0.7394	0.7742	0.8210	0.8562	0.1435	0.1490	0.1573	0.1641	0.1743	0.2286
	0.080	0.6954	0.7191	0.7561	0.7884	0.8329	0.8663	0.1480	0.1530	0.1609	0.1671	0.1769	0.2312
	0.100	0.7164	0.7382	0.7730	0.8033	0.8448	0.8754	0.1525	0.1570	0.1645	0.1701	0.1795	0.2338
	0.120	0.7360	0.7571	0.7893	0.8185	0.8567	0.8845	0.1565	0.1609	0.1680	0.1730	0.1820	0.2364
18	0.020	0.6791	0.7052	0.7451	0.7781	0.8230	0.8601	0.1440	0.1499	0.1582	0.1652	0.1751	0.2307
	0.040	0.6992	0.7234	0.7610	0.7919	0.8351	0.8691	0.1485	0.1539	0.1617	0.1683	0.1775	0.2330
	0.060	0.7191	0.7416	0.7773	0.8058	0.8471	0.8780	0.1530	0.1578	0.1652	0.1714	0.1799	0.2353
	0.080	0.7393	0.7598	0.7932	0.8200	0.8582	0.8860	0.1570	0.1617	0.1687	0.1745	0.1823	0.2376
	0.100	0.7594	0.7780	0.8090	0.8351	0.8692	0.8942	0.1610	0.1654	0.1721	0.1776	0.1847	0.2399
	0.120	0.7791	0.7972	0.8251	0.8501	0.8802	0.9021	0.1650	0.1697	0.1755	0.1806	0.1871	0.2422
20	0.020	0.7142	0.7391	0.7750	0.8052	0.8441	0.8791	0.1520	0.1570	0.1643	0.1709	0.1796	0.2357
	0.040	0.7336	0.7571	0.7908	0.8181	0.8552	0.8872	0.1566	0.1609	0.1677	0.1738	0.1819	0.2378
	0.060	0.7530	0.7750	0.8076	0.8310	0.8661	0.8953	0.1600	0.1648	0.1711	0.1767	0.1842	0.2399
	0.080	0.7731	0.7931	0.8224	0.8441	0.8770	0.9035	0.1640	0.1686	0.1745	0.1796	0.1865	0.2420
	0.100	0.7926	0.8112	0.8372	0.8571	0.8881	0.9113	0.1680	0.1724	0.1778	0.1825	0.1888	0.2441
	0.120	0.8122	0.8281	0.8509	0.8702	0.8981	0.9181	0.1730	0.1761	0.1811	0.1852	0.1910	0.2462
22	0.020	0.7421	0.7652	0.7963	0.8250	0.8592	0.8880	0.1580	0.1623	0.1695	0.1758	0.1829	0.2380
	0.040	0.7623	0.7831	0.8112	0.8380	0.8700	0.8961	0.1620	0.1662	0.1728	0.1783	0.1852	0.2400
	0.060	0.7825	0.8010	0.8260	0.8509	0.8809	0.9039	0.1660	0.1701	0.1761	0.1808	0.1875	0.2420
	0.080	0.8026	0.8179	0.8409	0.8642	0.8921	0.9121	0.1700	0.1740	0.1793	0.1833	0.1897	0.2440
	0.100	0.8217	0.8350	0.8561	0.8768	0.9021	0.9188	0.1740	0.1777	0.1825	0.1858	0.1919	0.2460
	0.120	0.8409	0.8527	0.8713	0.8891	0.9122	0.9260	0.1779	0.1813	0.1857	0.1883	0.1941	0.2480
24	0.020	0.7682	0.7871	0.8172	0.8423	0.8754	0.8973	0.1630	0.1674	0.1738	0.1788	0.1860	0.2402
	0.040	0.7851	0.8040	0.8311	0.8551	0.8853	0.9042	0.1670	0.1711	0.1769	0.1815	0.1880	0.2421
	0.060	0.8030	0.8210	0.8450	0.8680	0.8952	0.9111	0.1710	0.1746	0.1800	0.1842	0.1900	0.2440
	0.080	0.8221	0.8381	0.8600	0.8821	0.9050	0.9180	0.1750	0.1781	0.1830	0.1869	0.1920	0.2459
	0.100	0.8413	0.8550	0.8751	0.8942	0.9141	0.9251	0.1790	0.1817	0.1860	0.1896	0.1940	0.2478
	0.120	0.8605	0.8711	0.8891	0.9063	0.9234	0.9323	0.1829	0.1854	0.1890	0.1924	0.1960	0.2497
26	0.020	0.7850	0.8050	0.8283	0.8552	0.8842	0.9051	0.1675	0.1710	0.1759	0.1816	0.1881	0.2424
	0.040	0.8031	0.8218	0.8429	0.8684	0.8938	0.9121	0.1715	0.1746	0.1791	0.1844	0.1901	0.2443
	0.060	0.8222	0.8386	0.8576	0.8816	0.9034	0.9191	0.1755	0.1782	0.1823	0.1872	0.1921	0.2462
	0.080	0.8413	0.8554	0.8723	0.8948	0.9130	0.9261	0.1795	0.1818	0.1855	0.1900	0.1941	0.2481
	0.100	0.8604	0.8722	0.8870	0.9080	0.9226	0.9330	0.1835	0.1854	0.1887	0.1928	0.1961	0.2500
	0.120	0.8795	0.8890	0.9018	0.9212	0.9322	0.9401	0.1874	0.1890	0.1920	0.1956	0.1981	0.2519

Contributed by George W. Burley

SETTING DOUBLE-ANGLE FLUTING CUTTERS—III

Number of Teeth in Cutter	$\frac{W}{R}$ = Land Rad.	Value of x for "Elevation" Formula: $\alpha = 12°$, $\beta = 52°$	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	Value of y for "Cross-movement" Formula: 12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
28	0.020	0.7921	0.8182	0.8443	0.8654	0.8930	0.9111	0.1705	0.1739	0.1791	0.1838	0.1900	0.2445
	0.040	0.8121	0.8351	0.8581	0.8778	0.9025	0.9180	0.1745	0.1777	0.1821	0.1868	0.1919	0.2463
	0.060	0.8321	0.8520	0.8720	0.8891	0.9120	0.9250	0.1785	0.1815	0.1851	0.1888	0.1938	0.2481
	0.080	0.8521	0.8692	0.8860	0.9012	0.9213	0.9311	0.1820	0.1843	0.1881	0.1913	0.1957	0.2499
	0.100	0.8721	0.8851	0.9000	0.9133	0.9306	0.9371	0.1860	0.1881	0.1911	0.1938	0.1976	0.2517
	0.120	0.8921	0.9012	0.9133	0.9253	0.9390	0.9431	0.1900	0.1919	0.1941	0.1963	0.1995	0.2535
30	0.020	0.8172	0.8321	0.8560	0.8761	0.9011	0.9170	0.1740	0.1768	0.1820	0.1860	0.1918	0.2458
	0.040	0.8351	0.8491	0.8701	0.8881	0.9100	0.9241	0.1780	0.1801	0.1849	0.1885	0.1936	0.2475
	0.060	0.8530	0.8660	0.8842	0.9000	0.9190	0.9302	0.1820	0.1835	0.1878	0.1910	0.1954	0.2492
	0.080	0.8706	0.8822	0.8976	0.9120	0.9281	0.9362	0.1860	0.1870	0.1907	0.1935	0.1972	0.2509
	0.100	0.8882	0.8982	0.9110	0.9241	0.9372	0.9421	0.1895	0.1905	0.1936	0.1960	0.1990	0.2526
	0.120	0.9052	0.9142	0.9241	0.9362	0.9451	0.9480	0.1929	0.1940	0.1965	0.1985	0.2008	0.2543
32	0.020	0.8293	0.8441	0.8661	0.8841	0.9080	0.9221	0.1765	0.1797	0.1838	0.1877	0.1930	0.2470
	0.040	0.8476	0.8600	0.8792	0.8960	0.9171	0.9282	0.1800	0.1830	0.1867	0.1902	0.1949	0.2486
	0.060	0.8660	0.8759	0.8921	0.9072	0.9260	0.9343	0.1840	0.1863	0.1896	0.1927	0.1968	0.2502
	0.080	0.8831	0.8918	0.9053	0.9183	0.9342	0.9404	0.1880	0.1896	0.1924	0.1952	0.1987	0.2518
	0.100	0.9000	0.9081	0.9184	0.9291	0.9420	0.9463	0.1920	0.1929	0.1953	0.1977	0.2006	0.2534
	0.120	0.9163	0.9241	0.9313	0.9400	0.9500	0.9521	0.1955	0.1962	0.1982	0.2002	0.2025	0.2550
34	0.020	0.8400	0.8530	0.8743	0.8911	0.9141	0.9261	0.1785	0.1816	0.1859	0.1891	0.1941	0.2480
	0.040	0.8575	0.8691	0.8874	0.9020	0.9232	0.9323	0.1820	0.1849	0.1888	0.1916	0.1959	0.2495
	0.060	0.8750	0.8851	0.9003	0.9132	0.9310	0.9382	0.1860	0.1882	0.1916	0.1941	0.1977	0.2510
	0.080	0.8925	0.9010	0.9132	0.9243	0.9393	0.9444	0.1900	0.1915	0.1944	0.1966	0.1995	0.2525
	0.100	0.9100	0.9162	0.9263	0.9352	0.9472	0.9500	0.1935	0.1948	0.1971	0.1991	0.2013	0.2540
	0.120	0.9270	0.9328	0.9394	0.9462	0.9551	0.9551	0.1973	0.1981	0.1998	0.2017	0.2031	0.2555
36	0.020	0.8500	0.8621	0.8800	0.8981	0.9190	0.9292	0.1804	0.1836	0.1874	0.1902	0.1950	0.2489
	0.040	0.8695	0.8782	0.8931	0.9092	0.9271	0.9348	0.1850	0.1869	0.1901	0.1927	0.1968	0.2503
	0.060	0.8890	0.8943	0.9060	0.9200	0.9352	0.9404	0.1890	0.1902	0.1928	0.1952	0.1986	0.2517
	0.080	0.9045	0.9100	0.9191	0.9312	0.9433	0.9460	0.1925	0.1935	0.1955	0.1977	0.2004	0.2531
	0.100	0.9200	0.9251	0.9320	0.9411	0.9512	0.9516	0.1960	0.1968	0.1982	0.2002	0.2022	0.2545
	0.120	0.9381	0.9401	0.9450	0.9510	0.9590	0.9572	0.1994	0.2001	0.2010	0.2027	0.2040	0.2559
38	0.020	0.8561	0.8691	0.8862	0.9043	0.9230	0.9320	0.1819	0.1850	0.1885	0.1921	0.1961	0.2497
	0.040	0.8760	0.8850	0.8990	0.9152	0.9312	0.9374	0.1860	0.1883	0.1913	0.1943	0.1978	0.2511
	0.060	0.8941	0.9011	0.9121	0.9261	0.9393	0.9428	0.1900	0.1916	0.1941	0.1965	0.1995	0.2524
	0.080	0.9122	0.9162	0.9250	0.9368	0.9474	0.9482	0.1936	0.1949	0.1969	0.1987	0.2012	0.2537
	0·100	0.9282	0.9311	0.9381	0.9480	0.9555	0.9536	0.1970	0.1982	0.1997	0.2009	0.2029	0.2550
	0.120	0.9441	0.9461	0.9512	0.9633	0.9636	0.9590	0.2004	0.2015	0.2025	0.2031	0.2046	0.2563

Contributed by George W. Burley

No. 153, Data Sheet, MACHINERY, April, 1912

SETTING DOUBLE-ANGLE FLUTING CUTTERS—IV

Number of Teeth in Cutter	$\frac{W}{R}$ = Land Rad.	Value of x for "Elevation" Formula: $\alpha = 12°$, $\beta = 52°$	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	Value of y for "Cross-movement" Formula: 12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
40	0.020	0.8660	0.8760	0.8900	0.9081	0.9271	0.9352	0.1840	0.1863	0.1900	0.1927	0.1968	0.2504
	0.040	0.8828	0.8912	0.9031	0.9190	0.9352	0.9411	0.1875	0.1896	0.1926	0.1950	0.1985	0.2517
	0.060	0.8996	0.9064	0.9162	0.9300	0.9433	0.9459	0.1910	0.1929	0.1952	0.1973	0.2002	0.2530
	0.080	0.9164	0.9216	0.9293	0.9401	0.9510	0.9515	0.1950	0.1962	0.1978	0.1996	0.2018	0.2543
	0.100	0.9332	0.9368	0.9424	0.9500	0.9592	0.9562	0.1990	0.1995	0.2004	0.2019	0.2034	0.2556
	0.120	0.9500	0.9520	0.9550	0.9598	0.9659	0.9608	0.2025	0.2028	0.2030	0.2042	0.2050	0.2569
42	0.020	0.8720	0.8820	0.8951	0.9122	0.9292	0.9372	0.1855	0.1880	0.1909	0.1948	0.1975	0.2510
	0.040	0.8886	0.8972	0.9080	0.9231	0.9371	0.9431	0.1891	0.1913	0.1936	0.1969	0.1992	0.2522
	0.060	0.9052	0.9124	0.9210	0.9343	0.9449	0.9479	0.1925	0.1946	0.1963	0.1990	0.2009	0.2534
	0.080	0.9218	0.9276	0.9339	0.9444	0.9532	0.9531	0.1965	0.1979	0.1990	0.2011	0.2026	0.2546
	0.100	0.9384	0.9428	0.9471	0.9546	0.9610	0.9581	0.2000	0.2012	0.2017	0.2032	0.2042	0.2558
	0.120	0.9550	0.9580	0.9600	0.9645	0.9681	0.9628	0.2035	0.2045	0.2044	0·2053	0.2058	0.2570
44	0.020	0.8770	0.8870	0.9000	0.9151	0.9310	0.9391	0.1860	0.1887	0.1918	0.1944	0.1981	0.2515
	0.040	0.8936	0.9021	0.9131	0.9260	0.9391	0.9440	0.1900	0.1920	0.1945	0.1966	0.1998	0.2527
	0.060	0.9102	0.9172	0.9261	0.9371	0.9472	0.9492	0.1935	0.1953	0.1972	0.1988	0.2015	0.2539
	0.080	0.9268	0.9321	0.9389	0.9472	0.9551	0.9539	0.1970	0.1986	0.1999	0.2010	0.2032	0.2550
	0.100	0.9434	0.9472	0.9520	0.9569	0.9632	0.9591	0.2010	0.2019	0.2026	0.2032	0.2049	0.2561
	0.120	0.9600	0.9620	0.9649	0.9670	0.9700	0.9640	0.2045	0.2052	0.2053	0.2054	0.2065	0.2572
46	0.020	0.8820	0.8920	0.9040	0.9181	0.9338	0.9411	0.1875	0.1898	0.1926	0.1951	0.1987	0.2520
	0.040	0.8986	0.9070	0.9171	0.9293	0.9410	0.9459	0.1911	0.1930	0.1953	0.1974	0.2004	0.2531
	0.060	0.9152	0.9226	0.9300	0.9400	0.9491	0.9507	0.1947	0.1962	0.1980	0.1997	0.2021	0.2542
	0.080	0.9318	0.9371	0.9429	0.9502	0.9572	0.9555	0.1985	0.1994	0.2007	0.2020	0.2038	0.2553
	0.100	0.9484	0.9523	0.9558	0.9603	0.9651	0.9600	0.2019	0.2026	0.2034	0.2042	0.2054	0.2564
	0.120	0.9650	0.9670	0.9682	0.9705	0.9720	0.9634	0.2055	0.2058	0.2061	0.2064	0.2070	0.2575
48	0.020	0.8850	0.8960	0.9081	0.9210	0.9358	0.9426	0.1885	0.1907	0.1935	0.1958	0.1993	0.2525
	0.040	0.9020	0.9112	0.9212	0.9321	0.9430	0.9470	0.1920	0.1939	0.1962	0.1981	0.2010	0.2536
	0.060	0.9190	0.9261	0.9343	0.9432	0.9519	0.9521	0.1955	0.1971	0.1999	0.2004	0.2026	0.2547
	0.080	0.9360	0.9413	0.9471	0.9534	0.9593	0.9572	0.1990	0.2003	0.2016	0.2027	0.2042	0.2557
	0.100	0.9530	0.9562	0.9600	0.9632	0.9671	0.9610	0.2026	0.2035	0.2043	0.2050	0.2058	0.2567
	0.120	0.9700	0.9710	0.9720	0.9730	0.9740	0.9645	0.2062	0.2066	0.2070	0.2072	0.2074	0.2577
50	0.020	0.8880	0.9000	0.9130	0.9250	0.9389	0.9431	0.1892	0.1917	0.1940	0.1962	0.1998	0.2529
	0.040	0.9061	0.9149	0.9259	0.9351	0.9468	0.9482	0.1931	0.1949	0.1967	0.1985	0.2014	0.2539
	0.060	0.9239	0.9298	0.9389	0.9452	0.9536	0.9533	0.1970	0.1980	0.1994	0.2008	0.2030	0.2549
	0.080	0.9417	0.9447	0.9518	0.9553	0.9610	0.9571	0.2007	0.2011	0.2021	0.2031	0.2046	0.2559
	0.100	0.9585	0.9595	0.9637	0.9652	0.9677	0.9632	0.2039	0.2042	0.2048	0.2053	0.2061	0.2569
	0.120	0.9742	0.9744	0.9747	0.9751	0.9761	0.9650	0.2070	0.2072	0.2074	0.2075	0.2076	0.2579

Contributed by George W. Burley

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MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

May, 1912

THIRTY-TON ELECTRIC LOCOMOTIVE FOR THE FREDERICK RAILROAD, FREDERICK, MARYLAND

THE Frederick Railroad Co., of Frederick, Md., recently purchased a 30-ton Baldwin-Westinghouse electric locomotive for hauling freight between Thurmont and Frederick, a distance of 17.37 miles, and for occasionally hauling grain between Frederick and Middletown—approximately eight miles. The sharpest curves have a radius of 80 feet. The maximum grade between Frederick and Middletown is 7 per cent, and is part of a continuous rise of 600 feet in 2.5 miles. The maximum grade between Thurmont and Frederick is 2.588 per cent for 3450 feet.

The mechanical parts of the locomotive were furnished by the Baldwin Locomotive Works, Philadelphia, Pa. The locomotive has a single rigid wheel-base with two axles. It has a steel box cab and is arranged for double-end operation. The entire weight of the locomotive is carried by the two axles. The frame of the locomotive is built of structural shapes wherever practicable. The longitudinal sills are four in number, the two center sills consisting of 6-inch channels and the outside sills of 10-inch channels. (See Figs. 2 and 3). The end bumpers are of wood, backed by steel plates. Diagonal bracing is worked in between the center and outside sills, and special attention has been given to providing ample transverse strength. The journal boxes are guided in rigid pedestals, which are of cast steel and riveted to the outside frame channels. The pedestal boxes are of cast iron with bronze bearings, and are placed outside of the wheels, each box being surmounted by a half elliptic spring which supports the frame. The wheels are steel-tired with cast-iron centers.

The cab covers the entire frame and is substantially built of Z-bars and steel plates, covered with No. 14 B. W. S. sheet steel. It is 18 feet 4 inches long and 9 feet wide. Both end and side doors are provided. A clear space approximately 10 feet long is left in the center of the cab in which freight can be carried. The locomotive weighs 25 tons complete. However, provision is made for increasing the weight to 30 tons in order to obtain the adhesion necessary for hauling the maximum loads. This is done by means of a cellar under the floor between the two axles, which may be filled with five tons of steel rails in 6-foot lengths.

The principal dimensions of the locomotive are:

Diameter of driving wheels	36 inches.
Total wheel-base	10 feet.
Length of cab over bumpers	20 feet.
Width overall	9 feet.
Height from top of rail to center of drawbar	2 feet 10 inches.
Height from top of rail to top of cab	12 feet.
Weight including 10,000 pounds ballast	60,000 pounds.

Fig. 1. Thirty-ton Baldwin-Westinghouse Electric Locomotive for the Frederick Railroad

The air brake equipment is of the type 14-EL built by the Westinghouse Air Brake Co., Wilmerding, Pa., and has both the straight and automatic features. Air for the locomotive and train brakes is supplied by one D-3-EG compressor having a delivery capacity of approximately 25 cubic feet of free air per minute. The electrical equipment was furnished by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and consists of two No. 308-B-2, 600-volt commutating pole railway motors and type HL unit switch control.

To handle the large overload and the normal operating current of the locomotive, the Westinghouse unit switch, electro-pneumatic system of control was installed. This is the same as that employed in the locomotive built for the New York,

New Haven and Hartford Railroad, the Hoosac Tunnel service (Boston & Maine R. R.), and the Pennsylvania Tunnel and Terminal Co. The success this system has given in the Frederick locomotive, as well as in many other small engines, proves that the electro-pneumatic control is equally adaptable to large and small equipments. The hour-rating of the 308-B-2 motor at 600 volts is 120 H. P. Because of the large size of the motor, the box type frame is used. This is made of steel cast in a single piece with large holes bored out at each end for seating the housings and for taking out the armatures endwise. The complete weight of the motor is approximately 6500 pounds. Part of this weight is borne by the two axle bearings, while the remainder is supported by a nose cast on the frame and resting upon the truck bolster.

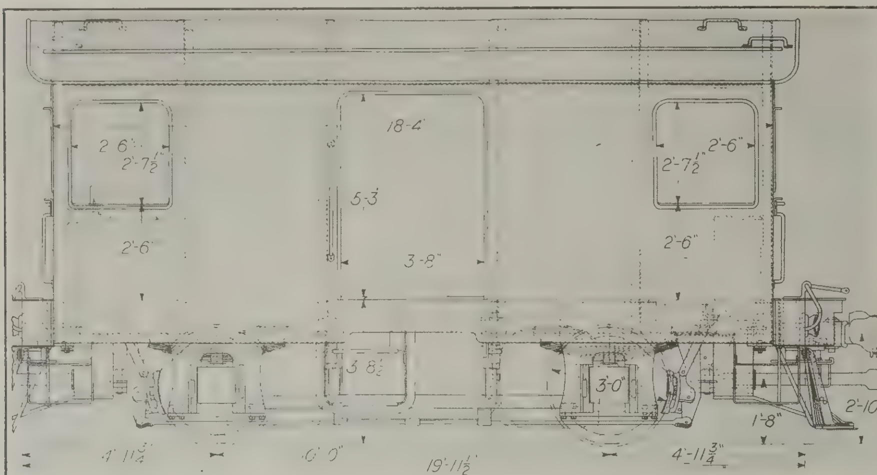


Fig. 2. Side Elevation of Electric Locomotive

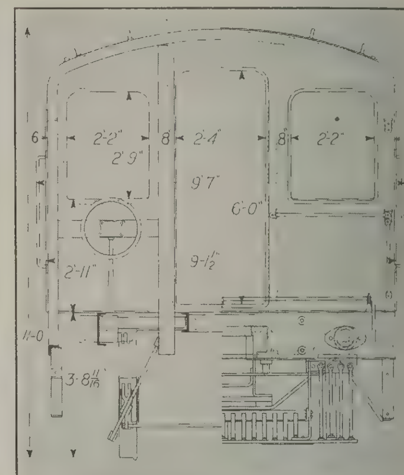


Fig. 3. End Elevation of Electric Locomotive

The speed characteristic is inherently slow, which, with the resulting high tractive effort and low power consumption, makes this motor particularly adapted to freight locomotive service. By virtue of the commutating-poles, enormous overloads in the motors are safely commutated. For one hour on 600 volts the locomotive will exert a tractive effort of 12,000 pounds at a speed of 7½ miles per hour. Momentarily the locomotive with sanded rails will exert a tractive effort of 17,500 pounds without ballast, or 21,000 pounds with ballast. Expressed in terms of weight of train and grade it has sufficient capacity to handle a load of 200 tons on a grade of 2.59 per cent, and may occasionally be required to haul a trailing load of 50 tons on a short grade of 7 per cent.

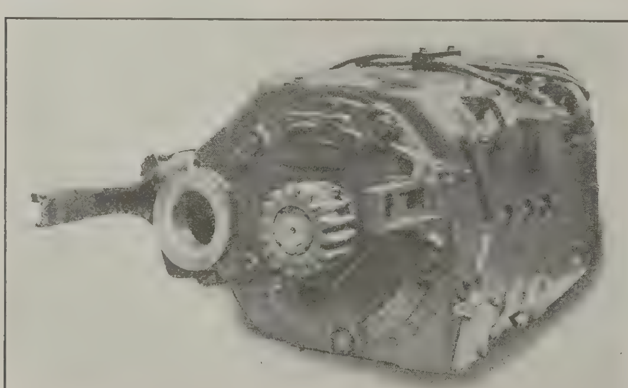


Fig. 4. Westinghouse No. 308-B-2 Commutating Pole Railway Motor—Pinion End

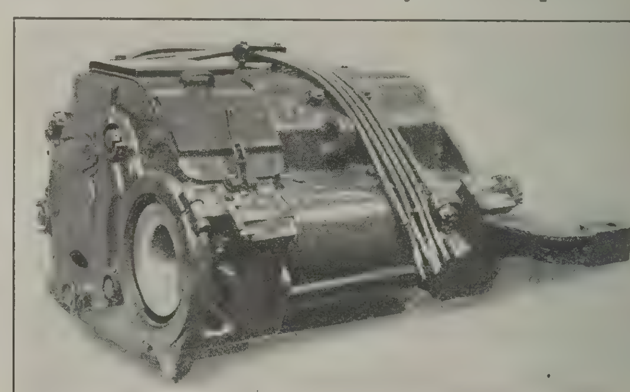


Fig. 5. Westinghouse No. 308-B-2 Commutating Pole Railway Motor—Commutator End

In switching service, on a straight level track, 31 cars, each weighing 45 tons with load, may be handled at 8.5 miles per hour at 600 volts; and 8 cars at the same speed on a one per cent grade.

The auxiliary apparatus supplied with the locomotive consists of a No. 13 Union standard Nuttall trolley, automatic M. C. B. radial couplers and bumpers. Tomlinson automatic radial couplers, Leach pneumatic sanders, and type LA Crouse-Hinds arc headlights. The latter are so arranged that both may be lighted at the same time, which is useful in switching. With the automatic M. C. B. radial coupler the locomotive can traverse a curve of 80-foot radius without uncoupling and with the Tomlinson coupler a 40-foot curve.

SUGGESTIONS FOR MACHINISTS, DRAFTSMEN AND ELECTRICIANS

Don't think that a horse can stand the same amount of current as a man.

Don't think you are an electrician just because you have been struck by lightning.

Don't think that it takes more than half a second to demagnetize a piece of steel.

Don't forget that electricity (like water) will go where it meets the least resistance.

Don't leave the windows open, so that dust can blow directly onto a generator or motor.

Don't run two lines of conduit side by side (carrying alternating current wires) without bonding them.

Don't forget that a wire will only carry its capacity in current, very much after the same manner as a water pipe.

Don't forget that some types of generators will not produce even a light until you get a certain amount of load on.

To use hot water for cooling while grinding may sound like a paradox, but some people think that it is a good thing.

The man with skilled hands and a cracked brain is like a modern machine shop with an inefficient power plant.

The thing that keeps many a man from making a fool of himself is the fact that he can't always do as he pleases.

The split pulley has its time of favor during the repair season, for it lends itself readily to removal and alterations.

Don't forget that a motor is more efficient when worked up to its full load, than when it is run either below load or over load.

Don't forget that many times (not always) the success of a machine is up to the man who makes the detail and shop drawings.

The older heads in the business may not know the most about it, but it is well for the young minds to remember that they have been at the game longer and have the best chance to know more.

Don't think that the old type of lathe is done away with yet, and when you have occasion to cut a thread, the number of threads to the inch of which is not exactly divisible by the number on the lead-screw, stop the lathe, drop the nut out,

and move the carriage back any even number of inches and throw the nut in again, for by this rule the tool will always engage the thread.

Don't make regular parallels for general work without making them of such proportion that a workman will see quickly which way they must lie to be of the same height; in other words they should be at least thirty per cent thinner than they are wide, with a large range of difference between the different sets, so a workman will be able to see by glancing at two or more different sets whether they are mated or not.

WATCH MOVEMENT MANUFACTURE*—1

METHODS EMPLOYED BY THE SOUTH BEND WATCH CO.

By DOUGLAS T. HAMILTON†

Fig. 1. Dial View of South Bend "Studebaker" Railroad Watch

A WATCH movement, when we consider its dimensions, the usage to which it is subjected, and the exacting requirements of its performance, is one of the most wonderful pieces of mechanism that man has devised. It may truthfully be called an automatic counting machine, which, with unerring regularity, counts every one-fifth second, day and night, and registers the count in larger units of seconds, minutes and hours on the dial. This is done without human aid, and without the pressing of buttons and the pulling of levers. All that is necessary is to wind up the main spring once in every twenty-four or thirty-six hours.

The South Bend 16 size watch movement shown in Fig. 3, the manufacture of which is to be described in the following, is made in the three-story brick building shown in Fig. 2. The main building is 402 feet long by 33 feet wide. This has several wings and extensions, the entire floor space being 55,220 square feet. All of the movements are made, assembled and tested in this building. The dials are made in a smaller two-story building at the rear. This company employs 500 men and women—most of them experts—and turns out 200 movements per day, quality and not quantity being the main consideration. The cases for the movements are produced by a well-known maker of watch cases, and as a watch is of little value as a timepiece without a case to protect it, some of the methods employed in their manufacture will be described in a future article.

Fig. 2. Factory of the South Bend Watch Co., South Bend, Ind.

Through the courtesy of Mr. C. T. Higginbotham, consulting superintendent of the South Bend Watch Co., South Bend, Ind., the writer is enabled to give a general outline of the methods employed by this company in the manufacture of watch movements. It is not intended that this article shall deal with the construction of a watch, except so far as is necessary to make clear the description of the methods employed in its manufacture. The illustration Fig. 4 is presented for this purpose. With this in view, a description will be given of the various steps followed in designing a new model; that is, a watch which differs in construction from that previously manufactured.

Designing and Making Watch Movements

The first step that is taken in designing a new model is to make all the mathematical calculations for the complete watch movement. These calculations embrace the size and strength of the main spring, the strength and dimensions of the hair spring, and also the balance. Calculations are also worked out to determine the pitch diameters of the wheels and pinions, the number of teeth and leaves and the center distances in the plates and bridges.

After all the calculations pertaining to the various parts of the movement have been completed, an artist's drawing similar to that indicated in Fig. 3 is made. This of no practical value in the manufacturing, except that it gives an idea of what the completed watch will look like. Profile and assembled drawings, plan and developed elevations are then drawn to an enlarged scale. An assembled plan and elevation drawing of the 16 size watch is shown in Fig. 5. The elevations of the complete watch are made in two different scales on the profile drawing—the second drawing made, the first working drawing being a plan view. The developed length is made 10 to 1, and height 50 to 1, which facilitates the laying out of the movement. For the plan views the scale is 10 to 1. The plan and elevation views of the assembled drawing shown in Fig. 5 are made 10 to 1. The developed length of a watch is laid out in the order in which the power is transmitted from the main spring to the escapement, as illustrated in Fig. 4 by the zig-zag dot-and-dash line joining the wheel centers.

From the profile and enlarged drawings the various details are taken and separate sketches of each part are made, giving the number of operations required and the dimensions of the piece after each operation. Upon the completion of all the detail drawings, prints are sent to the model-maker, who, by the use of a transfer chuck, which will be described later, makes a complete model watch. The model maker also makes the master plates, which are steel disks, 1.9 inch in diameter by 0.22 inch thick. In these, are carefully bored holes, exactly 0.1 inch in diameter. The location of every hole, the center of every turning, every curve center, milling, etc., is determined by these holes. The master plates are then used to determine the forms, and relative positions required in all

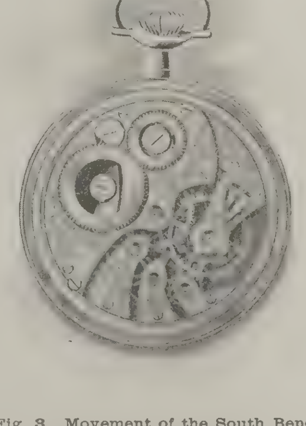


Fig. 3. Movement of the South Bend "Studebaker" Railroad Watch

* For further information on watch making and allied subjects, see the following articles previously published in MACHINERY, "Watch Crowns, Dies and Methods," December, 1909, engineering edition; "Some Machinery and Methods of Watch Making," July, 1909, engineering edition; "Making Watch Parts in the Commercial Automatic Screw Machine," June, 1908; "Split Die for Watch Regulator," August, 1907; "Watch Dials, Process of Making," February, 1907, page 36, advertising section; "The Watchman's Watch," March, 1904, engineering edition.

† Associate Editor of MACHINERY.

dies, chucks, jigs, and other tools used in the manufacture of the watch. All the curves in watch plates and bridges are made true arcs of circles—no irregular curves being used—so that there is not one part of a watch plate which cannot

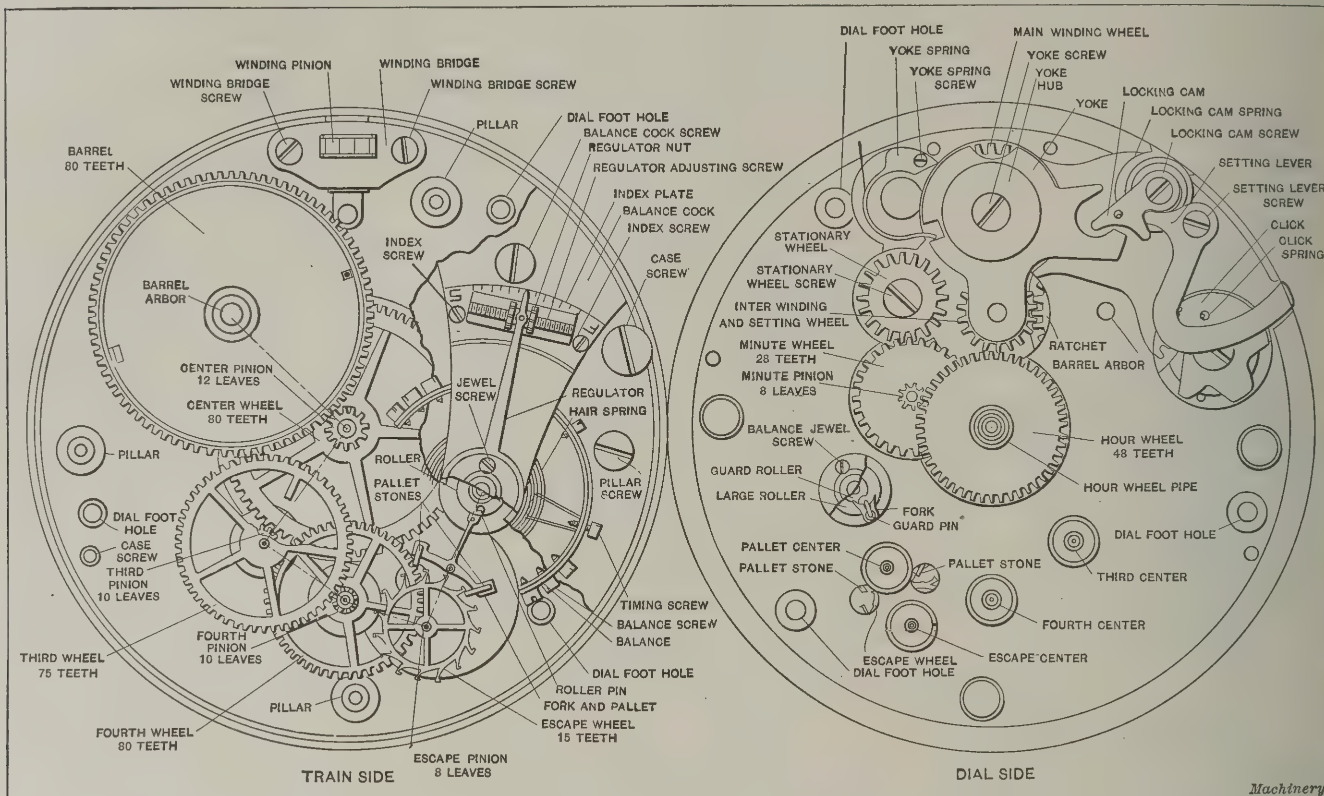


Fig. 4. Dial and Train Side Views giving the Names of the Parts of an 18-size South Bend "Studebaker" Railroad Watch

be produced on the transfer chuck. In order to enable the model-maker to reproduce the form on a greatly reduced scale, the holes in the plates and bridges are laid out in their rela-

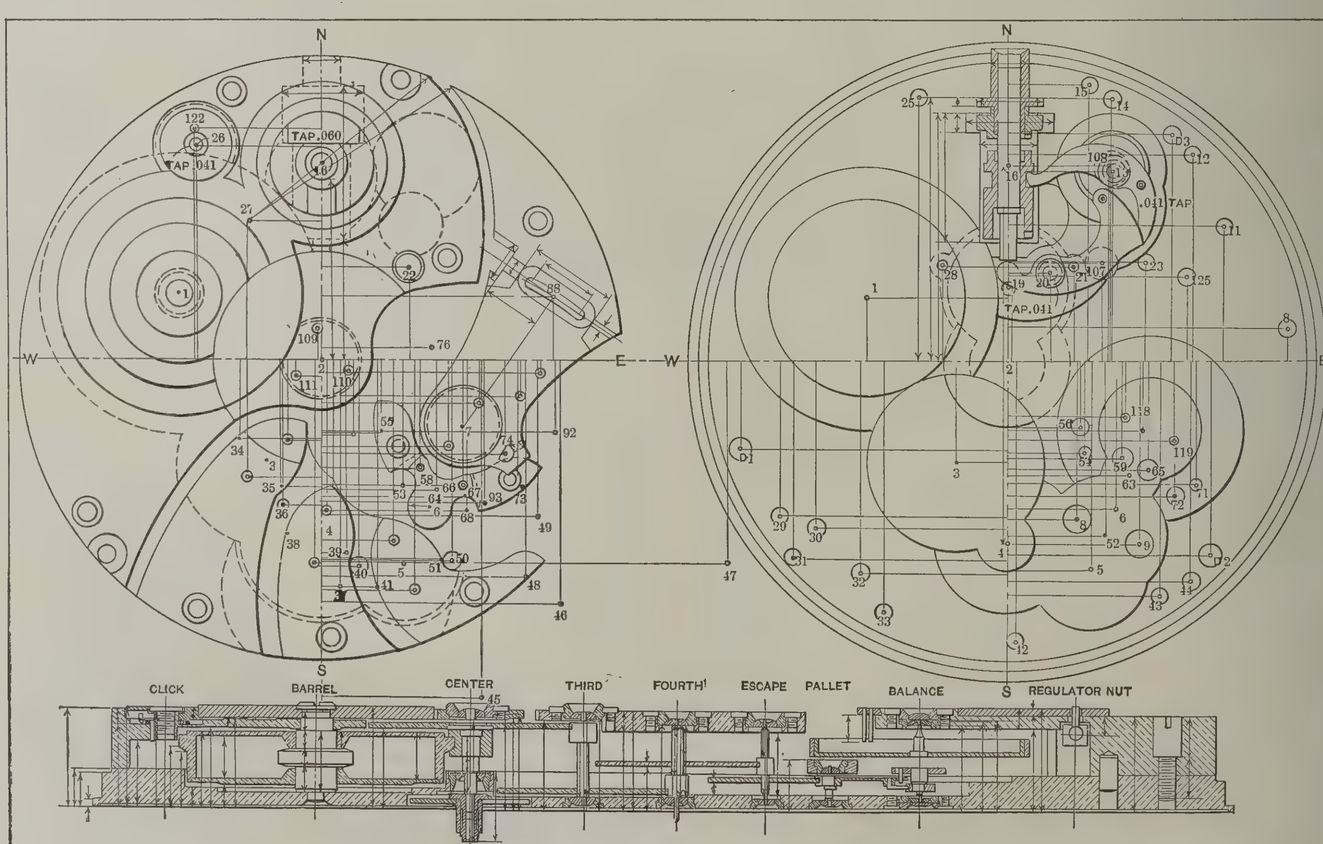


Fig. 5. Plan and Developed Elevation Views of the 16-size South Bend Watch, Enlarged

tion to what are called north, south, east, and west lines, radiating from the center of the watch. These lines are drawn in relation to the pendant which is always north; the position of the east and west in relation to right or left depends on whether the dial is facing up or down. This is illustrated clearly in Fig. 5.

Fig. 6 shows the upper section of a chart of the 16 size, L model watch, open face, which gives the numbers of the holes and the numbers of the master plates in which they may be found. Any hole determining a certain position in a watch always bears the same number, and is frequently placed in two or more master plates. The numbers in the columns are the numbers by which these different master plates are designated. This system enables the model-maker and toolmakers to produce the parts exactly as called for on the drawings.

The model-maker, by means of the transfer chuck, produces a complete watch which is thoroughly tested. If found to be all that is required as a time-piece of accuracy, the tools for making the various parts are then designed and made. These are sent out into the factory to the various departments in which they are to be used, and the work of making watch movements in quantities on a commercial basis is begun.

Watch Gearing

The calculation for watch gears or wheels, as they are called, is carried out in a slightly different manner from that pursued in the design of gears for other mechanical work. The pitch diameter, and the diametral pitch are calculated in just the same manner, of course, as for any other gear, but the shapes of the teeth of the wheels and the leaves of the pinions differ. The addendum or working face of the tooth is an epicycloid curve starting at the pitch circle and extending to the point of the tooth.

Where the wheel is the driver and the pinion the driven member, the face of the wheel tooth and the flank of the pinion leaves only come in contact. The tops of the pinion leaves are circular for convenience in finishing. These tops never come into action. The wheel tooth and pinion leaf should come into contact on the line of centers to give the best results. To accomplish this, the flanks of the teeth and leaves in the wheel and pinion are made radial with the center. The proper diameter of circle to use for generating the epicycloid curve of a watch wheel tooth is half the diameter of the pitch circle of the pinion with which the wheel is intended to mesh. The addendum is made 2.25 of the diametral pitch for the driver, and 1.0 of the diametral pitch for the driven pinion.

Hole No.		Name of Hole	Numbers Designating Master Plates											
	D 1	Dial feet. To left of pendant, dial down.	5464	5470	5471	6879	6886	6891		6974		7244	5460	5465
	D 2	Dial feet, E.	5464	5470	5471	6879			6892	6974		7244	5460	5465
	D 3	Dial feet, S. E.	5464	5470	5471	6879	6886	6891	6892	6974		7244	5460	5465
	1	Barrel, N. E.	5464	5470		6879						7244		
	2	Center	5464	5470	5471	6879	6886	6891	6892	6974	6981			
	3	Third, S. W.	5464											
	4	Fourth, S.	5464	5470	5471		6886	6891	6892	6974				
	5	Escape, S. E.	5464											
	6	Pallet, S. E.	5464											
	7	Balance, S. E.	5464								6981			
Other pin No. 12.	125–8	Balance cock steady pins, S. E.		5470										
	9	S. E.												
	10													
	11	Balance cock plate screw, N. E.		5470										
Other pins No. 125–8	12	Balance cock steady pin							6892					
	13	Clutch lever screw pendant set, N. E.		5470										
Other pin No. 30.	14	Barrel bridge steady pin, N. E.					6886							
Other screw No. 31.	15	Case screw, N. E.				6879								
	16	Winding wheel, N.		5470		6879	6886	6891	6892	6974				
	17													
	18													

Fig. 6. Chart of Master-plate Holes for the 16-size Model L, Open Face South Bend Watch

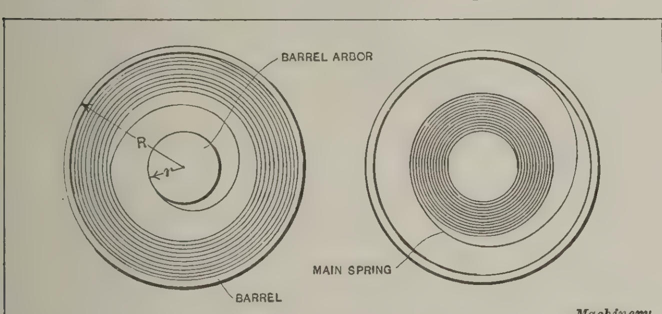


Fig. 7. The Main Spring wound and unwound—Note Space between Arbor and Inside of Chamber

In determining the width of the teeth in the wheel, nine-twentieths of the circular pitch is allowed, and seven-twentieths of the circular pitch for the width of the leaves of the pinion, leaving four-twentieths of the circular pitch for play, which is necessary in watch gearing to obviate dirt stopping the watch. There is no back-lash in watch gearing, because the drive is at all times in one direction.

Watch Train Computations

In laying out a watch train there are certain requirements which must be met. The essentials are, in this watch, that 18,000 vibrations per hour be imparted to the balance wheel, which gives 129,600 vibrations to 7 1/5 turns of the barrel which contains the main spring, and that the intermediate wheels driving the hour, minute and second hands rotate in the correct relation to each other. Another requirement in a railroad watch is that the main spring take 48 hours to unwind.

To proceed with the computation, refer to Fig. 4, which shows the gear train of an 18 size South Bend "Studebaker" railroad watch. The numbers of the leaves in the pinion are first considered, and as practice has determined different sets, we select those most suitable for the case in hand. For instance, the center pinion can have 10, 12 or 14 leaves; the third and fourth pinions 8, 10 or 12 leaves; and the fifth or escape pinion 6, 7 or 8 leaves. The main spring barrel is constructed to make 7 1/5 turns in 48 hours. In this case we select 12 leaves for the center pinion; 10 leaves for the third pinion; 10 leaves for the fourth pinion; and 8 leaves for the escape pinion.

Having decided on the number of leaves in the pinions, the next problem is to find the number of teeth in the barrel and intermediate wheels.

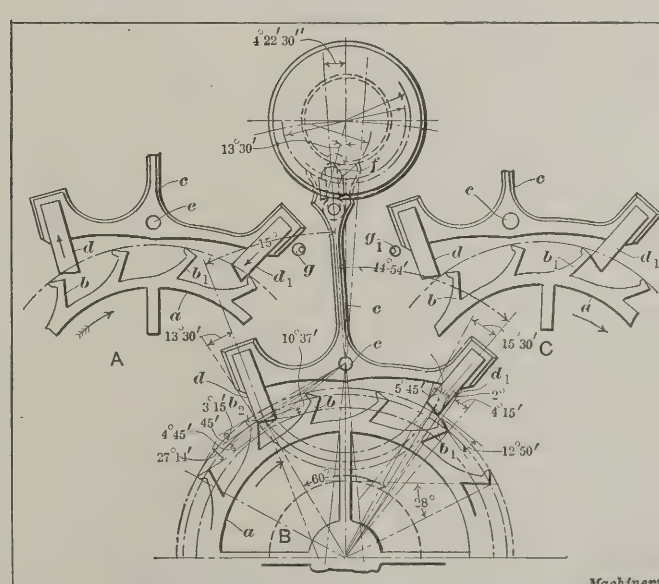


Fig. 8. Diagram illustrating Function and Action of the Detached Lever Escapement

The number of teeth in the barrel is:

$$\frac{48 \times 12}{7\,1/5} = 80 \text{ teeth}$$

As the balance wheel is to make 18,000 oscillations to one revolution of the center wheel, and as two oscillations of the balance wheel correspond to one tooth of the escape wheel, the latter having fifteen teeth, it follows, that the escape wheel will make:

$$\frac{18{,}000}{15 \times 2} = 600 \text{ revolutions per hour.}$$

The fourth wheel which is attached to the second hand must make 60 revolutions per hour, and as the escape pinion has 8 leaves, and makes 600 revolutions per hour, the number of teeth in the fourth wheel equals:

$$\frac{600 \times 8}{60} = 80 \text{ teeth.}$$

The numbers of teeth in the intermediate or third and the center wheels, are in a certain ratio to the number of leaves in the pinions with which they mesh, the product of which ratios must equal 60. The ratio in this case between the fourth pinion and third wheel is 1 to 7½, and between the third pinion and center wheel, 1 to 8. This multiplied by 10 give us, 7½ × 10, or 75 teeth in the third wheel, and 8 × 10, or 80 teeth in the center wheel; the ratio between the fourth

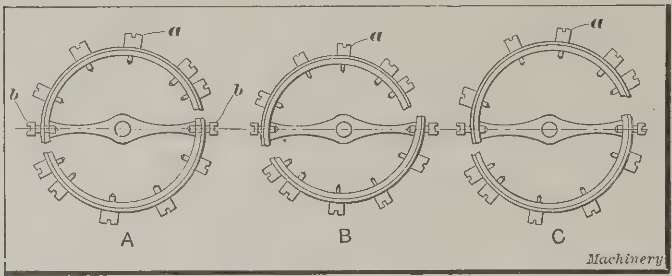


Fig. 9. The Compensating Balance in its Normal Condition and affected by Heat and Cold

wheel and escape pinion is 10. These ratios give the desired relation between the center wheel and escape wheel, the ratio between which is 1 to 600.

The dial train wheels and pinions are now worked out so that the hour and minute hands will be revolved in their proper relation to each other. The dial train is driven by the cannon pinion, which is frictionally held on the center staff. In this case the cannon pinion has 14 leaves, the minute wheel 28 teeth, the minute pinion 8 leaves, and the hour wheel 48 teeth. As the cannon pinion makes one revolution per hour and drives the minute hand direct, it follows that the hour hand will make $\frac{14}{28} \times \frac{8}{48} = \frac{112}{1344} = \frac{1}{12}$ revolution per hour.

The Main Spring

The main spring furnishes the power for driving the entire mechanism of a watch, and is made from the best steel obtainable, carefully hardened and tempered. To give the best action, the main spring has to be made in certain proportions to the barrel or chamber which contains it. The radius r of the barrel arbor, see Fig. 7, is made equal to one-third the radius R of the chamber, the space outside the barrel arbor being divided into two equal areas.* The main spring occupies half this area irrespective of whether it is wound or unwound. Owing to one of the laws governing the action of the main spring, it will give the greatest number of turns when made to these proportions.

The number of turns of the main spring which is necessary to carry the watch a given number of hours is found by the following formula:

$$N = \frac{H \times n_1}{n}$$

in which, N = number of turns of main spring,
H = number of hours the watch is to run,
n = number of teeth in barrel,
n_1 = number of leaves in center pinion.

Applying this formula to the watch shown in Fig. 4, we have:

$$N = \frac{48 \times 12}{80} = 7.2 \text{ or } 7\ 1/5 \text{ turns.}$$

The calculations involved in determining the strength and torque of a main spring are too complicated to be presented here; suffice it to say that if the main spring is made to conform to the requirements previously given, thinner or thicker material can be used until a main spring having the proper strength is obtained.

* For further information regarding flat spiral springs, see the article entitled "The Design of Flat Spiral Springs," which appeared in the July, 1910, number of MACHINERY, engineering edition.

The Detached Lever Escapement

The escapement of a watch movement transforms the rotary motion of the train of wheels into the vibratory motion of the balance. It also acts as a break to prevent the watch mechanism from "running away," retarding the motion of the train, and imparting the proper movement to the hands on the dial. To properly design an escapement, requires considerable study and is considered the most difficult problem in watch movement design. Ideal conditions are impossible to arrive at, so that compromises must always be made if an escapement to suit all requirements is to be obtained.

In action, the escape wheel a, Fig. 8, receives its motion from the wheel train, and by means of its peculiarly shaped teeth b coming in contact with the jewel pallets d and d_1 oscillates the fork c. To illustrate how this action takes place, we will assume that the fork c and escape wheel a are in the positions shown at A.

Now as the escape wheel a revolves, tooth b glides across the face of the pallet d lifting the latter up and forcing the upper portion of fork c, which is fulcrumed at e, to the right. This action lowers pallet d_1, bringing it in contact with the locking face of tooth b_1, as shown at C, and consequently stops the rotation of escape wheel a.

As the upper end of fork c is forced to the right, its forked end carries jewel pin f around, rotating the balance wheel, and putting the hair spring under tension. The hair spring, in unwinding, reverses the rotation of the balance and unlocks the tooth b_1 from the pallet d_1. The instant that this unlocking action takes place, the passage of the tooth b_1 across the inclined face of the pallet d_1 gives another impulse to the balance. This brings the fork and escape wheel into the positions shown at B, which happens as the fork c is returning to the banking g. Tooth b_2 now imparts an impulse to pallet d, and the order of actions is continued. The bankings g and g_1 stop the motion of the fork c in its oscillation from side to side.

The Compensating Balance

The balance wheel, or compensating balance, as it is called, is the heart of the watch. It regulates and controls the movement of the gear train from which it receives its motion. The

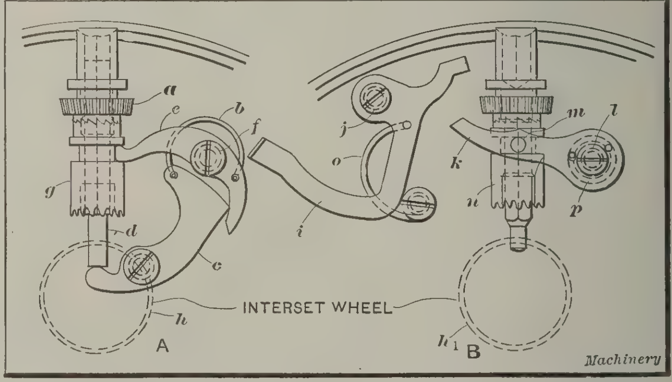


Fig. 10. Watch Setting Mechanisms

motion of the gear train is intermittent, while that of the balance is practically continuous. Five times every second the train starts up from a dead rest, and for a brief space of time moves forward, again coming to rest. In this same time the balance reverses its direction of rotation, stopping for such a brief period of time that the cessation of movement is almost impossible to detect.

A compensating balance is composed of a steel center arm and rim made from one piece of metal, to which a brass ring is fused. The brass ring has twice the coefficient of expansion of the steel rim, and the proportion between the thickness of the rims is approximately two-fifths steel to three-fifths brass. The construction of a compensating balance is clearly shown in Fig. 9. At A it is in its normal position; at B it is affected by heat; and at C by cold. The conditions of the balance are exaggerated here to make the changes in its shape more perceptible. Located around the rim of the balance are what are called "balance" screws a. These are made from either brass

or gold, and are employed for regulating, poising and altering the weight of the balance wheel in relation to the strength of the hair spring. The two screws *b* at each end of the arm are what are known as "timing" screws. These are employed to bring the watch to time without disturbing the regulator, which is always set at zero when it leaves the factory.

When a watch movement is subjected to heat, the tension of the hair spring is decreased and thereby weakened, and the balance arms are lengthened, thus increasing the diameter of the balance which adds to the load on the hair spring. The effect of this action, if not counteracted, would be to cause the watch to lose time. To compensate for this, the brass rim expands more than the steel rim and center, which effect causes the balance to become smaller in diameter tending to throw the mass of its weight more toward the axis, as shown at *B*. When a watch movement is subjected to cold, the hair spring contracts and becomes stronger. The steel rim and center of the balance contract, as does also the brass rim, but as the brass rim contracts more than the steel rim, it has the effect of straightening the rim, thus increasing the diameter of the balance wheel, and carrying the mass of its weight further away from the axis, which has a retarding effect. This condition is shown exaggerated at *C*.

The rim of the balance is provided with more holes than it has screws, so that more screws can be added, or their positions changed as conditions may warrant, when poising and subjecting the movement to temperature tests. These screws add to the weight of the balance and change its radius of gyration, thus compensating for changes in temperature and positions. All first-class watches are regulated for five positions, *viz.*, dial up, dial down, pendant up, and pendant to right and left.

Many ingenious devices have been developed for setting the hands and winding the main spring of a watch. They can,

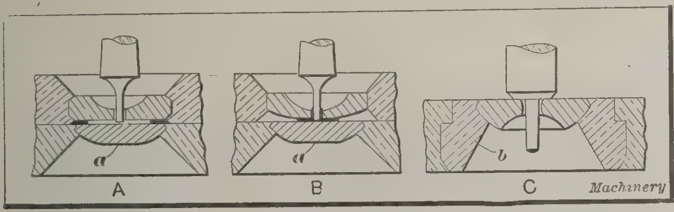


Fig. 11. Jewels, Settings and Pivots

however, be divided into two main classes, *viz.*, pendant and lever sets. A simple pendant and lever set which is used in the South Bend watch is illustrated at *A* and *B* in Fig. 10. At *A* is shown a pendant set mechanism in the position which it occupies when acted upon normally by the stem fastened to the crown, which is used for operating the mechanism. In this position, if the crown were rotated, the main spring would be wound up by means of the winding pinion *a* and intermediate wheels, not shown.

When the crown is pulled out, the stem is withdrawn, releasing the tension on spring *b* and allowing it, through the setting lever *c*, to force up the stem *d*. The spring and lever *c* also act on clutch lever *e*, raising its rear end, and as it is fulcrumed on screw *f*, the forward end is lowered thus carrying down the setting clutch *g*. This clutch, in lowering, meshes with the teeth in an interset wheel *h*, which operates the wheels and pinions connected to the hands on the dial.

The setting mechanism shown at *B* is what is known as a lever set, and is used principally in railroad watches. It is shown in the position that it occupies when the main spring can be wound up by rotating the crown. When setting lever *i*, which is fulcrumed on screw *j*, is withdrawn from the case, its forward end is rotated downward coming in contact with the end of the clutch lever *k*, which is fulcrumed at *l* and connected by a pin *m* to the clutch sleeve *n*. It is evident that this action disconnects the clutch *n* and brings the teeth in its lower end in mesh with the interset wheel h_1, which in turn, operates the hands on the dial. As setting lever *i* is pushed in again, it is returned to its normal position by spring *o*, and as it is released from clutch lever *k*, spring *p* returns this lever to its normal position connecting the clutch with the winding mechanism. With this mechanism it is impossible to set the hands without first pulling out the lever *i;* this is not the case with the mechanism shown at *A*, which is likely to be operated by simply removing the watch from the pocket by the crown, thus making the latter an objectionable mechanism for use in railroad watches.

Jewels

Jewels are introduced into a watch movement to reduce friction as much as possible and also to increase the life of the watch. The shape of the hole in the jewel has a considerable bearing on the reduction of friction and in obtaining the best results. At *A* and *B* in Fig. 11 is shown the incorrect and correct method of finishing the holes in a jewel. The hole in the jewel at *A* is called a "straight hole," having parallel sides and a flat bottom. This type of jewel allows the oil to be drawn between the settings, leaving the jewels dry and keeping the oil at the outer rim, as is clearly shown in the illustration.

At *B* is shown what is called the "olive hole." This reduces the retarding effect of the thickening of oil to a minimum. The face of the jewel has a hemispherical oil cup, and the back is well rounded. The hole is also rounded and is made slightly larger than the diameter of the balance pivot. Having a jewel shaped in this manner increases capillary attraction toward the center, the pivot acting as a piston to keep the supply of oil at this point until the last particle is exhausted. The distance between the hole jewel and its end stone *a* should be just sufficient to allow the interception of a thin oil film. At *C* is shown a common type of jewel for the wheel pivots. This, as shown, is held in a setting *b* and is provided with the olive hole previously mentioned.

* * *

WHY ARE OUR FOUNDRIES NEGLECTED?

In the September, 1911, number of MACHINERY, an editorial appeared, entitled, "Why are our Foundries Neglected?" As an answer to this question we may appropriately quote a few paragraphs from an address by Mr. H. M. Ramp, superintendent of the Modern Foundry Co., before the Superintendents' and Foremen's Club, Oakley, Cincinnati, Ohio. Mr. Ramp says:

"While the foundry deserves much criticism and correction, it has never had the attention, the brains, the research work, or the finances poured in upon it that the machine end of the iron industry has had to elevate and develop its possibilities. It has been considered more as a necessary evil than as a branch of the business that could be mastered and developed and controlled. The foundry, until the last few years, has been the last place to receive improvements and advice, and it is not as yet burdened with a load of either.

"The individual who entered the foundry as a life's business was always regarded as sinking his intellectual or mechanical abilities, if he had any. The foundry has been demeaned and often referred to as a place where the qualifications are 'a strong back and a weak mind,' and yet there is no business under the canopy of heaven that requires greater judgment and a more thorough knowledge of fundamental principles than the art of molding. When properly done it most certainly deserves to be classed as an art, and yet this is the atmosphere in which the foundries of our country were developed and the foundrymen of our country were made until the past few years, while the machine shop was commanding the gray matter and finances of the brightest men in our land. This prejudice against the foundry in the past, as a place of dirt and grime fit only for occupation by hewers of wood and haulers of water, has done much to retard the development of the foundry business and to keep the bright, ambitious and energetic men from mastering its science. But these are not the only reasons why the foundry fails to give the machine shop what it asks.

"When the machine shop seeks to improve its tools or methods, it does not put blacksmiths or candy makers on the job—it uses the best educated brains and experience in the machine business that money can buy. Yet too often the pattern, the very foundation of the foundry's work, is constructed as the designer, the pattern foreman, the engineer directs, without even consulting the experience and preference of the foundry, and in as great a measure as this prevails just as great is the handicap placed upon the foundry."

* * *

The prize of $5000 for an aerial engine, which has been offered by Mr. P. Y. Alexander through the three British aeronautical associations, the Aerial Society, The Aero Club, and the Aerial League of the British Empire, has been awarded to the Green Engine Co., the engine of which developed, during the competition, 61.6 H. P. at 1150 R. P. M. during two nonstop runs of twelve hours each.

RE-CUTTING MILLING CUTTERS WITHOUT ANNEALING

By F. B. JACOBS*

In an article published in the December, 1911, number of MACHINERY the writer outlined the method used in re-cutting ordinary milling cutters without annealing them. In this article the re-cutting of thin milling saws, and of the end teeth of large end-mills will be explained. Great numbers of milling cutters find their way to the scrap box before their days of usefulness are over. These could, at slight expense, be re-cut and put in service again. The saving is especially marked with the high-priced, high-speed steel cutters in common use.

To re-cut milling cutters without annealing them does not call for special skill, or the services of a high-priced toolmaker. All that is required is the ordinary cutter grinding machines found in nearly every tool-room, wheels of the proper materials in the correct grits, grades and bonds, and an operator possessed of a little originality and ordinary mechanical skill. In fact, when re-cutting worn out milling cutters about the same methods are used as when cutting new cutters, except that grinding machinery and abrasive wheels are used in place of the milling machine and milling cutters.

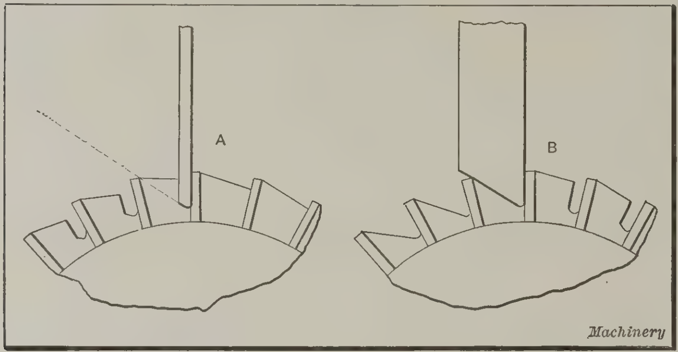


Fig. 1. The Two Steps taken in Re-cutting Milling Cutters by Grinding

The method followed can be readily understood from Fig. 1. This method applies to both peripheral and side teeth. The teeth are first gashed out as shown at *A*, with a thin vulcanite wheel, the object of this gashing being to preserve the corner of the wheel used in the re-cutting operation. At *B* is shown the re-cutting operation, the face of the wheel being trued to the proper angle. To re-cut milling cutters in one operation is not practical, as a hard and, therefore, slow cutting wheel would have to be used to preserve the corner of the wheel. With a thin elastic wheel of just the proper grain and texture for the gashing operation, and a fast cutting vitrified wheel to cut away the superfluous stock between the bottoms of the gashes and the points of the teeth, very economical and satisfactory results can be obtained with a little practice.

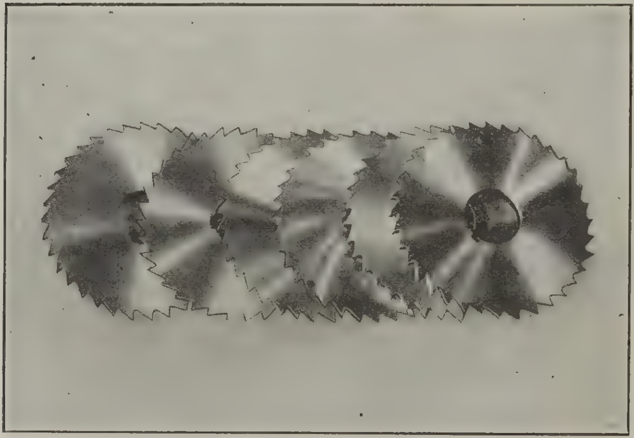


Fig. 2. A Number of Re-cut Slotting Saws

In Fig. 2 are shown six milling saws that for all practical purposes are now as good as new. These, however, were taken from the scrap box; four of them being 4 inches in diameter and 1-16 inch thick, and two of them, 5 inches in diameter and 1/8 inch thick. They were first located on an ordinary work arbor such as used in turning up thin collars, etc., paper washers being placed between the cutters to compensate for the side taper. They were then ground on a Walker grinder to a diameter of 3 9/16 inches. This work was done dry with an aloxite wheel 6 inches in diameter, 1/2 inch face, 1 1/4 inch hole, 50 grit, M grade, D496 bond. This operation ground all of the old teeth away from the large saws, and nearly so from the smaller ones.

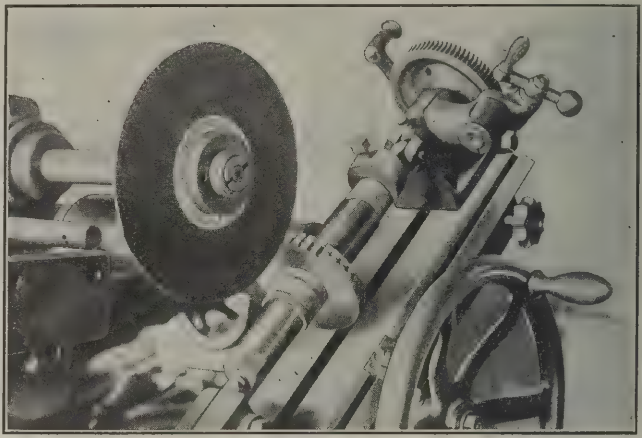


Fig. 3. The Gashing Operation

The work was then placed between the centers of the form cutter attachment of a Brown & Sharpe No. 3 cutter grinder, and the teeth gashed out to the required depth. This operation is shown in Fig. 3. The wheel used for this purpose was aloxite (vulcanite), 7 inches in diameter, 1/8 inch face, 1 1/4 inch hole, 30 grit, V-K-9 bond, run at a speed of about 4200 R. P. M. In this operation the wheel loss was very slight—only 0.008 inch. The depth of cut was 0.003 inch for each stroke, the graduations on the cross-feed screw being relied on for the correct depth. The work was fed under the wheel with a fairly rapid motion, one tooth being gashed to its full depth at a time.

Fig. 4. Cutting the New Teeth

The next operation, which consists of cutting the new teeth, is shown in Fig. 4. This operation is practically the same as the gashing operation, the difference being that a wide wheel is used, its face being trued to the correct angle, as shown at *B* in Fig. 1. The wheel used for this purpose is aloxite, 6 inches in diameter, 3/4 inch face, 1 1/4 inch hole, 40 grit, 0 grade, D497 bond, run at a speed of about 4200 R. P. M. The teeth were fed one at a time under the wheel, taking a cut of 0.002 inch at each stroke until the land of the tooth was of the correct thickness, or about 1/32 inch. The wheel loss in this operation was 1/64 inch. The teeth were then backed off as shown in Fig. 5. For this purpose an aloxite wheel 5 inches in diameter, 3/8 inch face, 1 1/4 inch hole, 50 grit, 0 grade, D496 bond, was used, the speed being 3650 R. P. M.

The total time consumed in re-cutting these cutters was divided as follows:

* Address: Care of The Carborundum Co., Niagara Falls, N. Y.

Getting ready and setting up for first operation	10 minutes
Grinding time on Walker grinder	30 minutes
Setting up cutter grinder for gashing operation	15 minutes
Gashing out teeth	60 minutes
Setting up for re-cutting operation	5 minutes
Re-cutting teeth	50 minutes
Setting up for backing off teeth	10 minutes
Backing off teeth	13 minutes
Time consumed in truing wheels, etc.	10 minutes
Total time	3 hours 23 minutes

In Fig. 6 are shown five high-speed steel end-mills, 3 inches long, 2⅜ inches in diameter, having sixteen teeth each; *A*

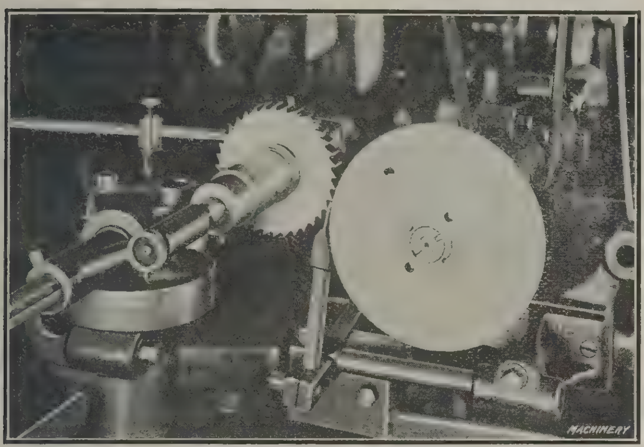


Fig. 5. Grinding the Clearance

shows a mill the end teeth of which are practically worn out, *B* illustrates a mill after the gashing operation, and *C*, *D* and *E* give a good idea of how the mills looked after the second or re-cutting operation.

Before re-cutting, the operator should first decide on the correct angle for the teeth, and then true the face of both wheels to this angle. For this purpose the writer has always used a carborundum stick 9 by ¾ by ¾ inches, 20 grit, H grade. With the wheels in question this will be found more satisfactory than a diamond. In the gashing opera-

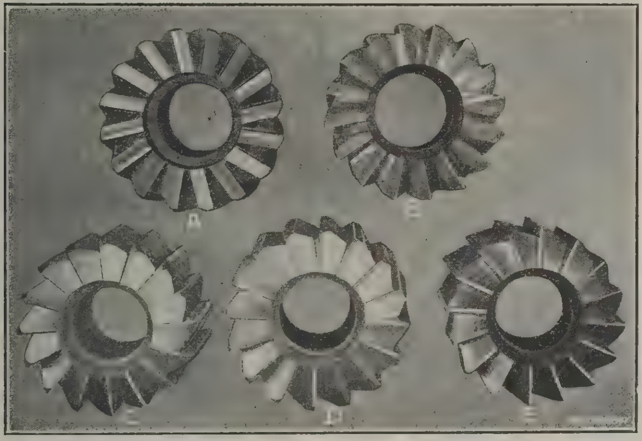


Fig. 6. Various Stages in the Re-cutting of End-mill Teeth

tion the cut should be carried to a depth where a line drawn parallel to the face of the wheel comes nearly to the edge of the tooth. (See *A* in Fig. 1.) In re-cutting end teeth it is necessary to use a machine equipped with a head that can be set at any angle in order to bring the lands of the teeth parallel. The writer used a Brown & Sharpe No. 3 cutter grinder, equipped with an end-mill grinding attachment, as shown in Figs. 7 and 8. In setting the head to the correct angle the cut-and-try method can be used, or the angle can be figured out when the operator has decided on the angle for the wheel face and knows the number of teeth to be cut.*

The gashing operation is shown in Fig. 7, the teeth being fed one at a time under the wheel with a cut of 0.002 inch, until the correct depth is reached. This is easily determined for all of the teeth by the graduations on the cross-slide screw, after the proper depth for the first tooth is decided on. In re-cutting four mills having sixteen teeth each the loss of the gashing wheel was only 1/64 inch. The re-cutting operation is shown in Fig. 8, the teeth being fed

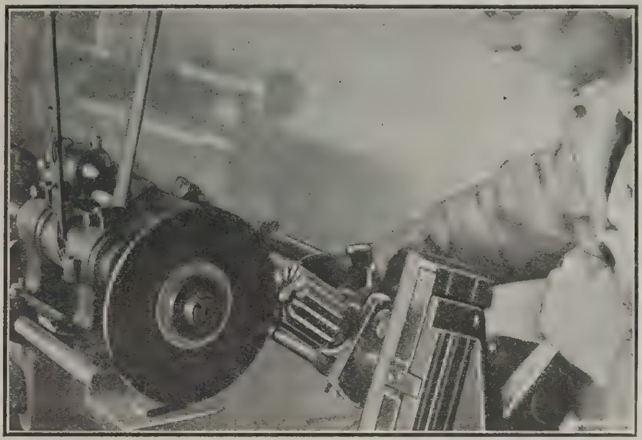


Fig. 7. Gashing the End-mill Teeth

under the wheel until the lands were of the correct dimension, or 1/32 inch. The wheel loss in this operation was ⅛ inch for re-cutting four mills having sixteen teeth each. As the width of the land is relied on in this case to determine the proper depth of the cut, the wheel loss is of no consideration, provided the wheel wears true, thus preserving ap-

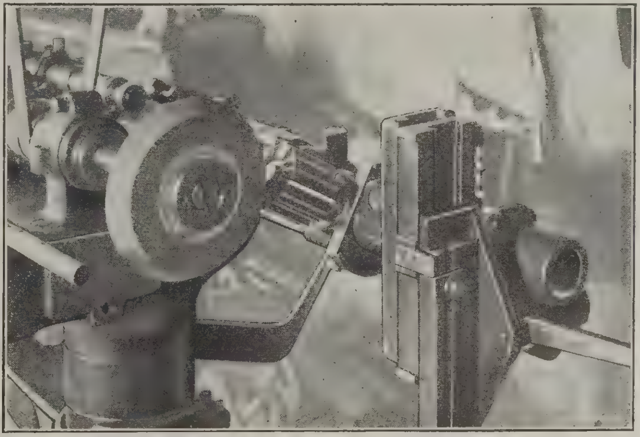


Fig. 8. Cutting the End-mill Teeth

proximately the correct angle. In this operation the most satisfactory results were attained with a soft coarse wheel, run at a comparatively high speed. When finer wheels in harder grades were used the tendency was to cut slow and burn.

After re-cutting, the teeth were backed off as shown in

Fig. 9. Grinding the Clearance on the End-mill Teeth

Fig. 9, this work being done on a Walker grinder equipped with a universal cutter grinding head. The wheel used for this operation was aloxite (cup), 5½ inches in diameter, 2 inches face, 1¼ inch hole, ¾ inch back, ⅜ inch wall, 50

* See MACHINERY, engineering edition, November and December, 1911, "Milling Radial Teeth in Cutter Blanks," and the Data Sheet Supplements accompanying these articles. Also see MACHINERY, April, 1904, "To Calculate the Setting of the Dividing Head when Cutting the Teeth of End-mills"; MACHINERY'S Data Sheet No. 32, "Tables of Angles for Headstock of Milling Machine when Cutting End Teeth in Mills, etc."; and MACHINERY'S Data Sheet Book No. 4, "Reamers, Sockets, Drills and Milling Cutters," page 32.

grit, 0 grade, D496 bond, run at a speed of about 3650 R. P. M.

The total time consumed in re-cutting four end-mills of the dimensions mentioned above was divided as follows:

Setting up cutter grinder for gashing operation and cutting and trying to determine the correct angle	30 minutes
Gashing out teeth	120 minutes
Re-cutting teeth	120 minutes
Setting up Walker grinder for backing off teeth	15 minutes
Backing off teeth	30 minutes
Time consumed in truing wheels, etc	15 minutes
Total time	5 hours, 30 minutes

As the work as explained was wholly of an experimental nature, it is fair to assume that any machinist of ordinary intelligence could, with a little practice, do the same work in much shorter time. However, for the sake of argument we will suppose that a machinist at thirty cents per hour consumed 8 hours 43 minutes in re-cutting the cutters described in this article. After figuring his time, adding a certain amount for fixed overhead charges, and noting the value of similar cutters as bought on the open market, it will readily be seen that it is more profitable to re-cut them by the method described than it is to sell them as scrap.

* * *

AUTOMATIC BOTTLE BLOWING MACHINES

Automatic machinery for some classes of manufacture has reached a remarkable stage of development. The Owen Bottle Blowing Machine Co., Toledo, Ohio, has glass bottle blowing machines in operation that automatically blow twenty-three ketchup bottles a minute, twenty-four hours a day, seven days a week and fifty-two weeks a year, neglecting the short shutdowns necessary to change the bottle molds. The machine consists of a large turntable carrying two sets of molds, one set being "gathering" molds and the other "bottle" molds. The molds are carried over a hearth filled with molten glass, and as a gathering mold passes over the hearth, a rod of hot glass is drawn into it by suction. The gathering mold opens, leaving a rod of hot glass standing vertically. The bottle mold closes over the gathered glass and air pressure forces the molten glass out to fill the die the same as a glass blower would blow it.

The blown bottle is automatically deposited in a cast-iron bar containing thirty holes in a line. The bar shifts one place for each bottle until it is filled, and then it is taken up by a traveling chain conveyor and carried sideways through an annealing oven. At the far end of the annealing oven two men stand who inspect the bottles and pack them into cases. The cast-iron bars are returned by the chain conveyor to the bottle blowing machine to pass through the same cycle as before.

The bottle molds are made of cast iron and a mold is good for 12,000 to 15,000 gross of bottles before it requires scaling. Compressed air plays an important part in actuating the dies, and natural gas is used for melting the glass. The batch is automatically mixed and fed to the furnace, thus reducing the manual labor required for the operation of a machine and furnace to three men, two of whom are packers. The machine tender regulates the furnace also and looks after the general operation of the apparatus.

* * *

There are more telephones in proportion to population in the United States than in any other country in the world. Canada ranges second in this respect, and Sweden third. It is interesting to note that in New York City alone there are as many telephones as in Germany. In Ohio there are as many as in Great Britain; and Boston has double the number of telephones of Paris. Apparently, most of the European countries have been much slower to appreciate the advantages of the telephone than has the United States. One reason for the slow introduction of the telephone in Berlin, however, is stated to be that the postal system, with its tube post, is so perfected that for less than one cent one can send a message through the mails within the city, receiving a reply within an hour or less.

JIG-BORING AT THE UNITED SHOE MACHINERY CO.'S FACTORY

By CHESTER L. LUCAS*

The illustration Fig. 1 does more to give a general idea of the appearance of the plant of the United Shoe Machinery Co., at Beverly, Mass., than paragraphs of reading matter could do, and as nine-tenths of the employes are machinists, it will be realized that the output of the factory is very large. As a matter of fact, over 20,000 machines for the manufacture of shoes are shipped annually. The plant consists of sixteen buildings of reinforced concrete construction, having twenty-five acres of floor space. Over sixty tons of steel are used each week in the manufacture of machines, and the drop-forging department alone turns out 60,000 forgings per week.

The toolmaking department of this factory is one of the best equipped in the country. The principal work of the toolmaking department is the building of jigs and fixtures, in addition to maintaining the thousands of jigs which are in daily use in the factory. The important part of the work of jig- and fixture-making is the proper location and boring of the holes for bushings, studs, etc. Fig. 2 shows one of the toolmakers engaged in locating the position of a hole to be bored in the jig shown on the machine. Boring machines made by the Universal Boring Machine Co., Hudson, Mass., are used almost exclusively for boring jigs and fixtures in this factory. As indicated in the illustration, the machines are used without the left-hand supports for the boring-bars. In setting up the work, all measurements are taken either from the table or from an angle-iron that is permanently mounted on the rear part of the table of the machine. This angle-iron, a rear view of which is shown in Fig. 3 (on the floor), is somewhat unusual in type. The ribs at the back are spaced very closely, and the angle-iron is clamped to the machine by means of four slots placed between the ribs. The angle-iron shown has been rough-planed, and is now left to "season," before being finished and put into use.

Fig. 1. Plant of the United Shoe Machinery Co., at Beverly, Mass.

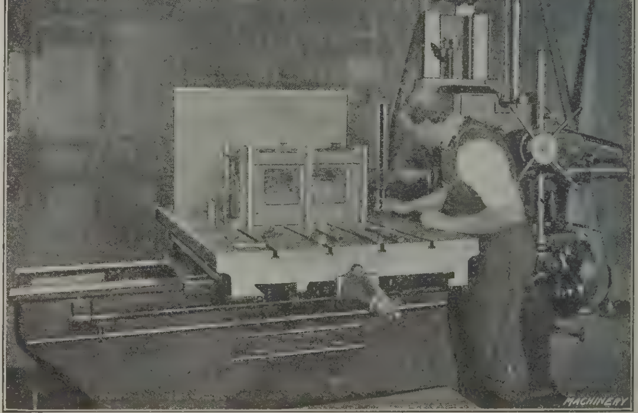


Fig. 2. Locating the Spindle in Position vertically for Boring a Hole in a Jig

In locating a jig in its proper position on the table of the boring machine, special height-gages are employed. In the toolmaking department there are about twenty-five of these special tools, which are made by the Brown & Sharpe Mfg. Co. These tools have extra wide and heavy bases. The jig is first placed against two stops that may be seen in the left-hand T-slot in the table in Fig. 2. With the height-gage, the jig is placed parallel with the angle-iron on the table, which, of course, is parallel with the spindle of the boring

* Associate Editor of MACHINERY.

machine. In locating the spindle of the machine for boring a hole, measurements are taken vertically from the table, either to the spindle itself, or to a plug which is fitted in the end of the spindle. Needless to say, the spindle must be abso-

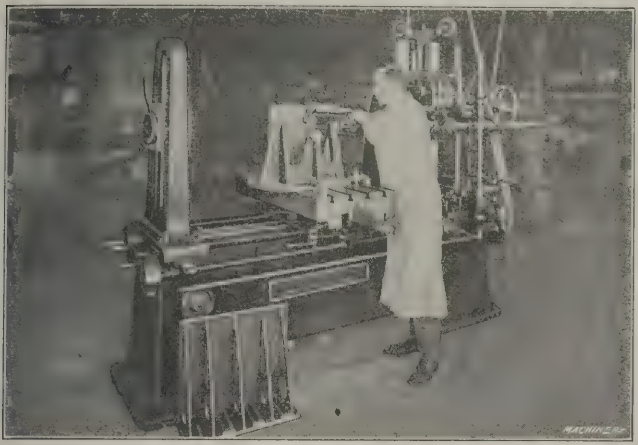


Fig. 3. Locating the Spindle laterally for Boring a Fixture

lutely without shake or play, and this condition is insured by a "take-up" at the head of the machine. After locating the spindle for the vertical dimension, the horizontal measurement is taken, as shown in Fig. 3, from the angle-iron to the plug

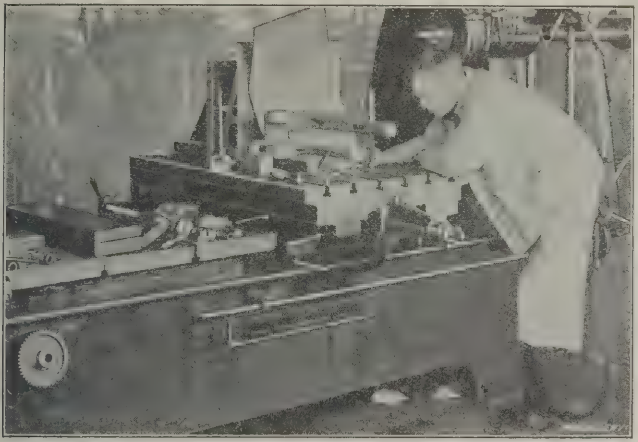


Fig. 5. Setting-up and Locating Experimental Work on Boring Machine

or spindle, as the case may be. After the spindle is properly located, the hole is bored for the bushing, and then attention is given to the next hole. Should there be two holes in line

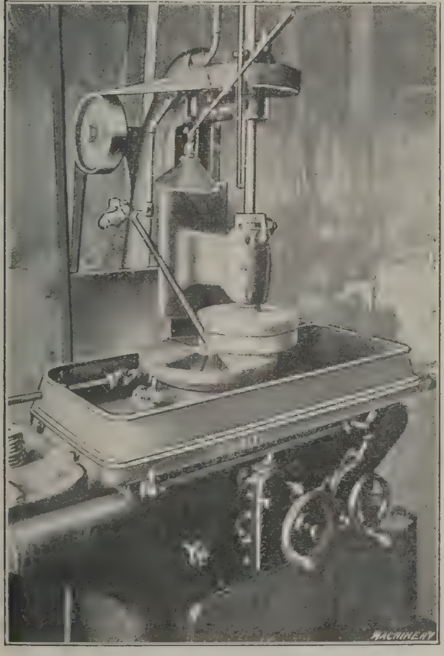


Fig. 7. Face-grinding the Drop-forgings

with each other on opposite ends or sides of the jig, they are not bored at one setting, as might be supposed, but the jig is reversed on the table of the machine and re-located for the second hole. This method is considered to be the best practice, because long boring-bars are not required, and it is not necessary to use the left-hand boring-bar support. Fig. 4 shows the toolmaker boring the hole in a fixture. The type

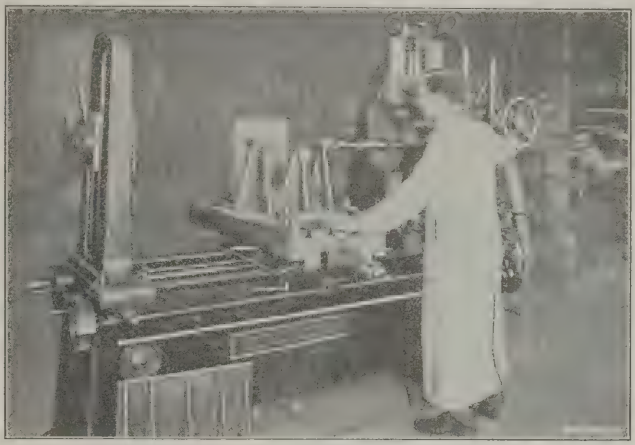


Fig. 4. Drilling one of the Holes in a Fixture

of machine used is particularly well adapted for jig-boring, because the operator can run the machine with his right hand, and at the same time watch the work of the cutter. It also has an added advantage over machines in which the head is at the

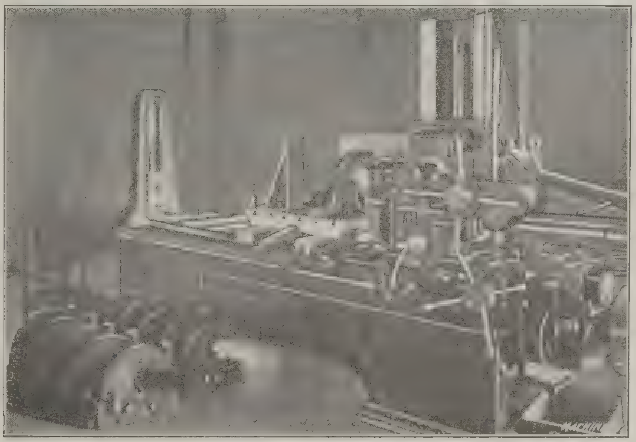


Fig. 6. Boring the Heads for Monogram-embossing Machines

opposite end, in that the operator can caliper holes without being obliged to use his left hand in so doing. This same advantage applies, of course, when trying size plugs.

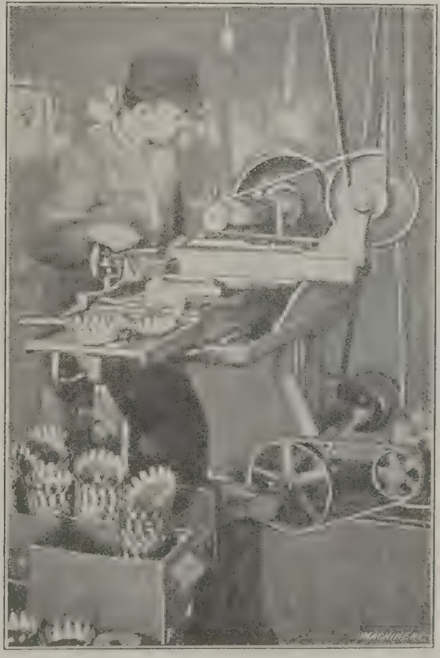


Fig. 8. Grinding Shoe-trimming Cutters

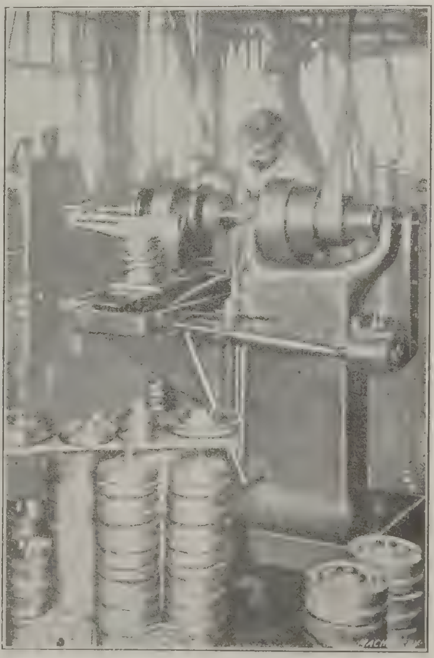


Fig. 9. One of the Cam-cutting Machines

Fig. 5 illustrates the method used in boring work in the experimental department, where trial machines for shoe manufacturing are built in small lots before the work has been

jigged for regular production. The piece shown on the machine is one of the parts of a shoe-leveling machine, and the machinist is setting up the piece and locating each hole to be bored, in accordance with the drawing which he has before him. On a job of this kind it takes a great deal longer to set up the work properly and lay out the positions of the holes than it does to do the actual machining which follows.

The machine in Fig. 6 is shown working on the heads of monogram-embossing machines, a group of which appears on the floor near the base of the boring machine. From the foremost of this group it will be seen that there are numerous

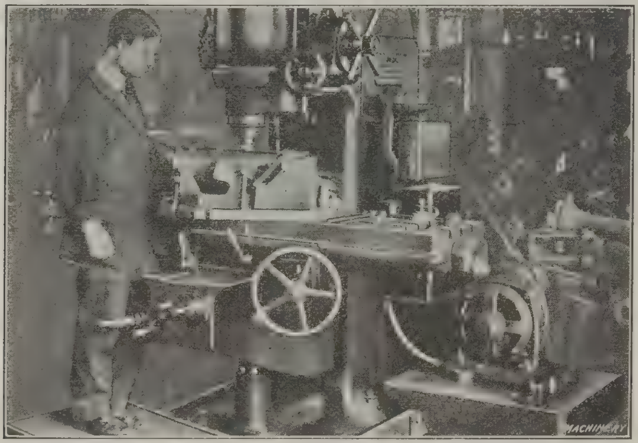


Fig. 10. Milling Fixture for Use on the Vertical Miller

small holes to be located and bored for the various shafts and rocker-arms. This work is essentially the same as in the jig-boring operations, a small angle-iron being used as shown. In this instance, however, the angle-iron is at the side of the table, instead of at the rear.

The Pratt & Whitney Co.'s face grinder shown in Fig. 7 is used extensively in the grinding department for facing small drop forgings, some of which are shown on the machine. The surfaces of these forgings must be parallel within limits of 0.0005 inch. In order to show this machine to better advantage, the water-guard is removed, thus exposing the table to view. The drop forgings, which have central holes, are located by placing them over a stud at the center of the table; a magnetic chuck is not required, for the pressure of the wheel is sufficient to keep the piece flat against the face-plate while it is being ground.

Another interesting grinding job is shown in Fig. 8, where

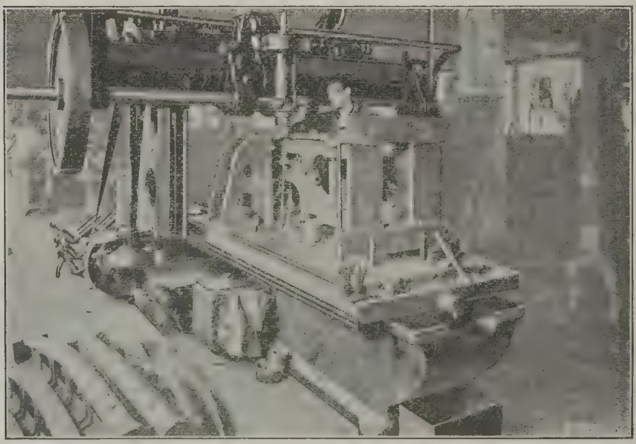


Fig. 11. Milling the Seats and Recesses on a Nailing Machine Column

the knives for shoe trimming machines are ground internally and externally on Heald No. 70 internal grinders. Two machines are used on the work, one being set up for grinding the inside and one for the outside. The machine shown is working on the insides of the cutters, and the same operator, running two machines, turns out two hundred finished cutters per day. The cutters are located by being slipped over a stud that engages the central holes, and are held in place by a nut and washer.

Cams are cut in large numbers and great variety in the United Shoe Machinery Co.'s plant, and a special department is maintained for the sole purpose of turning out the cams used on the various machines. While several makes of cam-cutting machines are employed, the favorite seems to be the machine made by the Kearney & Trecker Co., Milwaukee, Wis. One of these machines is shown in Fig. 9, and some of the various cams which have been cut on it are shown piled up about the machine. Special attention is called to those resting upon the board on the top of the piles in the foreground. This machine, like most other cam-cutting machines, must be provided with a master cam that governs the movements of the work in relation to the cutter.

The Cincinnati miller shown in Fig. 10 is working on tack-puller heads, one of which is shown in the fixture on the table of the machine. As will be noticed, provision is made on the base of the fixture for clamping it in various positions to facilitate the milling of the different parts of the work. It is obvious that it would be impracticable to shift the fixture around in this manner, if the milling being done were other than that of facing off parts in which the relative height is the only consideration.

On the Ingersoll upright type of milling machine shown in Fig. 11 the large columns for nailing-machines are milled to receive the different parts of the machine attached to it. One of these columns is shown at the right of the illustration. This particular job is well suited to this type of machine, because the short cuts that are required can be easily taken with a milling cutter, whereas, if the work were planed, the machine used would necessarily have to be out of all proportion to the amount of cutting to be done, on account of the difficulty of accommodating the extremely large casting.

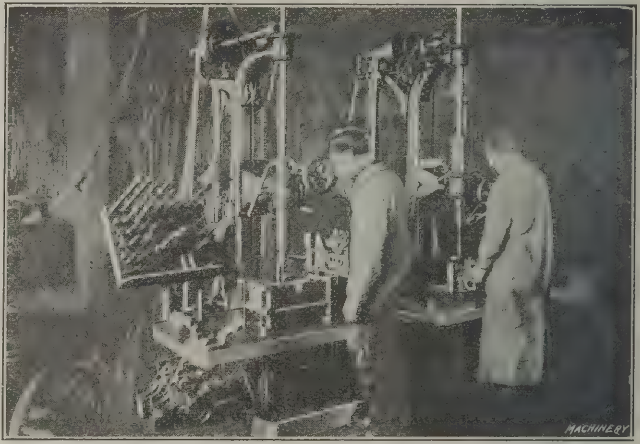


Fig. 12. Racks for Holding Tools used in Drilling Machines

Drilling operations are everywhere to be seen in this large factory, there being hardly a department that does not employ several hundred spindles. The manufacturing work, of course, is all jigged, and to facilitate the many changes which must be made in drills, reamers and counterbores, the large drill presses are fitted with tool-holding racks. In these the different tools used on the job are kept in regular order, so that they may be quickly gotten when wanted. At the same time, they are protected from being injured or mislaid, so that altogether the idea seems to be a good one. Fig. 12 shows a drill press with a rack.

Aside from the work done in the factory, much might be written on the conveniences installed in the factory for the workmen, in the form of metal lockers, washrooms, restaurant, etc. In addition there is a fully equipped emergency hospital. Here a trained attendant is in charge, who is qualified to administer first aid to the injured.

* * *

It appears from an article in *Zeitschrift des Osterreichischen Ingenieur und Architekten-Vereines*, that the water power available for industrial purposes in Switzerland is equivalent to 90 horsepower per square mile. The available water power in Sweden and Norway is about 45 horsepower per square mile of area. In Switzerland, nearly one-quarter of this available water power has already been made use of, while in Sweden and Norway but a small fraction, probably not more than one-fiftieth of the available water power has as yet been harnessed.

DRAWING A DEEP STEEL SHELL*

By JOSEPH V. WOODWORTH†

Fig. 1 shows the six successive operations required to produce the shell shown in Fig. 10, indicating clearly the evolution, proportions and dimensions. The material for which the tools were designed was 0.0359 inch dead soft cold-rolled drawing steel. The shell had to be true to size in diameter and height, smooth inside and out, and a strictly first-class product in every way.

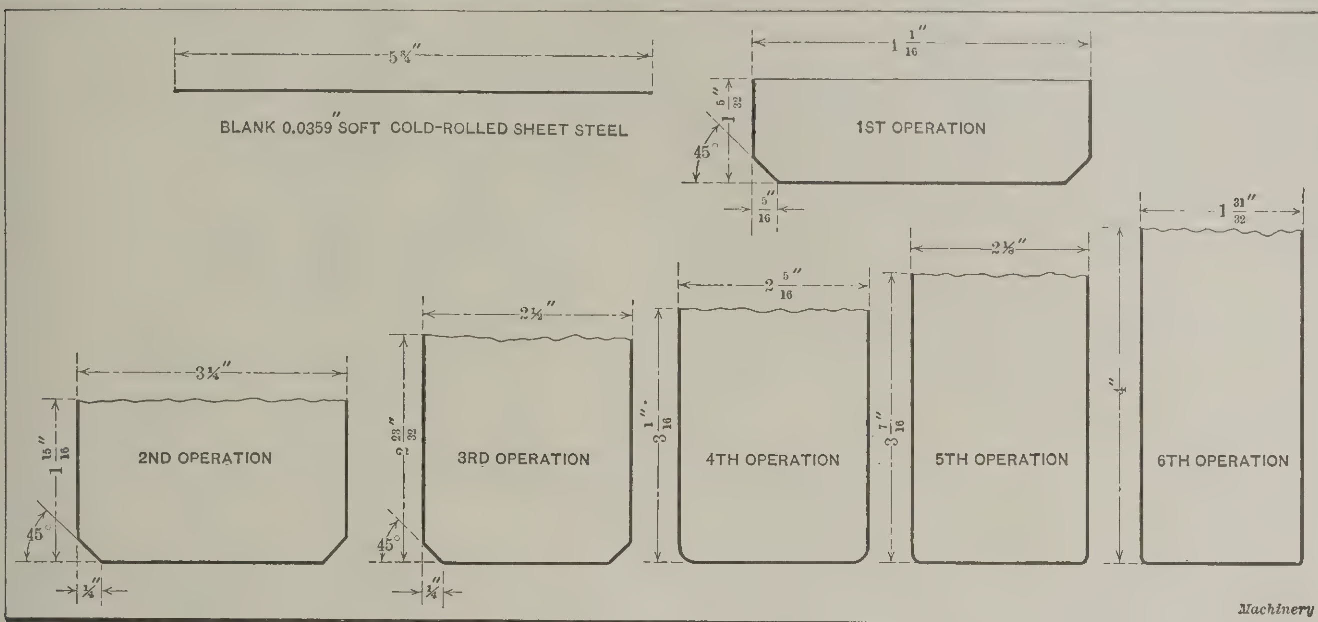
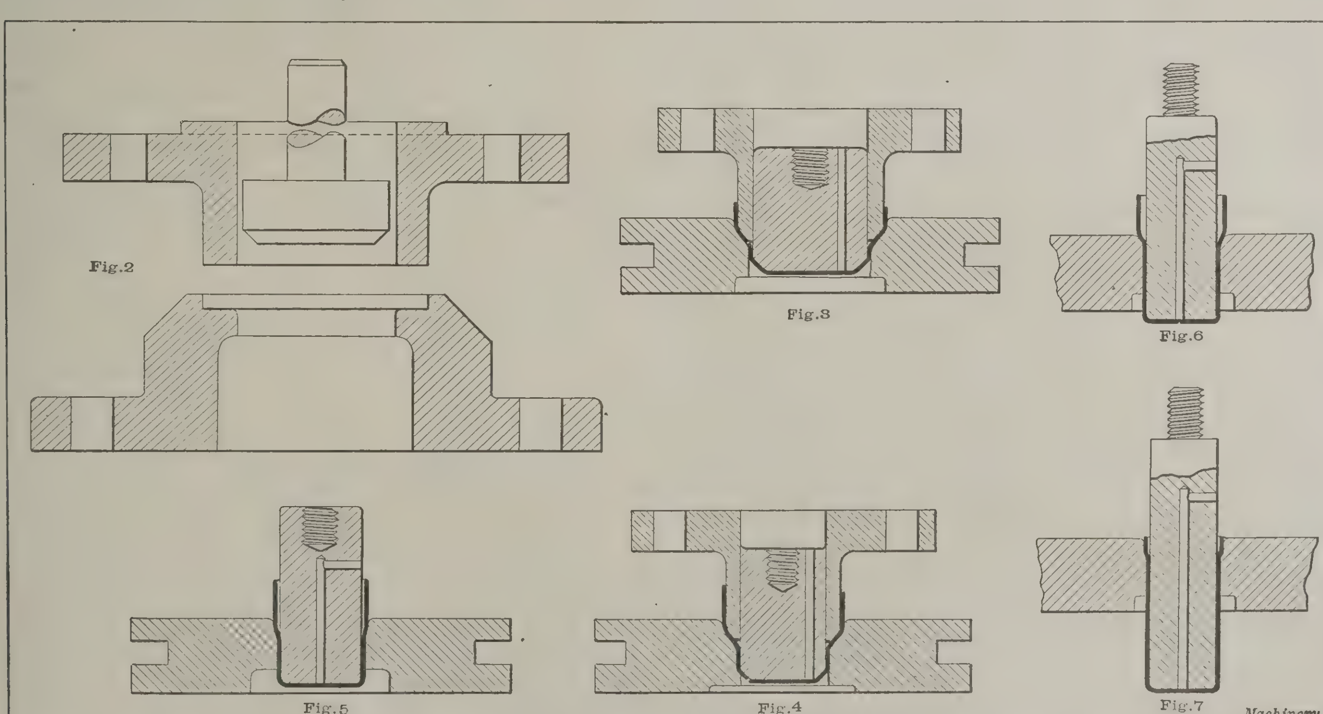


Fig. 1. Successive Operations in the Drawing of a Deep Shell

Fig. 2 shows the double-action blanking and drawing die for the first operation; Fig. 3 shows the tools for the second operation; Fig. 4, the double-action dies for the third operation; Fig. 5, the single-action reducing die for the fourth operation; Fig. 6, tools of the same construction for the fifth operation; and Fig. 7, the punch and die for the sizing and finishing operation. The illustrations show clearly the design, construction and operation of the tools. The shell was annealed four times and trimmed but once—after the last redrawing. A thin mixture of lard oil and white lead was used to lubricate while reducing.



Figs. 2 to 7. Tools for the Operations shown in Fig. 1

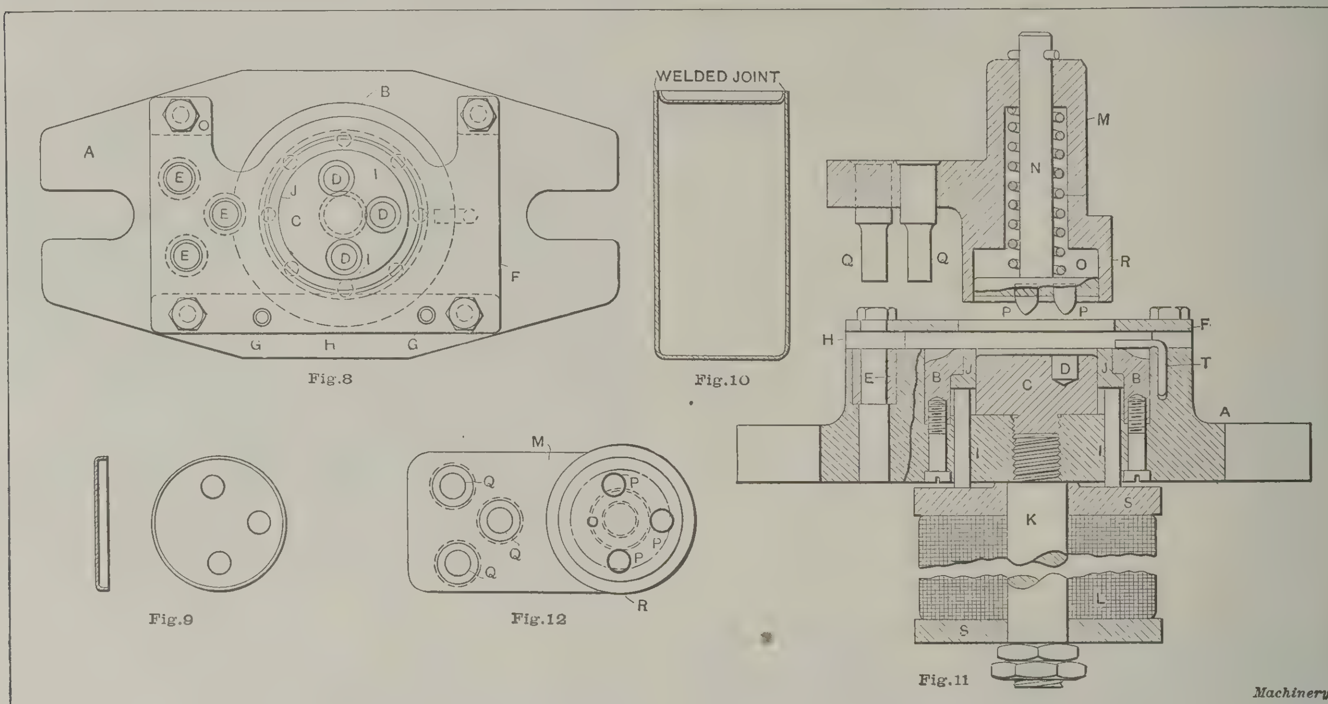
* See also MACHINERY, March, 1912, "Drawing a Flanged and Tapered Cylindrical Shell," and the articles there referred to.
† Consulting engineer, 165 Broadway, New York City.

Fig. 8 is a plan view of the single-action combination piercing, blanking and drawing die used for producing the drawn and perforated cover shown in Fig. 9, made of the same material as that for the shell. This cover was welded into the shell as shown in Fig. 10, the whole serving as a can receptacle for parts of an electrical device. Fig. 11 is a cross-sectional view of the complete punch and die designed for the cover, and Fig. 12 is a plan of the punch. A brief description will make plain the construction and action of the tools.

In the die, Figs. 8 and 11, *A* is the cast-iron die bolster; *E* are the interchangeable piercing die bushings of Blue Chip steel; *B*, the blanking die of the same material; *C*, the drawing pad; *D*, the pilot holes for pilots *P* in punch; *F*, the stripper of cold-rolled stock; *H*, the gage plates; *G*, the gage plate and stripper locating dowels; *I*, the eight blank-holder pressure pins; *J*, the blank holder ring; *K*, the spring barrel stud; *S*, the spring barrel washers; and *L*, the rubber spring barrel. In the punch, *M* is a tool steel forging machined to the shape shown; *R* is the blanking punch; *O*, the drawing die; *N*, the ejector pad with pilots at *P*; and *Q* the three piercing punches forced into slightly tapered holes in the punch proper.

Cold-rolled strips of the proper width are used for the

stampings, the metal being fed in at *H*, Fig. 11. The end is trimmed and the three holes punched, and then the strip is moved forward against stop pin *T*. The punch descending again, pilots *P* engage the pierced holes, and before the blanking punch touches the metal, locate the strip accurately. By laying out the operations and the evolution of shape as here shown, and making the drawings so as to show clearly the operation of the tools upon the metal to be worked, the expense of designing is reduced to a minimum, the tools can be put through the shop with few "cut and try" troubles, their cost will be reasonable, and their efficiency assured.



Figs. 8 to 12. Completed Can and Cover and Tools for the Latter

* * *

In an address on "Comparison between Industrial Conditions in the United States and Europe," read before the American Society of Swedish Engineers, Mr. A. L. Valentine, superintendent of the small tool department of the Pratt & Whitney Co., Hartford, Conn., quoted some figures which show how far the United States is behind Europe in the matter of safeguarding the workers. Figures show, said Mr. Valentine, that in this country 100 men are killed every day as a result of industrial accidents. Two million in a year are injured. For 1908 very reliable figures are obtainable, and these show that there were between 30,000 and 35,000 fatal accidents that year. Of the deaths of male workers between the ages of 15 and 44, 15 per cent are due to accidental causes, and of these, at least half, or 7½ per cent, are incurred in the act of making a living. If such a proportion were lost in battle, it would be considered a disaster. Figures also show that the loss of life per thousand in the mines in the United States is greater than in France, Belgium and Great Britain combined. Manufacturers in Germany, which country has been at work preventing accidents for a quarter of a century, are compelled to be members of protective associations. These associations employ inspectors whose duty it is to inspect factories, nearly always, semi-yearly, especially those where women are employed. Seventy-five per cent of our accidents could be avoided by precaution. Better light and ventilation and better spacing of machinery should be insisted upon. It is better to build right, than to furnish safeguards after things are done wrong. Laws which this country has relating to employers' liability should at least be enforced, and those responsible would give a little more thought to the value of human life.

* * *

The aerial navy of France is assuming large proportions. Increases have been made in former appropriations and according to the latest decisions of the French war department, the French army will, during the present year, have 322 aeroplanes and 15 dirigibles at its disposal.

DRILLING AND COUNTERBORING FROM CROSS-SLIDE IN THE AUTOMATIC

By S. NEVIN BACON

Hand screw machine operations are frequently performed on work partly made in the automatic machines, because in order to complete the work in the automatic machine it would require seven tools, which it is not possible to hold in the turret of a Brown & Sharpe automatic screw machine. At *A*, in Fig. 1, is shown a piece of work knurled on one end, which was made in a No. 2 Brown & Sharpe automatic screw machine. Now unless we wish to use a combination counterbore, the list of turret tools required will be a stop, center, drill, reamer, two counterbores and a knurl.

The method used in holding the extra counterbore is shown at *A* in Fig. 2. The counterbore is held in a holder placed on the cross-slide, and when the counterbore is in line with the hole in the work it is fed forward by means of the stop in the turret coming against the rear end *a* of the counterbore. The counterbore is made a good sliding fit in the hole

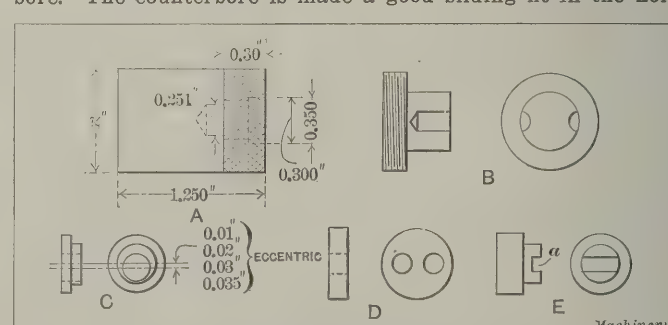


Fig. 1. Samples of Work Operated on by Counterbores and Drills held on the Cross-slide

in the boss, and is prevented from turning by the headless screw *b*. A pin driven into the shank of the counterbore and a helical spring assist in keeping the counterbore in the "back" position. The order of operations for producing the piece shown at *A* in Fig. 1, is as follows:

Order of Operations	Revolutions	Hundredths
Clearance	19.6	2
Feed stock to stop	19.6	2
Revolve turret	19.6	2
Center, 0.125 inch rise at 0.0063 inch feed	19.6	2
Revolve turret	29.4	3
Drill, 0.500 inch rise at 0.0056 inch feed	88.2	9
Revolve turret	29.4	3
Ream, 0.500 inch rise at 0.0072 inch feed	137.2	14
Revolve turret	29.4	3
Counterbore, 0.150 inch rise at 0.0014 inch feed	107.8	11

Revolve turret	29.4	3
Knurl on, 0.300 inch rise at 0.0102 inch feed.	29.4	3
Knurl off, 0.300 inch rise at 0.0153 inch feed.	19.6	2
Revolve turret	29.4	3
Advance front slide and dwell.............	88.2	9
Counterbore from cross-slide, 0.125 inch rise at 0.0021 inch feed....................	(58.8)	(6)
Clearance	(19.6)	(2)
Cut off, 0.477 inch rise at 0.00167 inch feed..	284.2	29
Total	980.0	100

The cams for producing the piece shown at *A* in Fig. 1 are shown in Fig. 3, where the various functions of the lobes are clearly indicated. The most interesting lobe on this set of cams is the lobe on the cross-slide cam from 63 to 71,

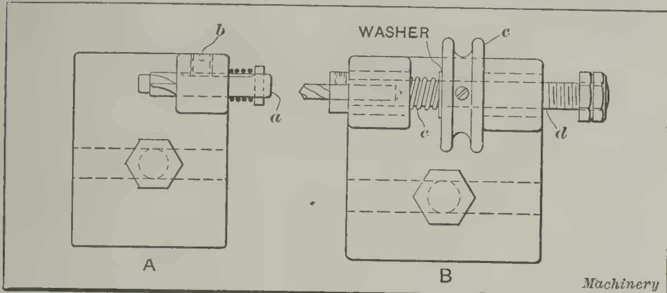


Fig. 2. Holders for Carrying Drills and Counterbores in the Cross-slide

which brings the special counterbore shown at *A* in Fig. 2 in line with the hole in the work. The stop in the turret used for feeding in this counterbore, and which is also used for gaging the stock to length is operated by the lobe from 63 to 69 on the lead cam. It will be noticed that this lobe is much lower than the lobe from 2 to 4 gaging the stock to length, the reason, of course, being that the counterbore projects much further from the chuck than does the stock when fed out.

Another simple method of holding an extra tool on the cross-slide is illustrated at *B* in Fig. 2. Here the holder is made

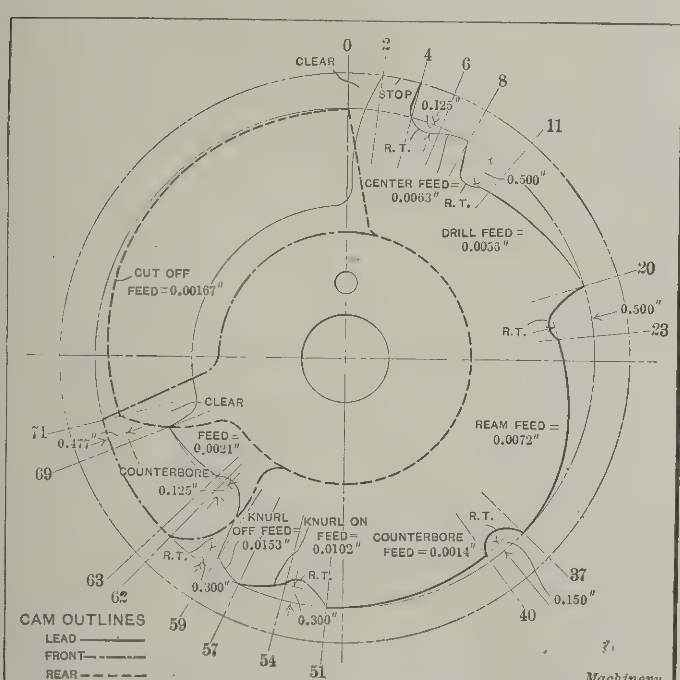


Fig. 3. Cams used in Producing the Piece shown at A in Fig. 1

so that it will take either a drill or a counterbore, as the case may be, which is held in it by means of a headless screw. The tool is rotated by means of the grooved pulley *c*, which is fastened to the spindle *d* as shown. This pulley is driven from the overhead works by a round belt, which is left sufficiently slack to allow the front cross-slide to advance to a position in line with the work. The drill is fed forward by a stop held in the turret, and is withdrawn by the coil spring *e*.

Other operations performed with drills and counterbores held on the cross-slide are shown in Fig. 1 at *B*, *C*, *D* and *E*, respectively. At *C* is shown a piece made with an eccentric hole. This is easily produced by means of a drill held in a holder fastened to the cross-slide. Of course it is necessary to lock the spindle when the hole is being drilled. A drill holder similar in construction to that shown at *B* in Fig. 2 is used. It will be noticed that the piece shown at *C* is made with holes having different degrees of eccentricity; otherwise the pieces made with an eccentric hole are of the same size and shape.

It is interesting to compare this method of drilling with the old method, which consisted in holding the stock in an eccentric chuck or in drilling each piece in a drill jig. The method last mentioned is expensive, and the eccentric chuck method is very destructive to the cut-off tools owing to the pounding of the stock against the cutting edge.

At *B* is shown how wrench slots were produced in a special nut. The holes were first drilled, after which the shank was turned down by means of a box-tool, leaving only one-half of the drilled holes in each side. To produce this piece, the cross-slide cam moves the drill and holder forward part way, then dwells while the first hole is being drilled, by means of a stop in the turret forcing the drill into the work. After the first hole is drilled, the cam advances into position for the second hole, when the same operation is repeated. At *D* is shown a washer provided with two holes which were also drilled in this manner. At *E* in Fig. 1 is shown a piece which requires a different movement. The lead cam is not used at all, and the groove *a* is cut with a reamer instead of a drill. After the machine spindle is locked in position by means of the brake, the reamer starts at one side and is fed across by the cross-slide cam operating the slide upon which the reamer is mounted. These special operations give little trouble especially on brass work, the material from which the parts described were made.

* * *

BRITISH VIEW OF BRITISH CONDITIONS

The following editorial from the *Mechanical World* gives an interesting view of some industrial conditions in Great Britain that are very different from the conditions here. That it should be considered remarkable that a firm should pay wages to its engineering apprentices, and that a business career should be considered "undignified," is strange to us, and while we have seen frequent allusions to the latter subject in stories and novels, yet we were hardly prepared to accept it as a plain fact with a practical bearing on the administration of engineering undertakings in Great Britain at the present day.

"A remarkable offer has just been made by an electrical company in order to attract into the shops and offices men of superior education and some social standing. Instead of asking a premium of three hundred pounds or more for the training of young men in electrical engineering, the company is prepared to receive a number of promising university men and make them a reasonable remuneration. The men are required for good positions and salaries in an administrative capacity later on, and it will be of some interest at some future time to learn the result of the offer. At present it is possible to obtain the best brains and experience in the world for the purely technical side of the industry on paying suitably for them, but for the administrative side the best material, we are told, is represented by the British office boy. It is strange that before making an appeal to those of university education an effort has not been made to secure suitable candidates from the technical colleges and schools; or has sufficient experience already been obtained with the material turned out by these institutions? If so, is it hoped to be more successful with university men, who have been taught to regard business as undignified or as representing a fall in the social scale? There may, however, be exceptions, and the hope may be expressed that they will be discovered, so that the experiment may be afforded a practical test."

* * *

The latest statistics relating to the exports and imports of machine tools in Germany show that the exports increased from 59,100 metric tons in 1910 to 71,500 tons in 1911. Austria-Hungary and Italy imported more German machine tools than any other country, but France and Russia also proved themselves to be good customers. The imports amounted to 7400 tons of which 4500 tons was from the United States, and 960 tons from Great Britain. The total value of the machine tools exported in 1911 was in round numbers $19,000,000, while the total value of the imports was $2,300,000.

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DOUBLE-CUTTING PLANERS

Many attempts have been made to design a planer that will cut with equal efficiency on both the forward and return strokes. Recently a planer was brought out in Great Britain which is claimed to possess certain advantages in this respect; but while it is evident that the elimination of the idle strokes means a considerable advance in efficiency, the great difficulty to be overcome is to design a planer which will cut in both directions with equal efficiency and accuracy. It is apparent that the planer, as made today, is designed to take a maximum cut in one direction only, and a radical change must be made in its design before a really satisfactory machine can be produced which will take heavy cuts in both directions. The tool-head is clamped to the face of the cross-rail, which, in turn, is clamped to the face of the housings, and the stresses produced in these parts when a cut is taken in one direction are quite different from those when the cut is taken in the other direction. In one case there is a tendency to compress all of these parts solidly, giving a firm support to the cutting tool; in the other the tendency is to pull all joints apart, thus depriving the cutting tool of the firmness of its support and creating a tendency to chatter. It appears that if planers are to be made double-cutting, the successful design must be arranged on lines quite different from those of present planers, so that equal support is given to the tool when cutting in both directions.

* * *

PANTOGRAPH PRINCIPLE IN INTERCHANGEABLE MANUFACTURING

When a new machine is developed consisting of many small parts which must be accurately shaped and cheaply produced, preparation for manufacturing ordinarily involves heavy expenditures for presses, punches, dies, jigs, reamers, boring cutters and other tools common to interchangeable manufacturing. When the future of the machine is reasonably sure, there can be no question as to the wisdom of providing the best and most efficient tools that skilled designers and toolmakers produce; but when the outcome of the venture is in doubt because of the practical impossibility of testing the commercial conditions in any other way than by putting the machines on the market, the problem may be sorely perplexing.

Generally, it will not do to put out handmade machines, as the slowness of production, inevitable inaccuracies and high cost make that procedure impracticable. The common practice in that event is to make expensive form milling cutters, dies and jigs for producing the vital parts and to make the auxiliary parts by hand and by ordinary machine tools.

The possibilities of the profiling machine in manufacturing parts of considerable size which do not require the highest accuracy of form have been known and widely applied for many years, but the pantograph principle applied to profilers, of which certain engraving machines are good examples, has not in our opinion been developed as much as its merits deserve.

Take the case of an adding machine which has been developed in the handmade form to a practical success. The matter of making parts from flat stock in hundred lots with pantograph profilers would consist first of making the "copy," say, five times scale, correcting errors by trial, and then actually producing the parts from flat stock cut into strips and held for the operations by suitable quick-action chucks. The pantograph profiler, unlike the form milling cutter on the Lincoln milling machine, is not confined to the production of contours from flat stock only, but can be designed to work in three directions, thus becoming universal in scope. If heavily designed, these machines could be made to function automatically, and produce work of widely varying forms at costs higher than punch and die work, it is true, but so low that the product could probably be placed on the market advantageously under the conditions set forth in the beginning.

* * *

APPRENTICES TEACHING APPRENTICES

In shops employing numbers of apprentices directly subject to the foreman, the common plan of instruction on the operation of machines is to delegate the boy about to give up a machine to instruct the next apprentice in its construction and operation. This method has the advantage of relieving the foreman of the duty of instructing the boys in machine operation—for which he usually has little time and which, in many cases, he could not effectually carry out—and of making each boy as he "graduates," review his knowledge by showing his successor how and what to do. This method also has disadvantages of a serious nature. Not many boys are capable of running a machine at its highest productive capacity, and they are not expected to. They are likely to gradually sink in the scale of efficiency through lack of comprehension or competent instruction until a very low state is reached. Not only may the functions of a machine be but partly understood and used, but improper instruction in oiling bearings and caring for tools, belts, etc., may lead to rapid deterioration of the machine and its product.

When the foreman wakes up to the situation, there is a grand "raking over the coals" and "jacking up all around." Boys genuinely ignorant of their duties are blamed, perhaps, for what they could hardly be expected to know, and the result is dissatisfaction all around. The foreman thinks that apprentices are nuisances generally, and the boys are sorry they started to learn the trade. Unfortunately, few foremen are qualified to act as apprentice instructors. If they are good foremen they are likely to be poor teachers, and, *vice versa*, good teachers are likely to be indifferent foremen. The ability to impart knowledge is a rare gift, fully developed only after years of training.

Conditions like those set forth are less likely to develop when the boys are in charge of an overseer who devotes himself exclusively to their instruction and to instilling those ideals which are necessary for the making of good mechanics. The plan of letting a boy instruct his successor may then work out; that is, when the boy acting as teacher has had careful training and is able to produce good work in reasonable time, and to take proper care of his machine. But unless he has been and is under competent supervision, it is likely to lead to inbreeding of vicious methods and principles.

HELPING A MAN TO FIND HIS PLACE

One of the valuable features of the new systems of management, generally known as "scientific," is that when properly conducted they aid the individual in finding that place in an organization where he can do his best work, receive the most compensation, and in general develop his latent powers so as to produce the greatest benefit to himself and his employer.

In factories organized on the task basis it is often found, for example, that a man working on a lathe cannot possibly fulfil the task that has been found to be easy for the average man. In such a case, this man is not kept at his machine, but is shifted around to other machines or work better suited to his capacity. In nearly all instances, a certain machine or work can be found in the shop whereon this man will be able to perform the set task with ease.

Under the old methods of management such a man would have been retained year after year at work for which he was not fitted. He would have been poorly paid, and at that would have been a poor investment for his employer. He would have been dissatisfied, and helpless to better his condition. Under the new system he finds his proper place, earns good wages, is satisfied and returns a much greater profit to his employer. Of course, all so-called scientifically-managed shops have not applied this important principle of management, and to the extent that they have not they have been unsuccessful with the new methods.

Scientific management is not a mere stop-watch system; it requires constant and intelligent attention. It is not a system which once installed will run itself, nor is it a system that can be run successfully by a man whose views on the relation between employe and employer are too narrow. Scientific management is a broad scheme with far-reaching purposes, and it requires a broad-gage man to handle it.

* * *

CASEHARDENING PROCESSES AND RESULTS

The common process of treating wrought iron with a carbonaceous compound to give it surface hardness is probably the oldest method employed to convert iron into steel. The surface hardness of "case" results from the infusion of carbon which penetrates the iron to depths depending on the nature of the pack and the time of heating. The converted iron (steel) hardens when heated and quenched in cold water. The ease and cheapness of the process by which common iron can be changed to steel of considerable endurance has made possible the use of the casehardening process for a multitude of purposes requiring a cheap, strong, and tough material with hardened surface. Fifty years ago, before the advent of Bessemer steel, some of the railway companies in England treated wrought-iron rails to harden the rail heads and thus increase their durability. The later development of the iron-clad and armored battleship led to the development of casehardening processes for steel armor plate of extraordinary efficiency, producing extreme hardness to a depth of several inches and leaving the remainder of the plate soft and very tough.

In machine shops the casehardening process has been used to some advantage in the making of tools, especially large milling cutters, taps, etc. Varied success has attended these efforts, and hardly any two men having experience in different shops will agree on the value of such products. One shop may obtain uniformly satisfactory work, when another can never be sure of the quality of casehardening work produced.

The reasons for these varied results are several, the chief, of course, being the nature of the pack and heat treatment. One common error is to quench the work in the bath as it is dumped out of the boxes. For all work requiring the best quality of casehardening the treated parts should be allowed to cool slowly when dumped, and then heated to the hardening temperature so as to harden on a "rising heat."

But with the best packing materials and approved heat treatment, the product will vary, and sometimes be unsatisfactory if the chemical composition of the mild steel commonly used includes impurities known to be deleterious to tool steel. Sulphur, manganese and phosphorus must be present in minimum percentages only, if the casehardened product is to have those qualities which give it reliability and durability. The salesman who offers a casehardening compound with the claim that qualities will be produced in the product which make it equal to tool steel, is not honest and sincere if he does not state that the steel used must have certain specified chemical components to start with. Another fact which should be kept in mind by the user of casehardening compounds is that the difference in cost of mild steel and tool steel is materially reduced by the cost of the compounds and the heat treatment. Not infrequently the saving may be reduced to a negligible amount.

* * *

THE MOVING PICTURE AS AN AID TO MECHANICAL INSTRUCTION*

By CHESTER L. LUCAS†

A few weeks ago, at one of the popular moving picture theatres in New York City, a film was shown to illustrate the way in which "photo-plays" are originated. Among other views, were several intended to convey an idea of the work incident to the making of the moving picture machine itself. One of these mechanical views showed the drilling of the frames of the machines, and as it was a close-range view of the work and table of the drilling machine, every detail of the operation being performed could be plainly observed. The drill could be seen entering the bushing of the jig; chips curled out from the drill with credit to the man who sharpened it, and the drill "broke through" in the most natural manner possible. Any mechanic in the audience must have felt a responsive thrill as he viewed that part of the film. Another view showed the making of the film-spool on an automatic turret lathe. The bar stock could be seen as it was fed forward; the turning tools and turret came up to the work just as a few hours before they might have been seen to do in many shops; the drills and forming tools could be plainly seen, and even the cutting-off tool was visible as it fed slowly into the work. There were several other views of a like nature, the whole comprising a most graphic illustration of some of the phases of machine shop practice.

There seems to be every reason to believe that the moving picture should be of great value in imparting mechanical instruction. While the operations shown in this case were necessarily elementary, in order to appeal to the general public, there should be no trouble in making films that would show the working of complex mechanism. If the mechanism was very small, it could easily be enlarged in showing the film, and therefore be even more clearly grasped than from observing the work itself. Again, if the parts moved with great rapidity, as in adding machine mechanism, the film could be "slowed down" until the operation was easily understood. With the addition of a lecturer, to explain difficult parts of the operations shown, such exhibitions would be highly instructive to apprentice, mechanic or engineer.

Undoubtedly the greatest stumbling-block in the path of this method of instruction at the present time is the cost of the film. It is said that the average film costs about one thousand dollars to produce, and except for the fact that each new film is copied from twelve to fifty times, there would be little profit in making films. In the case of films for illustrating mechanical operations, correct shop practice and similar subjects, no expensive company of actors would be required, which, of course, would lessen the expense of making the film.

Within a few years' time a moving picture machine will undoubtedly be just as necessary a part of the equipment of a college as a microscope is to-day. It would even now seem feasible for a large number of trade schools or educational classes to confer as to what phases of their work could best be illustrated and taught in this way, after which several films could be made, distributing the expense. These films, together with a machine for showing them, could be sent from one school to another for exhibition; thus all would derive full benefit at a minimum cost.

* For previous suggestions and comments on this subject see "Moving Pictures as an Aid to Teaching Trades," January, 1909; "Moving Picture Show as an Educator," page 527, engineering edition, March, 1909; and "Moving Picture Shows as an Incentive to Crime," page 604, engineering edition, April, 1909.

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NOTES AND COMMENT

Monel metal, which has been termed a "natural" alloy, is regarded as a successful substitute for steel and bronze in steamship propellers. It has recently been cast in pieces weighing as much as 25,000 pounds. Several castings for propellers have been furnished to the United States government.

The question of standard colors for piping systems has been taken up by several German engineering societies, and the following color scheme has been agreed upon: Green is to indicate water; yellow, gas; blue, air; white, steam; black, tar; pink, lyes; pink with a red ring, acid; brown, oils; and grey, vacuum. A black ring or band indicates impurity; a red ring, danger; thus a green pipe with a black ring carries refuse water; a white pipe with a red ring carries superheated steam, etc.

The trackless trolley systems which, during the past year, have been inaugurated in a number of places in Europe, appear to have a considerable future on account of the very decided saving in the initial investment. As an illustration it may be mentioned that Mr. H. Jackson, in presenting a paper before the Birmingham branch of the Institute of Civil Engineers, showed that routes of trolley systems 27 miles long, in the suburbs of Birmingham, could be established complete for a service of fifteen minutes intervals for about $375,000, while the same system along the conventional electric trolley line construction would cost about $1,650,000.

It appears from a recent Blue Book published by the British government, that the United States is practically the only country of any consequence in which there is no law for the compulsory working of patents. All other industrial countries have enacted laws—some long ago—which require the patentee to manufacture the patented article within a certain number of years, or to license somebody else to manufacture it. If the patented article is not manufactured to what is termed "an adequate extent" within the specified number of years, the patent becomes invalid. Great Britain makes this time four years, but most other nations do not permit so long a period before the patent must be actually exploited.

It is stated in the *Brass World* by Roy C. Davidson of Fort Blackmore, Va., that copper may be welded in the following manner: The pieces to be welded are placed in a fire and heated to a black heat, after which they are coated with borax. The two pieces are then removed and hammered. They are again returned to the fire and this process is repeated twice, after which the joint is covered with ferrous sulphate. The pieces are now placed in the fire again and heated as hot as the copper will stand without melting, and the joint hammered together. It will be found, it is stated, that a sound and homogeneous joint will then result.

According to *Engineering*, copper deposits of great importance have been found in the Katanga district in Congo, between the Zambesi and Congo rivers. It has been estimated that the Katanga district has copper deposits of sufficient extent to fill the world's demand for copper for the next hundred years. Besides the copper deposits, gold, platinum, silver and zinc are abundantly found in this district. While the enormous mineral wealth of this province has been a matter of knowledge in financial circles for some time, comparatively little has as yet been done with relation to mining enterprises, on account of the great transportation difficulties presented.

The import of machine tools to Great Britain is steadily increasing, and some concern is felt by the British mechanical journals on this account. It is stated that the import of machine tools in 1911 was three times that in 1910, and over two and one-half times that in 1909. On the other hand the export of machine tools from Great Britain in 1911 was less in tonnage, although greater in value, than in 1910, and considerably less than the export in 1909. The Machine Tool Association formed during the past year has now a membership of eighty firms and it is expected that the activities of this organization will make it possible to place the British machine tool building business on a more satisfactory basis.

Dr. J. W. Richards, in a recent lecture before the Engineers' Society of Western Pennsylvania, gave a review of the progress made in Sweden during the past year in the production of iron and steel by electrical processes. Dr. Richards has visited Sweden every summer for several years, and is well informed on the research and experimental work done by the Swedish Iron and Steel Institute (Jernkontoret), at Trollhättan. He asserted that there was no longer any doubt but that, under the latest Swedish practice, pig iron smelted from ore in the electric furnace will shortly displace the old charcoal iron that has made the Swedish iron industry famous. In fact, some steel makers maintain that the electrically smelted iron is superior to the charcoal iron.

To find the melting points of metals which fuse only at the very highest temperatures has been found to be extremely difficult, and until recently experiments have given widely varying results. By means of electric vacuum furnaces, however, some experiments giving accurate results have been undertaken in Germany by Otto Goecke, who places the melting points of the following metals as below:

Gold	1960 degrees F.
Manganese	2277 degrees F.
Chromium	2757 degrees F.
Platinum	3182 degrees F.
Iridium	4035 degrees F.
Vanadium Carbide (Va_4C_3)	4982 degrees F.

It is stated in the *Mechanical World* that the crankshaft for a 50-horsepower engine for a certain British type of aeroplane weighs only eighteen pounds. It consists of a tubular shell made of chrome-vanadium steel, the shell being ⅛-inch in thickness. It is stated that in the tests it has proved to have a margin of safety of 38 per cent over that necessary for the 50-horsepower engine. It would seem that the aviator runs a decided risk in employing an engine where the factor of safety of one of the most vital parts is as small as this. The frightful toll paid by the lives of aviators, it seems, could be diminished to a considerable extent if such perils were avoided as are introduced by employing machinery which is worked so near the danger limit.

A mechanic, in the *Mechanical World*, calls attention to the fact that there seems to be no standard for the squares or flats on taps and reamers. He states that many firms reduce the shanks too much, and in this way not only weaken the tap or reamer, but also produce a square which is not of a standard size. Some firms make the squares with sharp corners, while others merely mill four flats, so that the end of the tap looks more like an octagon than anything else. Standardization of this detail, though of comparative unimportance, is no doubt well worth while. If taps and reamers were made with squares of standard sizes, they would be more durable, the wrenches would last longer and their number would be reduced considerably.

The first locomotive in America, built for the Camden & Amboy Railroad in 1831, is still intact in the National Museum at Washington. It is interesting to make a comparison between this engine and the locomotive recently adopted by the Pennsylvania Railroad for its heavy passenger service. The weight of the old locomotive mentioned—called "John Bull"—is 24,625 pounds, while the Pennsylvania engine with tender weighs 430,000 pounds. The two driving wheels of "John Bull" are 54 inches in diameter, while the six driving wheels of the modern engine are 80 inches in diameter. The tubes of the "John Bull" are 7½ feet long and the tube heating-surface, 213 square feet. In the modern engine, the tubes are nearly 21 feet long, and the heating surface is 4420 square feet.

THE DESIGN OF CONICAL HELICAL SPRINGS*†

By E. R. MORRISON‡

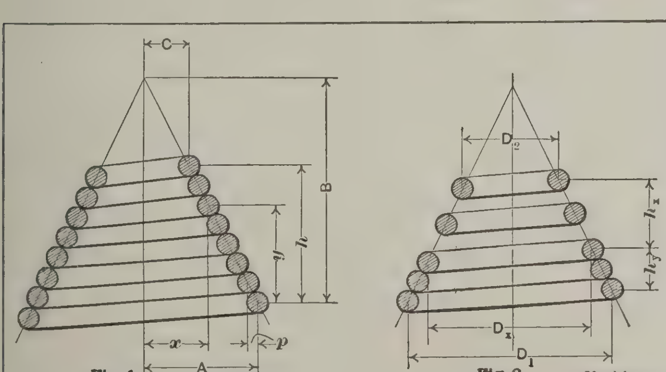
On account of their physical characteristics, conical helical springs divide themselves into two distinct classes, according to their use. The formulas applicable to a spring of this type used as a compression spring are not at all applicable if the spring is to be used as an extension spring. This is more obvious if we note that the safe load which an extension spring will carry is governed by the capacity of the largest or weakest coil, which condition is reversed in the compression state, where the spring retains its flexibility until the load becomes great enough to close up the smallest or strongest coil. It is the object of this article to develop the formulas applicable to the various types of conical helical springs. Round bar coils only will be considered.

Notation—Dimensions in Inches, Weights in Pounds

S = stress,
G = modulus of torsional elasticity,
f = deflection,
f_x = deflection under load P_x
H = free height,
h = solid height, assumed to equal $d \times N$,
y = solid height at any convenient coil,
P = capacity of spring,
P_x = any load not exceeding P,
P_1 = capacity of largest coil,
P_2 = capacity of smallest coil,
D_1 = mean diameter of largest coil,
D_2 = mean diameter of smallest coil,
d = diameter of bar from which coil is made,
A = mean radius of largest coil,
B = apex height of cone,
C = mean radius of smallest coil,
N = number of coils,
p = average horizontal pitch of coils,
w = weight of one cubic inch of steel,
l = length of bar in spring,
W = weight of spring,
x = mean radius of any convenient coil.

Deflection and Capacity of Extension Spring

It is obvious that P_x in this case must be understood to be not greater than the capacity of the weakest coil, inasmuch



Figs. 1 and 2. Diagrams for the Derivation of Spring Formulas

as a greater value of P_x would distort the spring beyond the realm of rational formulas. A conical spring is composed of an infinite number of elementary cylindrical coils, each element being in itself a uniform diameter helical spring, and each element differing from its neighbor in the one respect that each successive element has a mean diameter infinitesimally less than its first neighbor, and likewise infinitesimally greater than its neighbor on the other side. These increments of change in the mean diameter result in corresponding increments of change in the deflection of the successive elements, and being all governed by the one general expression for deflection of cylindrical helical springs, may be added together by resorting to calculus. Since the increments of change in the mean diameter are in this case in proportion to the increments of change in the solid height, it follows that the increments of change in the deflection also follow those of the solid height, and that we may expect to arrive at the summation of the deflection through a summation of the increments of change in the varying solid height, which for successive elementary cylindrical coils increases from 0 to its maximum h.

Now the expression for deflection in cylindrical coil springs is:

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$$

and for capacity:

$$P = \frac{\pi S d^3}{8 D}$$

The value of D is here, however, the variable, represented by $2x$. Therefore, in each elementary cylinder:

$$\frac{f_x}{f} = \frac{P_x}{P}, \text{ or } f_x = \frac{8 P_x (2x)^3 h}{G d^5} = \frac{64 P_x x^3 h}{G d^5}$$

Further,

$$\delta f_x = \frac{64 P_x}{G d^5} x^3 \delta y$$

$$f_x = \int_0^h \frac{64 P_x}{G d^5} x^3 \delta y = \frac{64 P_x}{G d^5} \int_0^h x^3 \delta y.$$

But, as shown in Fig. 1, $\frac{B}{y} = \frac{A}{A - x}$; whence $x = A - \frac{A y}{B}$

$$\text{Hence } x^3 = A^3 \left(1 - \frac{3y}{B} + \frac{3y^2}{B^2} - \frac{y^3}{B^3}\right)$$

Hence,

$$f_x = \frac{64 P_x A^3}{G d^5} \int_0^h \left(1 - \frac{3y}{B} + \frac{3y^2}{B^2} - \frac{y^3}{B^3}\right) \delta y$$

$$f_x = \frac{64 P_x A^3}{G d^5} \left(h - \frac{3h^2}{2B} + \frac{h^3}{B^2} - \frac{h^4}{4B^3}\right)$$

Also, from Fig. 1, we have: $B = \frac{A h}{A - C}$, whence:

$$f_x = \frac{64 P_x A^3}{G d^5} \left(h - \frac{3h^2 (A - C)}{2 A h} + \frac{h^3 (A - C)^2}{A^2 h^2} - \frac{h^4 (A - C)^3}{4 A^3 h^3}\right)$$

But $A = \frac{D_1}{2}$ and $C = \frac{D_2}{2}$. Hence,

$$f_x = \frac{8 P_x D_1^3 h}{G d^5} \left(1 - \frac{3(D_1 - D_2)}{2 D_1} + \frac{(D_1 - D_2)^2}{D_1^2} - \frac{(D_1 - D_2)^3}{4 D_1^3}\right)$$

$$= \frac{8 P_x D_1^3 h}{G d^5} \left(\frac{D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3}{4 D_1^3}\right)$$

$$= \frac{2 P_x h}{G d^5} (D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3) = \frac{2 P_x h (D_1^4 - D_2^4)}{G d^5 (D_1 - D_2)}$$

$$= \frac{P_x (D_1^4 - D_2^4)}{G d^4 \frac{(D_1 - D_2) d}{2h}}$$

Observe now that the expression in the denominator is the average horizontal pitch p (see Fig. 1) of the coils:

$$p = \frac{\frac{D_1 - D_2}{2}}{N}; \text{ but } N = \frac{h}{d}; \text{ hence, } p = \frac{(D_1 - D_2) d}{2h}$$

Therefore,

$$f_x = \frac{P_x (D_1^4 - D_2^4)}{G p d^4}$$

This then is the formula for the deflection of any extension type conical helical spring under load P_x, the value P_x not exceeding the capacity of the weakest coil, equivalent to the

* With Data Sheet Supplement.
† See MACHINERY, March, 1911, "The Design of Grouped Helical Springs," and other articles there referred to; January, 1910, "The Design of Automobile Springs," and other articles there referred to; and also MACHINERY'S Reference Book No. 58: "Helical and Elliptic Springs."
‡ Address: Sharon, Pa.

capacity of a cylindrical helical spring of a mean diameter equal to D_1 and bar diameter equal to d.

If the value of P_x equals the capacity P of this spring, we have:

$$P = P_x = \frac{\pi S d^3}{8 D_1}$$

Substituting this value of P_x, we have the total deflection:

$$f = \frac{\pi S (D_1^4 - D_2^4)}{8 G p d D_1}$$

which is the final formula for the total deflection of the extension conical helical spring.

It will be noticed that the previous discussion is based on the assumption that the solid height of the spring is equal to the diameter of the bar times the number of coils in the conical spring. However, as one coil seats within the other, the solid height is really less than that assumed; the solid height becomes less as the taper of the coil becomes greater, until for a true spiral spring the solid height is reduced to the diameter of the bar. The actual deflection is dependent on the "slant height" of the conical coil which is equal to $d \times N$, as assumed for the solid height, rather than upon the actual vertical height. Due to this assumption, the changing of the angle of the cone formed by the spring does not change the actual deflection so long as the value of the slant height itself is not changed. Inasmuch as the above discussion is based on the slant height, the actual solid height of the spring and also the free height of the spring should be corrected by deducting from the value of these heights the difference between the slant height and the solid height. Stated briefly, the assumption that the solid height is equal to $d \times N$ is necessary in order to obtain the correct value of the deflection; but after this deflection has been obtained, correction should be made for this assumption.

Deflection and Capacity of Compression Spring

The deflection of a compression spring of this type is a fundamental problem of the same type. In this case, however, the summation is not the summation of increments of deflection under a uniform load and varying stresses, but the summation of increments of deflection when each elementary spring is stressed to a maximum, and hence under uniform stress.

In this case $f = \dfrac{\pi S}{G}\left(\dfrac{D}{d}\right)^2 h$, becomes $f = \dfrac{\pi S}{G}\left(\dfrac{2x}{d}\right) h$

$$\delta f = \frac{\pi S}{G}\left(\frac{2x}{d}\right)^2 \delta y \text{ and } f = \int_0^h \frac{\pi S}{G}\left(\frac{2x}{d}\right)^2 \delta y$$

But $x = A - \dfrac{A y}{B}$. Hence:

$$f = \frac{4 \pi S A^2}{G d^2} \int_0^h \left(1 - \frac{2y}{B} + \frac{y^2}{B^2}\right) \delta y$$

$$= \frac{4 \pi S A^2}{G d^2} \left(h - \frac{h^2}{B} + \frac{h^3}{3 B^2}\right)$$

But $B = \dfrac{A h}{A - C}$, and $A = \dfrac{D_1}{2}$, and $C = \dfrac{D_2}{2}$. Hence the expression above can be transformed to:

$$f = \frac{\pi S h}{3 G d^2} (D_1^2 + D_1 D_2 + D_2^2)$$

$$f = \frac{\pi S h (D_1^3 - D_2^3)}{3 G d^2 (D_1 - D_2)}, \text{ and since } p = \frac{(D_1 - D_2) d}{2 h}$$

$$f = \frac{\pi S (D_1^3 - D_2^3)}{6 G p d}$$

which expresses the total compression for a conical helical compression spring.

The capacity, solid, equals that of the smallest coil, or:

$$P = \frac{\pi S d^3}{8 D_2}$$

Deflection of Compression Spring for Given Loads

If the given load is less than P_1, the entire spring remains flexible, and the formula for deflection is the same as that derived for an extension spring, the condition of varying stress still being present.

If, however, the load exceeds P_1, then a portion of the spring will become solid. The division point may be found, for $P_x = \dfrac{\pi S d^3}{8 D_x}$, and since the load in cylindrical coils varies inversely as D:

$$\frac{D_x}{D_2} = \frac{P_2}{P_x}, \text{ whence } D_x = \frac{D_2 P_2}{P_x}$$

The deflection of the two portions of the spring should now be considered separately and added, using the two final formulas just developed.

Fig. 2 shows a graphical illustration of the divided spring. Let p_x be the average horizontal pitch of the unclosed portion, above D_x. Let p_y be the average horizontal pitch of the solid portion, below D_x.

The total deflection is then:

$$f = \frac{\pi S (D_1^3 - D_x^3)}{6 G d p_y} + \frac{\pi S (D_x^4 - D_2^4)}{8 G d D_x p_x}$$

In Fig. 2, h_y is the height, solid, of the solid portion of the spring. Its value is derived thus:

$$\frac{h_y}{h} = \frac{D_1 - D_x}{D_1 - D_2}, \text{ whence } h_y = h \frac{D_1 - D_x}{D_1 - D_2}$$

Bar Length for Conical Spring

Fundamentally, $l = \pi \left(\dfrac{D}{d}\right) h$, so that we have in a conical spring

$$l = \delta \pi \left(\frac{2x}{d}\right) \delta y, \text{ or}$$

$$l = \frac{2\pi}{d} \int_0^h x \, \delta y = \frac{2 A \pi}{d} \int_0^h \left(1 - \frac{y}{B}\right) \delta y = \frac{2 A \pi}{d} \left(h - \frac{h^2}{2B}\right)$$

And since $B = \dfrac{A h}{A - C}$, and $A = \dfrac{D_1}{2}$, and $C = \dfrac{D_2}{2}$, we get:

$$l = \frac{\pi h}{d} \left(\frac{D_1 + D_2}{2}\right)$$

Weight of Conical Spring

Fundamentally, $W = \dfrac{l \pi d^2 w}{4}$. Hence

$$W = \frac{\pi^2 d h w}{8} (D_1 + D_2)$$

Summary of Formulas

Summarizing and substituting for S a value of 80,000 pounds per square inch, and for G a value of 12,600,000 we have:

Extension Conical Spring Formulas

$$f = 0.002493 \frac{D_1^4 - D_2^4}{p d D_1}$$

$$P = 31{,}416 \frac{d^3}{D_1}$$

Compression Conical Spring Formulas

$$f = 0.003324 \frac{D_1^3 - D_2^3}{p d}$$

$$P = 31{,}416 \frac{d^3}{D_2}$$

Weight in each case, $W = 0.35 \, dh \, (D_1 + D_2)$.

Bar length in each case, $l = 1.571 \dfrac{h}{d} (D_1 + D_2)$

Numerical Examples

Example: Compression spring, $D_1 = 4\ 9/16$ inches; $D_2 = 3\ 9/16$ inches; $d = 1\ 1/16$ inch; $h = 7\ 1/16$ inches.

Then $N = \frac{h}{d} = 6.65$; $\frac{D_1 - D_2}{2} = 0.5$; $p = \frac{D_1 - D_2}{2N} = 0.075$.

$$f = 0.003324 \frac{(4\tfrac{9}{16})^3 - (3\tfrac{9}{16})^3}{0.075 \times 1\tfrac{1}{16}} = 2\tfrac{1}{16} \text{ approximately.}$$

See the accompanying Data Sheet Supplement for table of cubes, and also for other powers of numbers required in conical spring calculations.

$$H = 7\ 1/16 + 2\ 1/16 = 9\ 1/8 \text{ inches.}$$

Example: Same spring in extension.

$$f = 0.002493 \frac{(4\tfrac{9}{16})^4 - (3\tfrac{9}{16})^4}{0.075 \times 1\tfrac{1}{16} \times 4\tfrac{9}{16}} = 1\tfrac{7}{8} \text{ approximately.}$$

$$H \text{ (extended height)} = 7\tfrac{1}{16} + 1\tfrac{7}{8} = 8\tfrac{15}{16} \text{ inches.}$$

As might have been expected, the free height for the compression type is greater than the possible extended length for the extension type. This is because sufficient load to fully stress the smaller or stronger coils cannot be applied without distorting the extension spring, whereas the coils may all be stressed to maximum stress in the compression type, the closing of the coils solidly together protecting the spring from over-stress.

Reversion to Cylindrical Helical Springs

It will be noted that in each of our final formulas we have introduced the factor $(D_1 - D_2)$ and the value of $p = \left(\frac{D_1 - D_2}{2h}\right) d$. This has been done to leave the formulas in as simple a form as possible. Note, however, that if D_1 and D_2 each be taken as equal to D_1 or to each other, the formulas in each case revert to the fundamental cylindrical helical spring formulas, as should be expected.

Substituting $D_1 = D_2 = D$ in the extension formula

$$f_x = \frac{2 P_x h}{G d^5} (D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3), \text{ we have}$$

$$f_x = \frac{8 P_x D^3 h}{G d^5}$$

This is the fundamental formula for the deflection of an extension helical cylindrical spring under any load P_x, derived directly from the formula for load:

$$P = \frac{\pi S d^3}{8 D}$$

in which S has been replaced by its value in the formula

$$f = \frac{\pi S}{G} \left(\frac{D}{d}\right)^2 h \text{ giving } P = \frac{G f d^5}{8 h D^3}$$

from which $f = \frac{8 P D^3}{G d^5} h$

Substitute, again, $D_1 = D_2 = D$ in the compression formula:

$$f = \frac{\pi S h}{3 G d^2} (D_1^2 + D_1 D_2 + D_2^2), \text{ and we have}$$

$$f = \frac{\pi S}{G} \left(\frac{D}{d}\right)^2 h$$

the fundamental formula for the deflection of a compression helical cylindrical spring.

The reason for this comparison between the formulas for cylindrical helical springs and conical springs, is particularly, to bring out the fact that, while each of the conical formulas are thus shown to revert to the same form when $D_1 = D_2$, yet the conical spring formulas themselves, for extension and compression springs, are different. As already mentioned, one is an expression for deflection under a given load, regardless of stress, while the other is the expression for deflection under a uniform maximum stress. The former condition is that of the conical extension spring, while the latter is that of the compression type.

Auxiliary Formulas

The expressions for deflection and capacity are the main formulas for all helical springs; from these are developed such other formulas as may be desired. In this particular case, care must be taken in making such further developments, if using the expressions $D_1^4 - D_2^4$ and $D_1^3 - D_2^3$, to note that resulting formulas will not revert to simple cylindrical helical formulas, because of the fact that a zero quantity has been introduced when D_1 becomes equal to D_2.

Therefore, further formulas are based on the longer but primary formulas which we have arrived at before the introduction of the quantity $D_1 - D_2$.

The Ratio between Free and Solid Heights

Since $H = f + h$, we have, for compression springs:

$$H = \frac{\pi S h}{3 G d^2} (D_1^2 + D_1 D_2 + D_2^2) + h$$

$$= h \left[1 + \frac{\pi S}{G} \left(\frac{D_1^2 + D_1 D_2 + D_2^2}{3 d^2}\right)\right]$$

$$= h \left[1 + \frac{\pi S}{G} \left(\frac{D_1^3 - D_2^3}{3 d^2 (D_1 - D_2)}\right)\right]$$

In a similar way, for extension springs:

$$H = h \left[1 + \frac{2 P_x}{G} \left(\frac{D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3}{d^5}\right)\right]$$

$$= h \left[1 + \frac{2 P_x}{G} \left(\frac{D_1^4 - D_2^4}{d^5 (D_1 - D_2)}\right)\right]$$

By introducing the factor $(D_1 - D_2)$ the formulas are thus simplified as before, so that they may be readily solved with a table of cubes and fourth powers.

Deflection when only Free Height is Given

Considering first the compression type, we substitute the value of h as found from the formulas in the last paragraph, in the general formula for f. Hence:

$$f = \frac{H}{1 + \frac{G}{\pi S} \left(\frac{3 d^3}{D_1^2 + D_1 D_2 + D_2^2}\right)} = \frac{H}{1 + \frac{G}{\pi S} \left(\frac{3 d^2 (D_1 - D_2)}{D_1^3 - D_2^3}\right)}$$

In a similar way, for extension coils:

$$f = \frac{H}{1 + \frac{G}{2 P_x} \left(\frac{d^5}{D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3}\right)}$$

$$= \frac{H}{1 + \frac{G}{2 P_x} \left(\frac{d^5 (D_1 - D_2)}{D_1^4 - D_2^4}\right)}$$

General Considerations

In the compression type it is sometimes desirable to fix the heights, both free and solid, and afterwards ascertain the resulting capacity. If the heights so fixed exceed the allowable deflection by the compression formula, the spring will not return to its original free height. In other words, it will have taken a set. If the difference in heights is less than that of the compression formula, it cannot be assumed that there will be a uniform stress throughout the spring when solid, as there would have been, had the spring been built to the highest free height possible, and the capacity will not then be in proportion to the deflection. If the deflection, for instance, is one-half of the formula deflection, the capacity will not necessarily be one-half that of the strongest coil, instead of equal to that of the strongest coil. This type then appears indeterminable for capacity, the difficulty being to so pitch the coils as to assure uniform stress when the spring is solid. This difficulty does not present itself in cylindrical coils as we have a uniform stress at solid height.

Uniform stress at solid height in a conical spring requires a pitch of coils in proportion to the deflection of same at maximum stress, or, which is the same thing, in proportion to the diameters of the various elements. As the diametrical increase per unit of bar length is not a straight line formula, the pitch of coils necessary to gain uniform stress when solid would have to follow the law of a definite curve. While it may be possible to develop a machine which will so pitch these elementary coils, yet the demand does not seem to have developed such a machine.

Where the deflection is made originally greater than the

maximum stress will allow, the first compressions of the hardened spring will reduce the deflection to the maximum which the steel will stand. Thus, in such a case there is an assurance of uniform stress.

The laws governing the action of grouped cylindrical helical springs apply likewise to grouped conical springs. Briefly, the design should maintain the same free and solid heights throughout, which means that for all coils in the group the $\frac{D_1}{d}$ ratio should be the same, and the $\frac{D_2}{d}$ ratio should likewise be the same for all coils.

* * *

THE CUTLER-HAMMER MFG. CO.'S STUDENT COURSE

The Cutler-Hammer Mfg. Co., Milwaukee, Wis., has a course for training engineering graduates which differs in some essentials from those offered by other companies. The course embraces from three to six months of shop work in the various departments, from two to six months of testing room work, with additional time not specifically determined by any hard or fast rules, in the engineering department in designing work. In all cases the student is given an opportunity to use his own initiative. An attractive feature, from the student's point of view, of this course is that he is paid a salary which enables him to support himself, and to thus raise his self-respect. He is paid $60 a month for the first six months; $75 a month for the second six months; and $90 a month at the end of the first year. Progress beyond that figure depends solely on each man's ability and energy.

The company expects to meet with a loss in the training of these students during the first year, but it is expected that during the second and third years there will be an opportunity for returns on the investment, it being hoped that the students will remain for that length of time, observing the implied obligation. It is interesting to note that the company considers a pleasant personality a qualification for entering this student course. A disagreeable personality, it is stated, diverts the attention of the fellow workers from business, and hence involves a distinct loss.

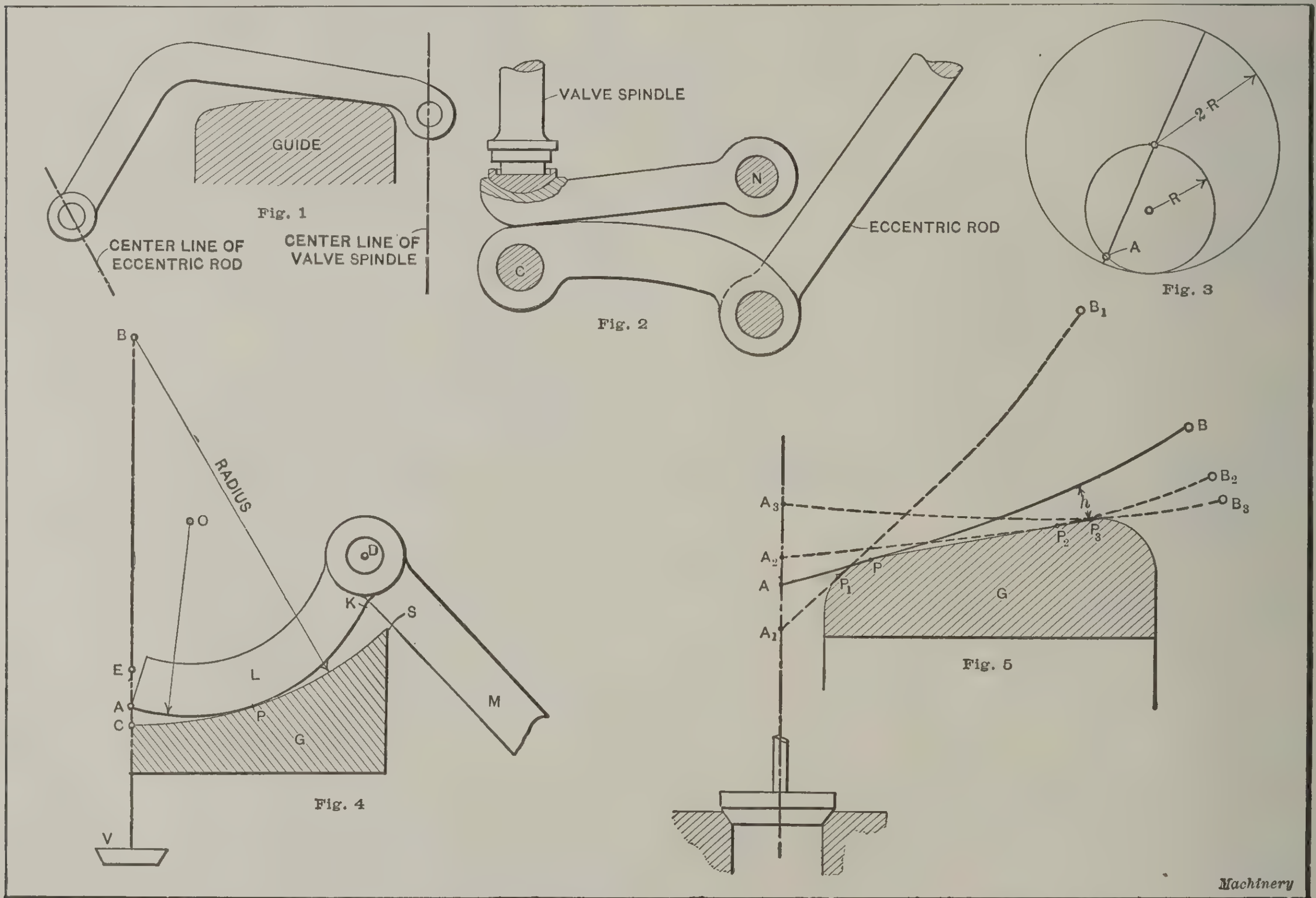
ROLLING LEVERS

By H. L. NACHMAN*

Rolling levers are commonly employed to actuate the valves of large gas engines as well as the poppet-type valves of steam engines, which are extensively used in Europe. These levers may be divided into two classes—the single-lever type shown in Fig. 1, and the double-lever type shown in Fig. 2. In the first case the lever rolls on a fixed guide, and has thus a continuously moving fulcrum, which travels from one end of the guide to the other. In the second case the levers are fulcrumed at fixed points, as at C and N, Fig. 2, and roll upon each other.

The levers should have a pure rolling motion in order to insure a minimum of wear. The valves should be opened quickly and should close with a constantly decreasing velocity, so as to seat quietly and without shock. It is not practicable to construct a mechanism that would fulfill these requirements with theoretical exactitude, but it may be of some interest to show how a simple pair of rolling levers that will approximately satisfy the requirements, may be designed. If a circle of radius R rolls inside of another circle, the radius of which is 2 R, as shown in Fig. 3, any point A in the small circle will travel along a straight line passing through the center of the large circle, as shown. In Fig. 4 the method of applying this principle to a valve motion is indicated. Here G is the fixed guide with a cylindrical surface of radius BC. The rolling lever L is actuated by a rod M. As the point of contact, P, travels from C to S, the point A will move from C to E along line CB. The valve stem is assumed to be attached at point A.

The example shown is a case of pure rolling motion. The point P is the instantaneous fulcrum of the rolling lever; therefore, the velocity of any point is proportional to its distance from this fulcrum. At the beginning of the motion the contact point is at C; hence the velocity of A is then zero. At the end of the motion the fulcrum is at S, and the velocity of A is to that of point D as AK is to DK. If M is actuated by an eccentric, as is usually the case, the valve will start to move slowly, its velocity being gradually increased to a maximum value, and will then again become zero at the end of the upward motion. The same action in reverse order takes place



Figs. 1 to 5. The Principles of Rolling Levers

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on the downward stroke. The constructional difficulties of this mechanism, however, are such that it is not used in practice, and it must be modified to some extent. In its modified state, while there is not a pure rolling action, excellent results are nevertheless obtained.

In both the single and double lever type it is usual to make one of the two elements straight, and find the proper curve of the other element, to give the desired motion to the valve. In the single-lever type it is necessary to continue the guide to the center line of the valve spindle in order to start the valve at a velocity of zero. This would require the guide to be forked, which, however, is not generally done, and, therefore, the lever will strike the spindle at the moment that the valve opens with a perceptible shock. The velocity at the end of the stroke, however, may be kept quite low by a suitable form of lever.

In Fig. 5 let P be the point of contact of the lever and guide at the moment when the valve starts to open. The velocity ratio of the lifting point A to the driving point B (assuming pure rolling motion) is as AP to BP. It is evident that this ratio increases rapidly as the contact point travels toward the right. The rate at which the velocity increases depends on the radius of curvature of the lever, and therefore on the distance h between the guide and the lever. The larger this distance is, the more slowly will the valve open. It is customary to make h from 1/16 to 3/8 inch. Near B the radius of curvature should increase, thus reducing the velocity of the valve as it comes near to its top position. This decreases the stresses in the mechanism due to inertia. For pure rolling action, point A and contact point P should always be in one straight line perpendicular to the path of point A. The distance of point P from this perpendicular is a measure of the amount of sliding. To eliminate side pressure on the valve spindle, the center line of the eccentric rod and of the valve spindle, and the common normal to the curves at the contact point must all meet in a common point.

The two rolling levers in Fig. 2 are used for operating the exhaust valve of a large gas engine. The condition of pure rolling is that the point of contact must always lie on a line joining the two fixed centers C and N, at which the levers are fulcrumed. Generally one of the levers is simply made straight, while the other is made of such curvature as to give the desired motion to the valve.

* * *

SOME DISADVANTAGES OF SPECIALIZATION

In an address on "Comparison between Industrial Conditions in the United States and Europe," read by Mr. A. L. Valentine of Hartford, Conn., before the American Society of Swedish Engineers, the disadvantages that sometimes are incident to a too highly developed system of specialization, were referred to. With relation to the training and experience of the men in charge of shops and departments, Mr. Valentine said:

"The superintendents and foremen in America are usually experts in their respective lines, which is evidently an advantage, although at times this special knowledge and skill is gained only at the expense of a more general understanding of shop work and mechanical matters. If special skill is gained in such manner, it may prove a disadvantage. No matter how efficient a man may be in doing a certain line of operations, it is evident that his usefulness would be increased if his knowledge were not confined entirely to the kind of work he is doing. In this particular respect it may not be out of the way to mention that in Europe the apprenticeship system is very much more developed than here, and that a man can hardly ever expect to hold as responsible a position as that of shop foreman, for example, who has not served an apprenticeship, and thus gained a general knowledge of mechanical matters. In this country, on the other hand, it is not unusual that a man who has operated but one kind of machine or machines will eventually take charge of a department of such machines. However great an importance there may be attached to special training, the general training will always be of supreme value."

* * *

Haste may make waste in tool grinding as well as in tool using.

ACTUAL AND CONSTRUCTIVE PATENT INFRINGEMENT—2

By E. D. SEWALL*

The deductions made in the previous installment of this article are not, it appears to the writer, wholly in accord with a number of recent decisions of the circuit courts and circuit courts of appeal, about to be referred to. The original doctrine of contributory infringement which has already been briefly set forth, in a narrow sense imposes restrictions on the public beyond the terms of the patent claims, although in a broader sense it does not, but deems the contributor to join with another in infringing the complete combination claimed. The cases about to be referred to, however, hold as contributory infringers persons who have not conspired with another to make or use, without authority, the patented thing.

A Dangerous View of Contributory Infringement

The first of these cases, decided in 1896, is the celebrated Heaton-Peninsular Button Fastener Company *vs.* Eureka Specialty Company, 77 F. R., 288, reversing the circuit court. Complainant was the owner of a patent for a machine for fastening buttons by stapling them to a shoe. It sold machines, made in accordance with the patent, having attached thereto a plate on which were delineated the following words: "This machine is sold and purchased to use only with fasteners made by the Peninsular Novelty Co., to whom the title to said machine immediately reverts upon the violation of this contract of sale." The fasteners were ordinary unpatented and unpatentable staples, adapted to be fed from a magazine on the machine. They had to be of a size to fit the magazine and were not claimed as a part of the combination patented. Defendant sold such staples to one of the purchasers of a patented machine. No demand for the return of the machine was made thereafter. The court was satisfied that defendant had knowledge of the contract of sale and held him as a contributory infringer, on the theory that although the machine had been sold to the purchaser the use had been restricted, and defendant had conspired with the purchaser to violate the use, the right to impose restrictions upon the use being a portion of the patentee's monopoly.

Another similar case is Cortelyou *vs.* Johnson, 145 F. R., 932, reversing the circuit court. In this case the patentee of a copying machine known as the "rotary neostyle" sold the machines under a restriction requiring the paraffined paper and the ink used with the machine, both unpatented, and forming no part of the machine claimed, to be purchased from the makers of the patented machine. Defendant was proven to have sold ink to a purchaser of the machine. The circuit court held him as an infringer of the patent, but the circuit court of appeals reversed the court below on the ground that it was not affirmatively shown that defendant had knowledge of the conditions, and the U. S. Supreme Court affirmed the court of appeals.

The Court's Statement of the Conditions

The circuit court of appeals in this case stated its intention to follow the Heaton Peninsular case when the facts were the same, even though "as an original question" they might have ruled differently. The court then points out the embarrassments likely to follow the application of this decision:

"When confined to articles, whether patented or not, which are made for the express purpose of inducing infringement and are not intended for any legitimate use, the doctrine of contributory infringement is logical, just and salutory. But we doubt the wisdom of extending it to the ordinary commodities of life, used in connection with a patented machine, because the patentee sells or licenses the machine upon the condition that he alone is to furnish those commodities. Care should be taken that the courts in their efforts to protect rights of patentees do not invade the just rights of others engaged in legitimate occupations, by creating new monopolies not covered by patents and by placing unwarrantable restrictions upon trade. We think it is clear that the doctrine may be carried far enough to produce such results. For instance, should the patentee of a fountain pen, by such a notice as we have under consideration, be permitted to hold as an infringer one who sells ink to the owner of the pen even though he knows the restrictions? To compel the dealer to make

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inquiries and take the precautions necessary to save himself from being sued as an infringer would place intolerable burdens upon business. . . . If the doctrine be driven to its ultimate conclusion, the merchant and the consumer may find themselves enmeshed in a network of monopolies embracing all the necessaries of life. No one may safely sell coffee to the consumer but the patentee of his coffee mill, no one can furnish him flour but the patentee of his baking pans, and he may yet be compelled to buy milk from the patentee of his milk can and soap from the patentee of his bath tub."

The Indefinite Meaning of the Law

This is a very forceful statement of the evils of the doctrine; but it alleges no definite legal ground whereby these evils may be checked, and leaves the question to be decided on a consideration of the mere degree of the restraint imposed, or the particular things with respect to which the restraint applies. If the restraint applies to the sale of soap and flour perhaps it may not be sustained; but if it applies to ink or wire perhaps it may be sustained.

In Dick *vs.* Milwaukee Specialty Co., 168 F. R., 930, defendant was held guilty of infringement for selling, with knowledge of a restriction, unpatented ink to be used with a patented copying machine known as a mimeograph. In Crown Cork & Seal Co. *vs.* Standard Brewery, and same *vs.* Greenberger, 174 F. R., 252, the Brewery Co. was held to be an infringer of a patented machine purchased by it under a restriction that only crown seals (not patented) made and sold by the patentee of the machine should be used with it, because it used seals made and sold by another. Here the court said defendant was liable "*even though he buys and pays for the machine and is vested with the legal title thereto*, and its use by him in violation of such restriction is an infringement of the patent." Greenberger, who furnished the crowns, was held guilty of contributory infringement. In Commercial Acetylene Co. *vs.* Autolux Co., already referred to, the defendant company was held for contributory infringement not only because it aided in reconstructing the patented package, but on the further ground that it had aided in violating a license agreement set forth on a plate secured to the receptacle.

These last cited cases, it will be seen, hold that under the patent laws, although one has bought a machine and paid the full price for it and obtained the legal title to it, he may not use it except in accordance with the wishes of the patentee, if any be expressed, and that the patentee may restrain trade in unpatented supplies used with a patented machine. There are many other cases to the same effect, all based on the decision rendered in 1896 in the case of Heaton-Peninsular Co. *vs.* Eureka Supply Co.

In view of the doctrine of the Heaton-Peninsular case, it has also been held that where a patented machine has been leased on condition that unpatented supplies therefor be purchased from the patentees, it is contributory infringement for a third party to furnish such supplies to the licensee with knowledge of the conditions of use. In Tubular Rivet Co. *vs.* O'Brien (93 F. R., 200), defendant was held liable under the patent laws for supplying to a licensee of a patented machine tubular rivets of a well-known kind in common use, because the license agreement required the licensee to purchase such rivets only from the licensor. Similarly, in Rupp, *et al.*, *vs.* Elliott, (131 F. R., 730), one who supplied ordinary wire to be used by a licensee in a patented machine was held to be an infringer.

The Right to Fix Resale Prices on Patented Articles

Another form of ultra-claim infringement, by judicial interpretation, consists in the resale, by a purchaser, of a patented device at a price less than that fixed by the patentee as the resale or retail price. This interpretation of the law is also ostensibly based upon the opinion in the Heaton-Peninsular case. In Victor Talking Machine Co. *vs.* The Fair (123 F. R., 424), one of the leading cases on this point, patented talking machines were sold to a department store subject to a condition appearing on a plate fixed on each machine that they should not be resold at a price less than $25. The department store offered them for sale at $18 each, and on appeal to the circuit court of appeals was held to be guilty of infringement of the patent and enjoined from making any further sales at cut prices. In Automatic Pencil Sharpener Co. *vs.* Goldsmith Bros. (190 F. R., 205), the rule was stated as follows: "The owner of a patent may sell the patented article under restrictions as to the price at which it shall be resold, and is entitled to an injunction to restrain a violation of such restrictions, by one having full knowledge of them, as an infringement of the patent."

In the case of Edison *vs.* Smith Mercantile Co. (188 F. R., 925), the facts, as appears from the decision, were substantially as follows: Patented talking machine records were made and sold by the patentee subject to a restriction on the price at which they were to be resold. The stock of Edison records in the store of an authorized dealer became damaged by fire. Some cartons containing the records were smoked, others blackened, and others more seriously injured. The stock was abandoned to an insurance company which took it over. The insurance company sold the stock to a salvage company and the latter sold the records in question in the case to the defendant who sold them at retail at less than the resale price fixed by the complainant, the patentee. Defendant was held to be an infringer of the patent for the record. The court remarked with reference to the language of the resale restriction imprinted on the records and the cartons containing them: "Whether the language in question effectively operates in this way after the article has once reached the ultimate user, and has been used, is a question not presented by this record, and which may not be in all material respects the same question as the present one."

There are other cases on the same point decided in the same way; but in the District of Columbia, in an application by the patentees of a medicine known as "sanatogen," for an order restraining a druggist from selling sanatogen at a cut price as an infringement of the patent, the order was denied by the Supreme Court of the District of Columbia without comment. (Bauer Chemical Co. *vs.* O'Donnell, August 4, 1911.)

Review of the Present Conditions

The class of cases of which Dick *vs.* Milwaukee Specialty Co. is a representative, holds that the patent law may be used to restrain trade in unpatented materials to be used with a patented machine which has been sold by the patentee, and legal title to which has passed from the patentee. This ruling nullifies with respect to patented articles the general rule of common law that the owner of a chattel is entitled to the free and innocent use thereof, and appears to nullify the common law, and the state and federal statutes against contracts in restraint of trade, which are, in the language of Mr. Justice Holmes, "contracts with a stranger to the contractor's business (although in some cases carrying on a similar one) which wholly or partially restrict the freedom of the contractor in carrying on that business as he otherwise would." (Northern Securities Co. *vs.* U. S., 193 U. S., 197.)

The class of cases of which Rupp *et al.*, *vs.* Elliott is a representative, holds that the patent law may be invoked to restrain trade in unpatentable materials to be used with a patented machine which has been leased, and likewise appears to nullify to a like extent the laws against contracts in restraint of trade.

The class of cases of which Victor Talking Machine Co. *vs.* The Fair is an example, holds that the patent law may be used to prevent a purchaser and holder of the legal title to a patented article from selling it at a price lower than that dictated by the patentee, thus nullifying to that extent the general rule of law against restrictions on alienation. "If a man be possessed of a horse or any other chattel, real or personal, and give his whole interest or property therein, upon condition that the donee or vendee shall not alien the same, the same is void, because his whole interest and property is out of him, so as he hath no possibility of reverter, and it is against trade and traffic and bargaining and contracting between man and man." (Hughes, J., quoting from Coke on Littleton in Dr. Miles Medical Co. *vs.* Park & Sons, 220 U. S., 373.)

In the case of Dr. Miles Medical Co. *vs.* Park & Sons, the U. S. Supreme Court held that such a contract with respect to an unpatented proprietary medicine was a contract in restraint of trade, and void so far as it affected interstate commerce. The same court has held that a like contract with respect to the price at which copyrighted books should be re-

sold, is not sustainable as a right conferred by copyright, saying: "To add to the right of exclusive sale the authority to control all future retail sales by a notice that such sales must be made at a fixed sum, would give a right not included in the terms of the statute, and, in our view, extend its operation by construction beyond its meaning." (Bobbs-Merrill Co. *vs.* Strauss, 210 U. S., 339, Day, J.)

In all three classes of cases above, the injury to the patentee was breach of contract, a wrong which the state courts and general law and equity are capable of dealing with, and was not an infraction of a patentee's right to exclude others from making, using or selling the invention, and there was no need therefore to resort to the patent law, and no remedy in the patent law appropriate to the wrong.

What Can be Done to Change the Present Situation?

Ordinary citizens, unlearned in the law, and accustomed to believe that the people, in consenting to the grant of a patent, have consented only to refrain from making, using and selling without permission from the patentee that which is defined in the claims of the patent, evince surprise and resentment when they learn that they may also be restrained by the law from making, using and dealing in ordinary unpatented articles of commerce; from deriving the protection of the general laws against restraint of trade when patented articles are involved; from selling at any price they see fit patented articles that they have bought. They begin to ask themselves whether they are not paying too high a price for the benefits derivable from public encouragement of invention. The people forced the annulment of the registration law of 1793 because of the abuses that grew up under it, and the enactment of the present law in its place in 1836. Since that time industrial conditions have changed. Trusts and corporations established for the purpose of monopolizing trade and manufacture prevail everywhere, and if the patent laws are to be construed to aid restraints of trade beyond those which the people consented to submit to by the grant of patents, the people are likely to demand, finally, their amendment or abolition.

Action in Great Britain

Already the English people have declared their intolerance of any interpretation that shall enable a patentee to monopolize more than the patent grants, urged thereto by practices of American corporations upheld by American courts. The British patent act of 1907 thus declares:

"Sec. 38. (1). It shall not be lawful in any contract made after the passing of this Act in relation to the sale or lease, or license to work, any article or process protected by a patent, to insert a condition the effect of which will be

(*a*) to prohibit or restrict the purchaser, lessee, or licensee from using any article or class of articles, whether patented or not, or any patented process, supplied or owned by any person other than the seller, lessor, or licensor, or his nominee; or

(*b*) to require the purchaser, lessee, or licensee to acquire from the seller, lessor, or licensor, or his nominees, any article or class of articles not protected by the patent;

and any such condition shall be null and void, as being in restraint of trade and contrary to public policy."

Action in the United States

The people of the United States, by their representatives in Congress, are showing their dissatisfaction with ultra-claim restraints enforced under the cloak of patents, as appears from proceedings in the last session of Congress. On May 8, 1911, a concurrent resolution was submitted in Congress resolving: "That a joint committee of both Houses of Congress is hereby created . . . empowered and directed . . . to ascertain the methods of sale, leasing, disposing and control of patented articles in the United States; to ascertain whether patents are used or misused in the establishment of industrial trusts or monopolies; and to investigate all other matters material or pertinent to the purposes of this resolution, and to report their findings to Congress with recommendations as to any needful legislation to protect the public interest and to promote the general welfare."

Among other bills to amend the patent laws introduced in Congress is Senate Bill 2158, "To protect trade and commerce against unlawful restraints and monopolies," providing (Section 8) "that every person engaged in any business, any portion or all of which constitutes a violation of tnis Act, shall forfeit by reason of such violation any and all rights which such person may have to protection under or right to damages for infringement upon any patent right held or owned by such persons, whether directly from the United States or under purchase, assignment or otherwise; and the right to the free manufacture and use of any and all articles, devices, or machines so held under right of patent by the person who shall have violated any of the provisions of this Act, shall thenceforth be open to all."

House Bill 2930 provides "that whenever any letters patent issued by the United States, or any article, commodity, compound, device, mechanical appliance, or machine protected by patent . . . is owned, leased, used, or controlled by any individual, firm, association, syndicate, corporation, or combination which is engaged in any vocation, business, or enterprise in violation of any law of Congress or of any state, prohibiting, restraining or regulating trusts, monopolies, or combinations in restraint of trade, the right to any protection under the patent laws of the United States shall cease and terminate."

House Bill 8661 reads as follows: "That no owner, proprietor, or beneficiary of any letters patent of the United States covering any tool, implement, appliance, or machinery shall, directly or indirectly, by any means or device whatsoever, make it a condition or provision, expressed or implied, of any sale or lease of, or license to use, any such tool, implement, appliance, or machinery, that the purchaser, lessee, or licensee thereof shall not buy, lease, or use, whether in connection with the operation or use of such tool, implement, appliance, or machinery, or otherwise, machinery, tools, implements, appliances, material, or merchandise of any person, firm, corporation, or association, other than such vendor, lessor, or licensor; nor shall any such owner, proprietor, or beneficiary of any such letters patent, directly or indirectly, by any means or device whatsoever, revoke any such sale, lease, or license made by any such owner, proprietor, or beneficiary, on account of the purchase, lease, or use by any such purchaser, lessee, or licensee, of machinery, tools, implements, appliances, material, or merchandise of any person firm, corporation, or association, other than such vendor, lessor, or licensor: Provided, that nothing in this Act shall be construed to prohibit the appointment of agents or sole agents to sell or lease machinery, tools, implements, or appliances.

"Sec. 2. That any such owner, proprietor, or beneficiary of any such letters patent who shall violate the provisions of this Act, and any other person, whether or not an agent of such owner, proprietor, or beneficiary, who shall wilfully assist in, or become a party to, any such violation, shall be punished for each offense by a fine not exceeding five thousand dollars."

Conclusion

Those who attain to power from the exercise of special privileges are very apt to reach for more. Corporations that have become wealthy through the monopoly of patents have grasped for further monopolies of things not protected by patents, and of things which though patented have been sold, returned their profits, and passed without the monopoly. And in this they have been sustained by U. S. courts, but not yet by the Supreme Court.

If the patent statutes do accord this ultra-claim privilege to a patentee, it is apparent that the people are going to change the statutes. Whether they do accord this privilege or not cannot be deemed settled until the Supreme Court shall have passed upon it. "A question arising in regard to the construction of a statute of the United States concerning patents for inventions cannot be regarded as judicially settled when it has not been so settled by the highest judicial authority which can pass upon the question." (Andrews *vs.* Hovey, 124 U. S., 694, Blatchford, J.)

The question may therefore be regarded as still open to discussion. If the patent statutes do not sustain the patentee's right to put a restraining hand on trade beyond the right to exclude others from making, using and selling the thing claimed in his patent, it would be inadvisable to complicate the statutes by the addition of declaratory sections, and by the possible imposition of drastic qualifications out of sympathy with the spirit of patent law.

A good law by inaccuracy or laxity of administration and interpretation may prove as injurious to the community as a bad law accurately applied. If some things that are done and permitted in the name of patent law are warranted by it, the law ought to be amended, or perhaps even abolished. But if such things are unwarranted by it, the remedy lies in more accurate administration and more careful application. The writer thinks the United States patent law, accurately applied, is, as it was expected to be by its framers, promotive of public welfare. Possibly it may be advantageously amended in minor particulars, but as a body of statutes it is believed to have no superior in its particular field. It would be unfortunate if the greed of those who have been granted special privileges by the patent law, in grasping for further privileges under the cloak of that law, should arouse such resentment in the people as to force hasty and drastic legislation where none is needed. The warning words of Professor Robinson are worthy of heed by all friends of the patent privilege: "Continued concessions to the patentee are as unjust, and ultimately as disastrous, as continued restrictions of his powers; for they constantly give rise to new grounds of litigation and are sure to produce, at some time, a reaction in public sentiment under whose impulse the entire system of exclusive privileges may disappear." (Robinson on Patents, Vol. 1, section 23.)

* * *

An automobile fire engine in Newark, N. J., was recently disabled when responding to a fire call by a fireman's coat, that had carelessly been thrown over a rear wheel becoming jammed between the driving chain and sprocket. The chain was broken and other damage done that put the machine out of use for several days. The accident is but another illustration of the folly of building motor trucks with unprotected chains and sprockets.

DIAGRAM FOR FINDING HORSEPOWER TRANSMITTED BY WORM-GEARING

By F. A. G.

A great many manufacturers of worm-gear drives in Europe build and guarantee drives for a given horsepower at a given speed. The accompanying diagram is one which has been used to determine the necessary factors in this connection in the designing-room of a large gear factory. The diagram makes it very simple to find the pitch of the gearing, if the speed of the worm and the horsepower are given. The most important rule for worm drives is to keep the diameter of the worm as small as possible. The diagram, therefore, gives for each pitch and each horsepower and speed the largest allowable pitch diameter of the worm. Under no circumstances is it advisable to make the pitch diameter of the worm larger than allowed by the diagram, as the gearing may then run hot and start to cut. On the other hand, there is no objection to making the pitch diameter smaller. The larger the lead of the worm the greater is the efficiency. In order to obtain the best results, double or triple threads should be used for the worm.

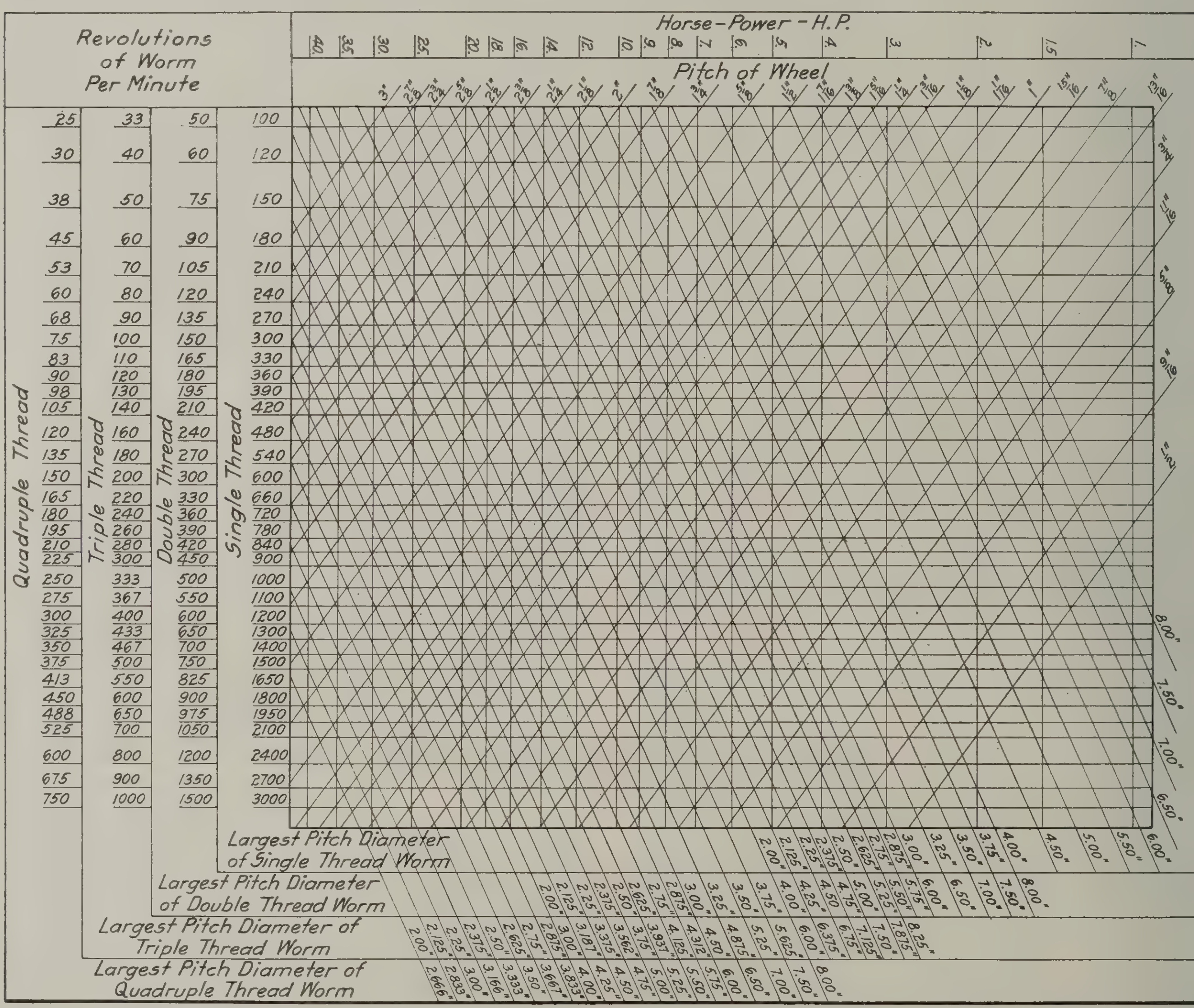


Fig. 1. Diagram of Relation between Horsepower, Pitch and Revolutions per Minute of Worm Gearing; Gear, Phosphor-bronze; Worm, Hardened Steel

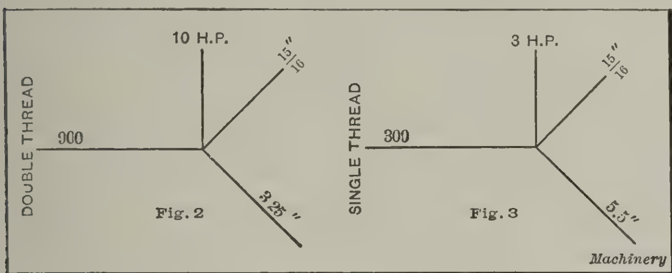
For cast-iron worm-wheels and worms with unfinished teeth, the pitch should be 1.33 times greater than that obtained from the diagram, as this is prepared for worm drives with cut teeth, made from any suitable materials. In the case of unfinished teeth, the pitch diameter of the worm should be only 0.8 times that given in the diagram.

The best material for worm gearing is hard phosphor-bronze

* The following articles on this and kindred subjects have previously been published in MACHINERY: "Table for Calculating the Outside Diameter of Worm-wheels," April, 1911; "Allowable Load, and Efficiency of Worm Gearing," September, 1910, engineering edition. See also the previously published information referred to in connection with the last-mentioned article.

for the worm-wheel and hardened steel for the worm. The next best materials are cast iron for the worm-wheel and hardened steel or cast iron for the worm. Steel or steel castings for both the worm-wheel and worm are only allowable for slow speeds. The teeth in the worm-wheel and the thread on the worm should always be cut, whenever the gearing is to be used steadily or at a reasonably high speed.

As an example of the use of the diagram, assume that an electric motor making 900 R.P.M. is to transmit 10 horsepower by means of worm gearing, the ratio of which is to be 1 to 30. By entering the diagram as indicated in Fig. 2, we find that for single thread, the pitch should be about 1⅛ inch. This would make the pitch diameter too small, and therefore the use of a double thread is necessary. In that case



Figs. 2 and 3. Diagrams indicating Use of Diagram in Fig. 1

the pitch will be about 15/16 inch, and the maximum pitch diameter of the worm somewhere about 3¼ inches. These factors having been found, the diameter of the worm-wheel, the center distance, and other necessary dimensions are determined as usual.

A lathe requiring 3 horsepower is to be driven through a cast-iron worm-wheel. The worm makes 300 R.P.M., and the speed ratio is to be 1 to 90. By entering the diagram as indicated in Fig. 3, we find that a pitch of 15/16 inch would be satisfactory for a phosphor-bronze worm-wheel, but for a cast-iron worm-wheel the pitch should be 1.33 times larger or equal to about 1¼ inch. The pitch diameter of the worm-wheel is found in the usual manner, the worm being assumed to have a single thread.

* * *

The American Society of Automobile Engineers has undertaken the standardization of motor trucks. At a recent meeting of a committee of the society it was decided tentatively that a motor truck should be capable of rendering normal or continuous service under its tonnage rating, and should have an overload capacity, for temporary or emergency service, of 25 per cent above its normal capacity. It was recommended that the desirable speed of trucks of various capacities should be as follows:

For 1-ton trucks	15 miles per hour
For 2-ton trucks	12 miles per hour
For 3-ton trucks	10 miles per hour
For 4-ton trucks	9 miles per hour
For 5-ton trucks	8 miles per hour

* * *

It is reported by Consul-General John E. Jones, of Winnipeg, Manitoba, that an industrial exhibition will be held this year in Winnipeg which will be the largest and most important ever held in Western Canada. The exhibition will be opened on July 10. The secretary and treasurer of the exhibition is Dr. A. W. Bell, Chamber of Commerce, Winnipeg.

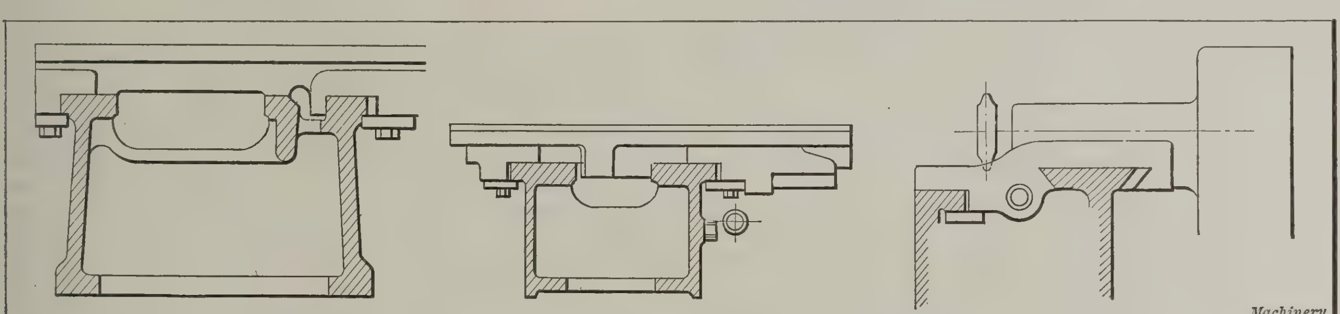
THE ADVANTAGE OF THE "NARROW GUIDE"*

By H. T. MILLAR†

The analytical faculty is very necessary in designing, for although it is the constructive ability which is brought into play when planning a structure or mechanism, this latter should also be analyzed for agreement with mechanical laws. It seems unfortunate that there is not more of critical analysis published in the technical press, since the contributors often have special facilities for it. These remarks are especially prompted by the article by Mr. J. G. Horner on "The Forms of Lathe Beds" in the February number of MACHINERY. In discussing the "narrow guide" lathe bed, Mr. Horner states that in the last five or six years it has effected a revolution in lathe construction. There is no analysis, however, of the claims made for it, and it is, therefore, the purpose of the writer to analyze the conditions of guiding surfaces, and the narrow guide in particular.

The question of the advantage of the narrow guide does not enter a great deal into American lathe design. If there has been any tendency to alter American designs, it has been away from the principles of the narrow guide, since the inverted V is perhaps the most highly developed instance of the principle, and the tendency has been to increase its included angle on account of the vertical pressure. The question arises, however, in American designs of other machines.

The accompanying illustrations Figs. 1 and 2 are taken from Mr. Horner's article and illustrate lathe carriages made by J. Lang & Sons, Johnstone, and J. Stirk & Sons, Halifax, respectively. Fig. 3 shows an example of American practice as embodied in a Brown & Sharpe gear cutting machine. Referring to Figs. 1 and 2, Mr. Horner says: "It is possible with these designs to obtain a length of guide of as much as ten times the width between the guiding surfaces, which has the effect of producing a steady motion with a greater amount of freedom from twisting than is the case when the saddle fits on the front and rear outer edges of the shears."



Figs. 1 to 3. Different Designs embodying the Narrow Guide

In other words, according to this, the amount of cross-wind is a function of the ratio of the length of a slide to its width, and hence the narrower a slide is made in proportion to its length, the less would be the cross-wind for a given amount of clearance between the strip and the slide. This is accepted almost as an axiom by many machine-tool designers. It can easily be shown, however, that this is not so, and that for a given length of slide and a certain clearance between the strip and the slide, the amount of cross-wind is unaffected by the width between the guiding surfaces. This was shown by a contributor in the April number of MACHINERY, and, in order to make the present analysis of conditions complete, it will be briefly reviewed here. Fig. 4 illustrates in diagrammatic form two slides superimposed. They are similar in every respect, except that one has a narrow guide and the other fits on the front and rear edges of the shears. Let w be the width of the narrow guide and W the width of the ordinary guide; let K be the clearance between the slide and the strip, and ϕ and ϕ_1 be the respective angles of cross-wind, which in this case may be regarded as infinitesimal. Then triangle ACE is similar to triangle APO; hence AE is proportional to

* See MACHINERY, April, 1912, "Narrow vs. Wide Guides for Machine Tools," and January, 1912, "The Introduction of the Narrow Guide on Machine Tools."

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OA, and triangle $A_1C_1E_1$ is similar to triangle A_1PO; hence A_1E_1 is proportional to OA_1.

The angle of cross-wind for width W (in radians) $= \dfrac{AE}{OA}$

and for width $w = \dfrac{A_1E_1}{OA_1}$.

Therefore, for a given length of slide and clearance K the amount of cross-wind is independent of the widths W and w.

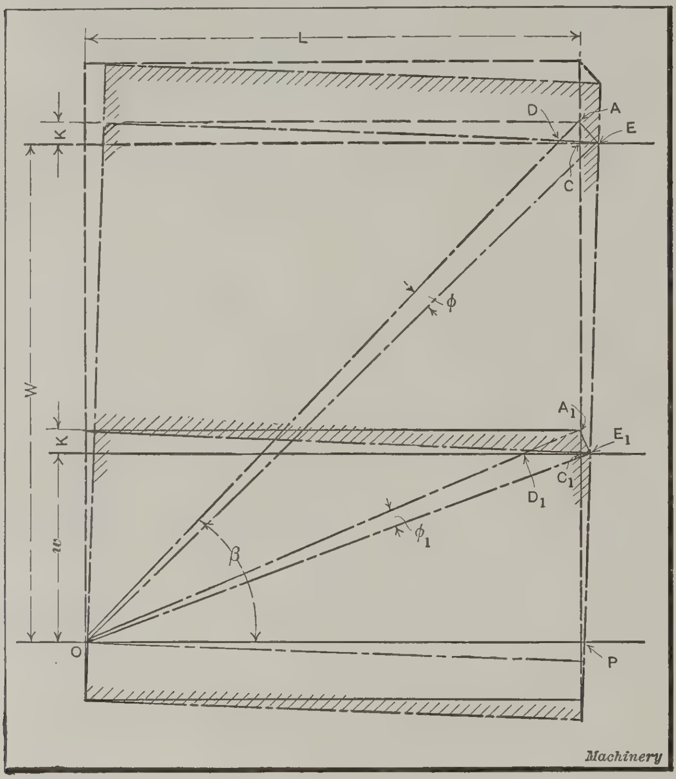


Fig. 4. Analysis of Cross-winding Action

The fact that the angle of cross-wind is a function of the strip clearance K and the length of the slide does not seem to have suggested itself to most writers on the narrow guide, but it will be easily seen that this is so.

The backlash or clearance K is equal to AC. Then,

$$AE = \frac{AC}{\cos\beta};\quad OA = \frac{OP}{\cos\beta}.$$

$$\text{Cross-wind} = \frac{AE}{OA} = \frac{AC}{OP} = \frac{\text{clearance}}{\text{length of slide}}$$

From this it is apparent that the narrowing of the width between the guiding surfaces does not directly affect the angle of cross-wind. When a generally held reason for an accepted practice is disposed of by mathematical considerations, it is wise to look around for another reason. It is not safe to dismiss a point too quickly which has been accepted and in practice for a considerable time. In this case, the narrowing of the distance between the guiding faces may have advantages, although it does not affect the angle of cross-wind. One advantage is that the chance of closing in the bed by setting up the strip too tightly is avoided. This, however, is probably not a very important point. Mr. Horner, elsewhere in his article, suggests what appears to the writer to be the chief advantage of the narrow guide. He says: "In conjunction with this, it is also the practice to bring the lead-screw as close as is practicable to the guide ways, and the twisting tendency and friction caused by the old-style construction is minimized. Thus the force is applied at the correct place near the guide ways."

It is in the resultant improvement in the relative positions of the feeding force, the resistance, and the guides, that the advantage of the narrow guide lies. In the case of the lathe, the narrow guide in front is near to the resistance due to the cut and the feeding force of the rack or lead-screw. If we take a general case of a slide moved forward by a force eccentric to the guides, and neglect for the moment any resistance due to the cut and friction on the top of the bed, we shall see that there is a limiting case for the proportion which the eccentricity of the force bears to the length of the guides. In Fig. 5 is a diagrammatic view of the slide, where T is the propelling force with the eccentricity r; P is the resultant pressure on the guides. Let μ be the coefficient of friction; then $T \times r = P \times L$, or $T = \dfrac{P \times L}{r}$. The resistance to motion (excepting the cut, friction on top of bed, etc.) equals $2\mu P$, and is assumed to act midway between the guides. Hence,

$$2\,\mu\,P = T = \frac{P \times L}{r},\ \text{and}\ \frac{L}{r} = 2\,\mu$$

Hence, if the ratio of the length of a slide to the eccentricity of the propelling force is not at least as great as the ratio of 2μ to unity, it is impossible to move the slide. Since the coefficient of friction is not likely in this case to exceed 0.1, and will probably be less, the limiting case for movement under these conditions would be when $L = 1/5r$, or, in other words, when the eccentricity of the feeding force is five times the length of the slide. The conditions in practice, of course, never reach this minimum.

In practice, however, the case is complicated by the addition of other resistances—resistance due to the cut, the friction on the top of the bed, and the sliding friction of the shaft bearings. Since the shaft generally revolves, this latter friction is very small. The effect of the friction on the top surface of the bed varies a great deal in different cases. The resist-

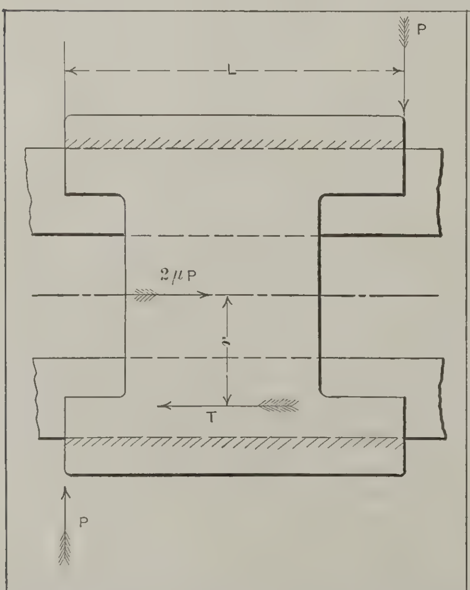


Fig. 5. Analysis of Frictional Resistance and Leverage

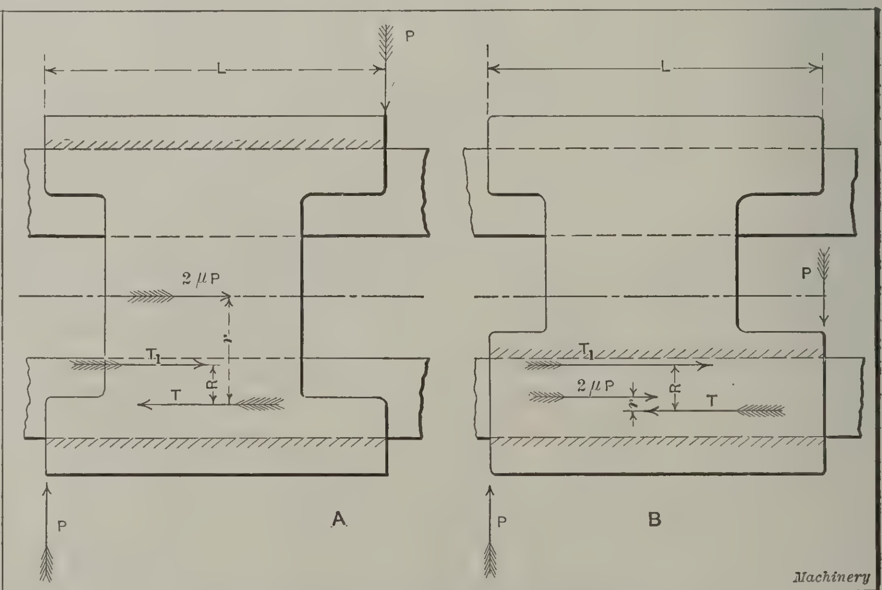


Fig. 6. Comparison between Wide and Narrow Guide

ance due to the cut is the greatest, and in the case of lathes varies in position, and consequently the moment varies. The conditions which obtain due to the cutting resistance are illustrated in Fig. 6, where, at A, is shown the ordinary construction with a wide space between the guide surfaces, and at B the conditions obtaining in a lathe with narrow guide. Let T_1 be the resistance due to the cut; T, the feeding force, and P the pressure on the guide as before. We see then that $2\mu P + T_1$ must not exceed T if movement is to take place.

$$PL = Tr - T_1(r - R) = Tr - T_1r + T_1R \qquad (1)$$

$$2\mu P = T - T_1 \qquad (2)$$

From (1) we get

$$T - T_1 = \frac{PL - T_1R}{r}$$

$$2\mu P = \frac{PL - T_1R}{r}$$

$$2\mu = \frac{L}{r} - \frac{T_1R}{Pr}, \text{ or } \frac{L}{r} = 2\mu + \frac{T_1R}{Pr}$$

In the limiting case, then, the minimum proportion for the length of the slide to the eccentricity of the feeding force is, of course, greater by the amount $\frac{T_1R}{Pr}$, than in the former case.

We can now see the reasons for the advantages of the narrow guide. The frictional resistance of the guiding surfaces may be assumed to act midway between them. If the position of the guide is such that this resistance has a small moment the conditions are improved. Comparison of the conditions in A and B, Fig. 6, illustrates the advantage of the narrow guide. It is evident that if the direction of the feeding force and the direction of other resistances were in the same straight line, the width between the guiding surfaces would be immaterial; in fact, no guides would be necessary. This is, of course, a condition impossible to attain in practice.

Conclusions

In conclusion it may be stated:

1.—That the width between the guiding surfaces does not affect the angle of cross-wind, but that this is a function of the length of the slide and the clearance between the strip and the bed.

2.—That the narrow guide has advantages, but that these advantages are dependent mainly upon its correct location: It must be placed close to the resistance and the feeding force; a narrow guide strip at the back of the carriage would probably be more detrimental than the ordinary wide guide. For the same reason, in American tool construction only one V and one flat way are used. The V must be nearer to the feeding force and the resistance.

3.—That when the narrow guide is placed near to the feeding force, its advantage lies in the reduction of the moment of the frictional resistance and the required feeding force.

4.—That some advantage is derived from the better mechanical construction possible with the narrow guide, since the guiding surfaces cannot be closed in, and most makers fit a taper strip in place of the common angle-strip set up with the points of screws acting against it.

* * *

On March 7, Henri Selmet, a Frenchman, flew in an aeroplane from London to Paris, a distance of 222 miles, in 2 hours and 57 minutes, without alighting anywhere on the way. This is the most remarkable record ever made in fast flying, the average speed for three consecutive hours being 75 miles an hour. The flight was made in a storm accompanied by very high wind, and most of the time in a drenching rain. While this weather, of course, increased the dangers of the flight, the speed made could probably not have been accomplished if it had not been that the aviator was riding on a favoring gale, the same as do birds of migration. Even if the aeroplane should become actually useful in the future as a means of transportation under certain conditions, it is very likely that it will be necessary to make a close study of wind conditions, and to arrange flights so as to take advantage of favorable air currents.

* * *

It should no longer be a question of whether or not you need or desire safeguards around machinery. The only question for debate now is, which kind.—*The Wood-Worker.*

DETERMINATION OF HELIX ANGLES*†

By GEORGE W. BURLEY‡

When calculating the angles of helices or spirals (as they are usually, though wrongly, called) for setting the tables of universal milling machines, the heads of twist-drill flute milling machines, etc., it is necessary to employ the formula:

$$\tan \alpha = \frac{\pi D}{L}$$

in which

α = the helix or spiral angle required,
D = the diameter of the work,
L = the lead of the helix or spiral.

Having calculated the value of $\pi D \div L$ for any particular case, the next step in the process is the consultation of a table of natural tangents for the determination of the value of α from tan α. To do away with calculations and consultation of a trigonometrical table, the table in the accompanying Data Sheet Supplement has been prepared, this table giving the values of the helix or spiral angles for a large number of values of the ratio of L to D. For the determination of the helix or spiral angle for any value of $L \div D$ not included in the table, the "simple proportion" method will give a result sufficiently exact, owing to the slight differences between consecutive helix-angle values in the table.

As an illustration, let us suppose that we wish to determine the value of the helix or spiral angle for a case when $L \div D = 3.75$. Consulting the accompanying table we find that when $L \div D = 3.70$, $\alpha = 40$ deg. 21 min., and when $L \div D = 3.80$, $\alpha = 39$ deg. 35 min. Therefore, when

$$\frac{L}{D} = 3.75,\ \alpha = \frac{40^\circ\, 21' + 39^\circ\, 35'}{2} = 39^\circ\, 58'.$$

This is the same value that would be obtained if the formula above were used, there being no difference between the exact value and the approximately calculated value of the angle. This is a very close result, but in no case is the difference between the two values greater than 7 minutes, and this only where the angle is in the neighborhood of 90 degrees, so that the percentage of error is very slight, and, therefore, negligible.

* * *

PROPOSED INSTITUTION OF MACHINE TOOL ENGINEERS

A society, known as the Institution of Machine Tool Engineers, is proposed by the *Practical Engineer*, London. This journal points out that the Institution of Mechanical Engineers in England is not giving the subject of machine tools a great deal of attention, and that, in many cases, not only the quantity but the quality of papers on machine tool design, presented before this society, has been rather unsatisfactory. In most cases, the only thing that has been done has been to discuss finished machines in a way similar to that in which a salesman discusses his own and his competitors' products. The designer's side of the subject of machine tool design has, in nearly all cases, been left severely alone. There is also need for standardization, which a society of machine tool designers would be able to accomplish in a more satisfactory manner than the larger societies. Some of the opinions stated by the *Practical Engineer* in drawing a picture of British conditions are true of conditions in this country. Our engineering societies have done little to gather and distribute information dealing with the design of machine tools, notwithstanding the fact that the machine tool industry is, so to speak, the basis of all machine building industries.

* * *

It is claimed that soap water used instead of ordinary water in mixing concrete makes it waterproof. A grain elevator, at times exposed to inundation, was built in Germany from reinforced concrete made with soap water, and this building was successful in withstanding the effect of the water, while another building of the same material, but having been made without soap water, failed to completely keep out the water.

* With Data Sheet Supplement.
† See also MACHINERY'S Data Sheet No. 93, "Table Giving Lead of Spiral for Given Angle," and MACHINERY'S Data Book No. 6, "Bevel, Spiral and Worm Gearing," pages 18 and 19.
‡ Address: University of Sheffield, Sheffield, England.

THE USE OF ENGRAVING MACHINERY*

By C. H. COPPACK†

Having seen some articles in MACHINERY on special work done on the Gorton engraving machine, the writer thought that a description of the uses to which the machine made by Taylor, Taylor & Hobson, Ltd., of Leicester and London, can be put, would be of interest. This machine was originally made for engraving photographic mounts with the maker's name, which formerly had to be done by rolling before lacquering. With this machine, the work can be done after all surfaces are lacquered, as no burr is raised by the engraving process. The machine was so much in demand that it was re-designed after a few years, making it available for a wider range of work.

The principle of operation is that of the pantograph with sliding adjustments for varying the size of the letters or designs made from the copies. The copies must be at least three times the size of the work to be produced, and are in one plane only. The varying depths are obtained by a hand feed through a screw. The variety of work which has been done on this machine is very great. Letters may be cut varying in height from 0.002 inch to 3 inches. Twenty letters have been cut on the head of an ordinary brass pin in one line. The machine has also proved useful in making models. Enlarged copies of the parts are made on a drawing, say ten times the actual size, and then transparent celluloid about 0.020 inch thick is placed over the drawing and the outline scribed on this. The celluloid is then cut out, both a male and female model being thus obtained. This is especially useful when making press tools. Numerous punches and dies have been made on this type of machine. The dies and punches are left with about 0.005 inch of metal for hand finishing.

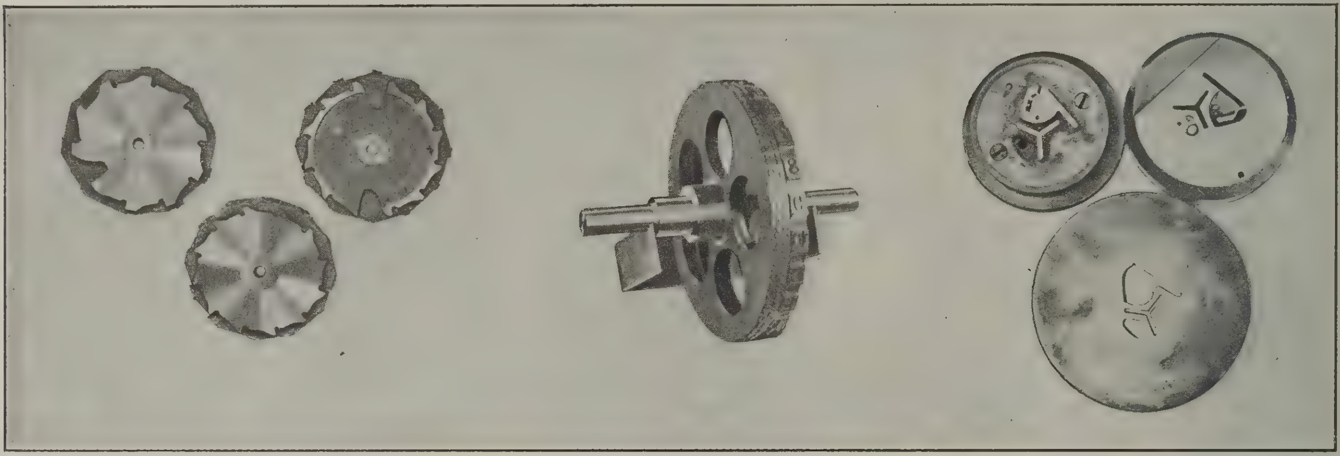


Fig. 1. Steel Wheels, with both Ratchet Teeth and Figures on Rim, cut in Engraving Machine Fig. 2. Time Recorder Wheels cut by Engraving Machine in Four and One-half Hours Fig. 3. Punch, Die and Stripper cut in Engraving Machine

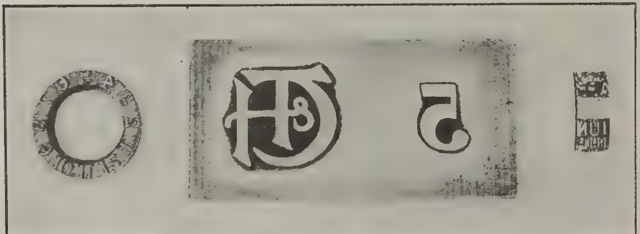


Fig. 4. Additional Examples of Work done in Engraving Machine

In instrument work, when about one hundred pieces are sometimes required, it would not pay to make press tools, especially if the piece were at all irregular. In this case the machine proves especially advantageous, as the pieces may be turned out at a cost of perhaps only one-half that of the press tools. One example of work done by this machine is that of the type wheels used in time recorders, where one wheel has twelve numbers and another sixty. Of course by means of die-casting processes, these wheels can be made cheaper in quantities, although the dies are expensive, but the metal of die-castings does not stand a great deal of wear; even brass types wear considerably in the course of time, and the best results are obtained with machine steel, casehardened. The cost of cutting the pair of wheels for the time recorder shown in Fig. 2 is about 84 cents, the time required being four and one-half hours, and the work being done by a girl.

Another interesting piece of work done on this machine is the cutting of sets of steel wheels as shown in Fig. 1, having ratchet teeth on the sides and figures on the rims. The ratchets are cut solid with the wheel. The ratchet spaces are recessed as indicated, so that a square-ended pawl can be used. The teeth are cut within a limit of 0.001 inch, and opposite teeth are tried across the center with a special gage. The figures are cut in exact relation to the ratchet teeth so that when a dozen of these wheels are put together, they will print a row of figures in a perfectly straight line. This would have been a very difficult matter to accomplish if the ratchet had been riveted to the rim, as it would then have been difficult to obtain the same accuracy.

In Fig. 3 is shown an example of punch and die work done on the engraving machine, the illustration showing a punch, die, and stripper. The punch is cut to a depth of 0.300 inch with a cutter of 0.050 inch diameter. The die is cut to a depth of 0.200 inch with the same cutter, leaving in each case 0.003 inch for finishing. Both punch and die are made of tool steel. The stripper is made of cast iron, 1/4 inch thick, and is finished complete on the engraving machine.

In Fig. 4 (center) is shown an embossing punch, cut 1/8 inch deep, the corners being finished with a cutter 0.005 inch in diameter. At the left in the same illustration is shown a small wheel with figures, which was cut in fourteen minutes in lots of two hundred.

* The following articles on this and kindred subjects have previously been published in MACHINERY: "Brass Engraving, by Machinery," April, 1912; "Engraving Calibrated Circular Scales," and "Equipment for Engraving Pearl Revolver Handles," April, 1911; "Gorton Special Engraving Machine," March, 1911; "Die Sinking and Engraving Machines," May, 1908, engineering edition.

† Address: 4 Gotha St., Leicester, England.

* * *

A new industrial school, combining, it appears, certain features of the trade school and high school in one, has recently been opened in Vienna, Austria. The school is claimed to be the largest educational structure in the world, and practically all trades are taught. The building has a capacity for 5200 students, simultaneously instructed, and 337 separate study-rooms are provided, making the average number of pupils per room and teacher not more than between fifteen and sixteen. The building has five complete stories besides basement, and is built so as to entirely enclose a court yard. The total length of the building is about 425 feet, and the total width about 250 feet. In addition to the square building surrounding the court-yard, two buildings connect the long side wings, thereby forming three separate courts. Besides the study-rooms for the education in the trades, considerable space is set aside for gymnasiums, recreation rooms, a restaurant where the students can obtain meals at cost, etc.

* * *

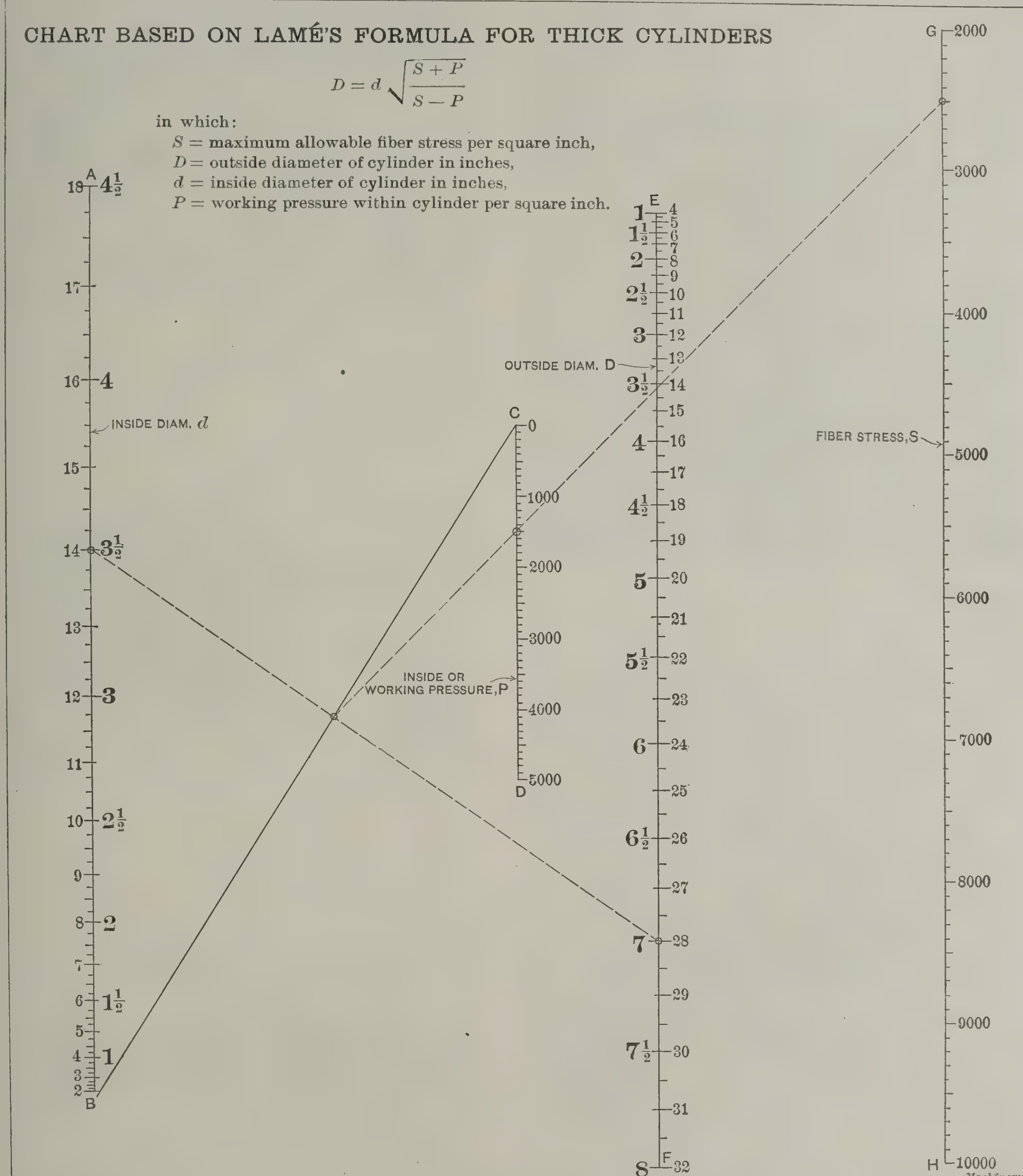
The famous 1400-H. P. Corliss engine which operated the machinery at the Philadelphia Centennial in 1876 and which subsequently was used to operate the plant of the Pullman Palace Car Co., in Chicago, was recently dismantled and sold for scrap iron.

CHART FOR THICK CYLINDERS*

By JOHN B. PEDDLE†

The accompanying chart for the rapid determination of the dimensions of thick cylinders is based on Lamé's well-known formula. This chart makes it possible to find the outside diameter of the cylinder very quickly when the fiber stress, the working pressure, and the inside diameter are known. Of course, the chart can also be used to find any other of the four quantities when three of them are known. The method of using the chart is as follows:

Locate the fiber stress on line *GH* and the working pressure within the cylinder on line *CD;* draw a line through the two points thus located, and extend this line until it intersects the auxiliary line or axis *BC;* through the point of intersection with this line draw a line which passes through the dimension for the inside diameter of the cylinder as found on scale *AB*, extending this line until it intersects scale *EF*. The point of intersection with line *EF* gives the required outside diameter. It will be seen that the scales *AB* and *EF* are provided with a double set of figures. When using these scales, the heavy-faced figures on *AB* should be used in connection with the heavy-faced figures on *EF*, the same rule being followed with regard to the light-faced figures.



An example of the use of the chart is indicated by the dotted lines. Assume that the allowable fiber stress per square inch is 2500 pounds. The working pressure within the cylinder is 1500 pounds per square inch, and the inside diameter is 14 inches. By following the directions given, we find that the outside diameter should be 28 inches; or, if the inside diameter were 3½ inches, as given by the heavy-faced figures, then the outside diameter would be 7 inches.

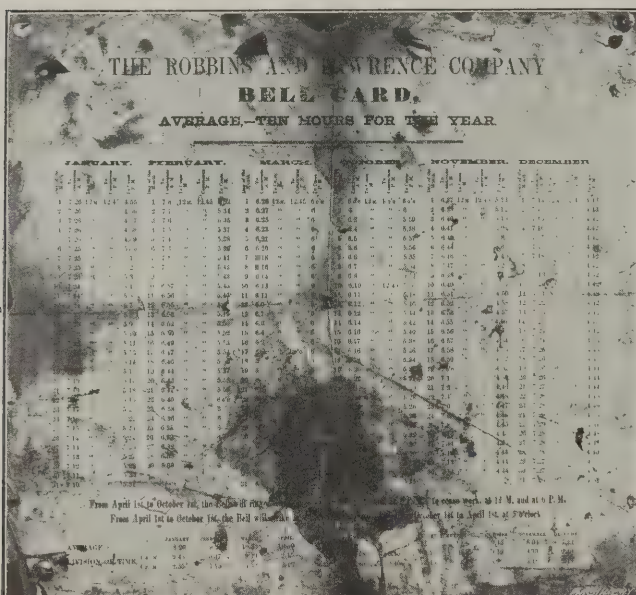
* See MACHINERY, July, 1909, engineering edition, "Thick Cylinders," and the articles there referred to. See also MACHINERY'S Reference Book No. 17, "Strength of Cylinders," and MACHINERY'S Data Sheet Book No. 17, page 35, "Ratio of Outside Radius to Inside Radius of Thick Cylinders."

† Address: Rose Polytechnic Institute, Terre Haute, Ind.

ANCIENT PISTOL AND SOME OLD TOOLS FROM A NEW ENGLAND SHOP

By F. R. HUMPHREY*

About 1850, one of the most progressive concerns in this country was the Robbins & Lawrence Co., of Windsor, Vt. This company had a good reputation and was well known everywhere, and a machinist who had served his apprenticeship there had no trouble in commanding the highest wages in any machine shop in the country. In many ways this company was far ahead of its competitors. An old gentleman who had served his apprenticeship in this shop claimed that the equipment of jigs and fixtures at that time was twenty years


THE ROBBINS AND LAWRENCE COMPANY

BELL CARD.

AVERAGE,—TEN HOURS FOR THE YEAR.

JANUARY. FEBRUARY. MARCH. OCTOBER. NOVEMBER. DECEMBER.

Fig. 1. A "Bell-card" of the Robb'ns & Lawrence Co., Windsor, Vt., in use about 1850

ahead of that of any firm manufacturing a similar line of work.

In Fig. 1 is shown a reproduction of the "bell card" which was used about 1850. The card from which the photograph was taken has apparently seen some hard usage; the dark stains covering it represent tobacco juice. This card gave the time when the factory bell—still in place on the old shop—would ring each day of the year. The time varied a few minutes each day, and was so arranged that the working hours of the shop averaged ten hours for the whole year, while at the same time the use of artificial light was avoided. During the month of December the average working time was only 7 hours and 54 minutes, while during the months of May, June, July and August, the men worked 11 hours a day.

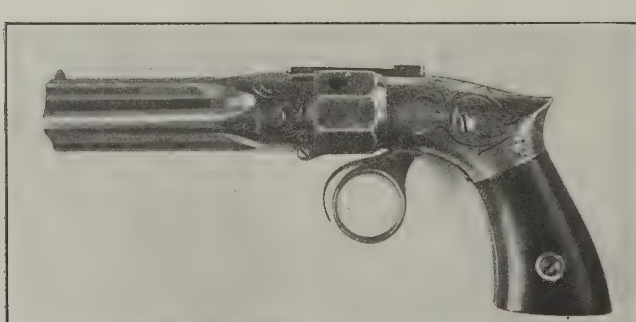


Fig. 2. An Old Pistol made by the Lawrence & Robbins Co., patented 1849

Fig. 2 illustrates a five-barreled "hammerless" revolver which was patented in 1849. This old weapon shows, in many of its details, indications of the skill of the mechanics working with the poor facilities of that time. The revolver is of 0.28 caliber. The forward part of the barrels, shown at *A* in Fig. 3, is rifled, and the rear part, shown at *B*, is chambered for the powder and ball. Percussion caps were used to cause the explosion of the powder. At *F* are shown the vents through which the gases and smoke from the caps escaped. At *C* is shown a part of the frame which is made from a steel casting, and evidently machined by the use of jigs and fixtures. The grips at *E* are made of fine selected black walnut. The chambers, the plate and the frame are ornamented with scroll design which was hand engraved.

The hammer shown at *A* in Fig. 4 struck each cap in succession. It was milled in such a manner that it would re-

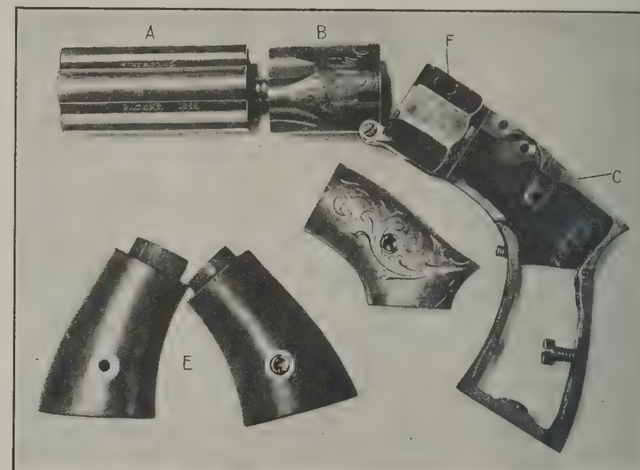


Fig. 3. Main Parts of Pistol in Fig. 2

volve one-fifth revolution while being drawn back or set, and it traveled straight ahead when released. It was milled with a combination of straight and spiral grooves, so as to be able to move in the manner indicated. The nut *H* fits on the hammer. The triggers, of which there are two, are shown at *B*. They are so arranged that by pulling back the ring *K* the hammer is set; then, by a slight pressure on the small trigger

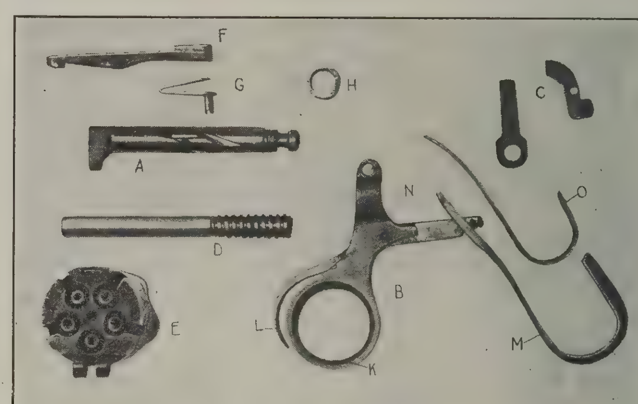


Fig. 4. Details of Pistol

L, the spring *M* is released, and the hammer is driven forward. The trip *N* is part of the trigger *L*. The button *C* is a release which acts the same as the trip *N*. The screw *D* serves to lock the barrel in place. Spring *O* returns the trigger after firing. At *E* is shown a rear view of the chambers. This view shows the nipples for the caps and the vents through which the gases escape. At the bottom is shown the

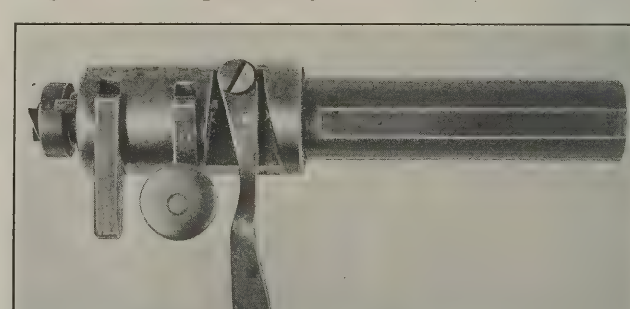


Fig. 5. An Old Hollow Mill and Threading Die with Holder

hinge. The latch *F* serves for a rear sight, and the spring at *G* holds the latch in place.

In Fig. 5 is shown a combination hollow mill and die. This unique tool was used on one of the early turret lathes. The details of the tool are shown in Fig. 6. The body *A* is made of soft steel in one piece; the hollow mill *H* is set into the

* Address: P. O. Box 585, Windsor, Vt.

spindle *B* and is threaded on the inside, thus forming the die. The lever *C* has a pin which engages in the slot *J* and thrusts spindle *B* forward in holder *A*. Parts *E* and *F* swivel on pin *D*. The thumb piece *E* travels in the cam slot *K* and forces the spindle forward; the lock *F* keeps the spindle from turning and catches in the notch *L*.

In Fig. 7 is shown a box-tool which was used on the same machine as the former tool; the details of this tool are shown in Fig. 8. The box *A* is machined from a forging; parts *B*, *C* and *D* are bushings which are used as back-rests; *C* and *D* are held in place by the nuts *E* and *F*. The tool is provided with two turning tools *G* and *H*, and a forming tool *K*. The tool *G* is held in place by clamp *J*, and the tools *H* and *K* are held by clamps *L* and *M*, and screws *O* and *P*. There are three screws *N* which are used for adjusting the tools relative to the center. These tools were used in the Windsor shops and happened to be left when the gun department was moved by the Winchester Arms Co. to New Haven, Conn.

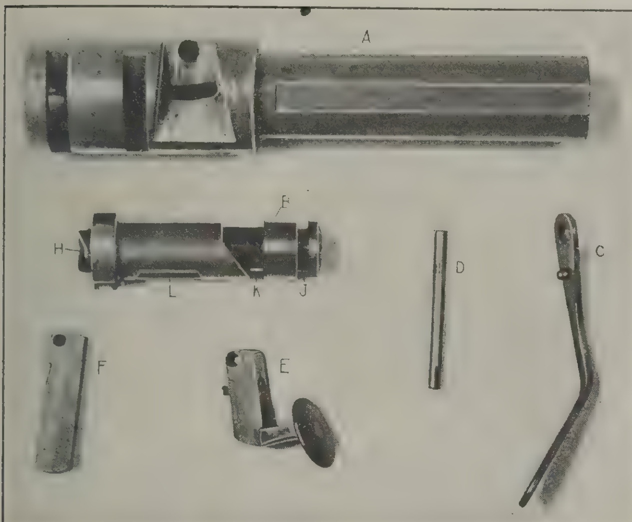


Fig. 6. Details of Tool shown in Fig. 5

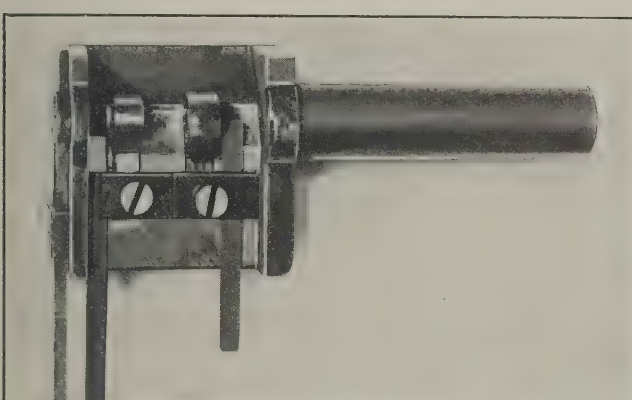


Fig. 7. A Box-tool from about 1850

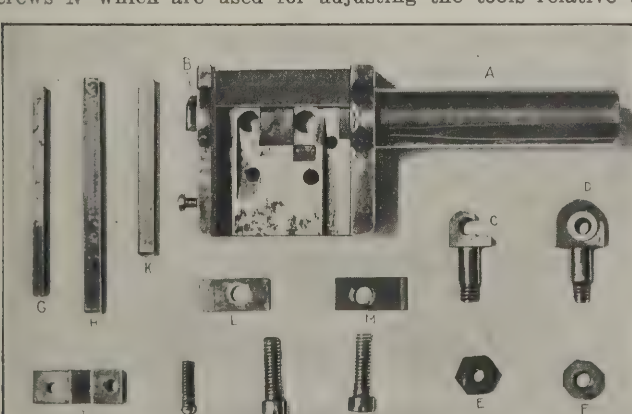


Fig. 8. Parts of Box-tool shown in Fig. 7

* * *

A careless workman with a big monkey-wrench is expensive to have around where there are many small bolts or nuts to be tightened.

OCEAN LINERS WITH DIESEL ENGINES

It appears that the trials of the *Selandia*, a Diesel engine-driven liner, with a gross tonnage of 4900, marks a new departure in the driving of large ocean-going vessels. The East Asiatic Co., for which this vessel was built by Messrs. Burmeister & Wain, Copenhagen, Denmark, has three vessels of this type, and appears to be fully satisfied with their performance, as eight more motor-driven vessels have been ordered, two of 10,000 tons and six of 6000 tons capacity.

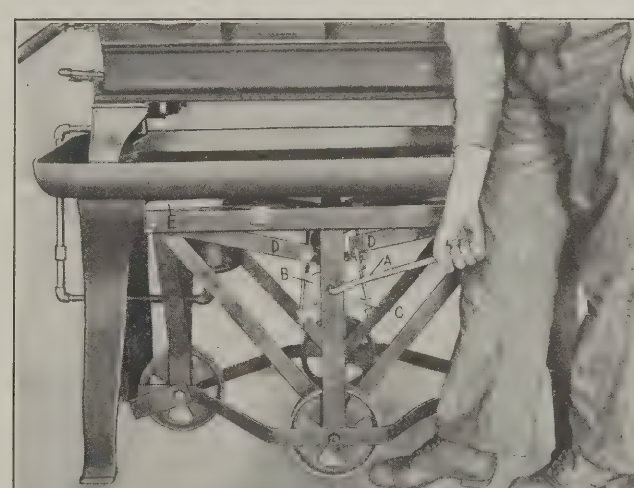
It is stated that, contrary to the expectations, there was a complete absence of vibration and noise during the trials of the vessel. In fact, even steamship engineers agreed that the machinery ran more quietly than steam-engines. The engines are under perfect control, as was proved during the trials, when the *Selandia* almost collided with another steamer, but was saved through the prompt reversing of her engines. Only fifteen to twenty seconds was necessary to change the direction of rotation from full-ahead to full-astern. On account of the absence of funnels, the vessel presents a peculiar appearance. The exhaust is led up through the hollow mizzen-mast, and the outlet is about 25 feet above the deck. The advantages gained in cargo-carrying capacity are considerable. The great bulk of the space usually given over to coal bunkers can be used for cargo. The main fuel tank of the vessel is provided for by her double bottom, which has a capacity for 900 tons of oil, sufficient to keep her main engines going during a voyage of twenty thousand miles under average condition.

The vessel is provided with twin-screws driven by two eight-cylinder engines, each developing 1250 brake horsepower (1500 indicated horsepower) at 140 R. P. M. The machinery cost about $50,000 more than steam engines, but it is expected to save some $40,000 a year by the use of the Diesel engines. This saving is accounted for partly by the saving on the fuel and partly by the fact that the vessel can carry 1000 tons of cargo more than a steam-driven vessel of the same capacity.

* * *

A HANDY TRUCK FOR MOVING MACHINES

The accompanying illustration shows a homemade truck, used in the shops of F. E. Wells & Son Co., Greenfield, Mass., that is extremely useful in moving or shifting the positions of partly erected machines. It is called the "back-saver" by the men, for it eliminates a great deal of lifting and pulling when moving a machine.



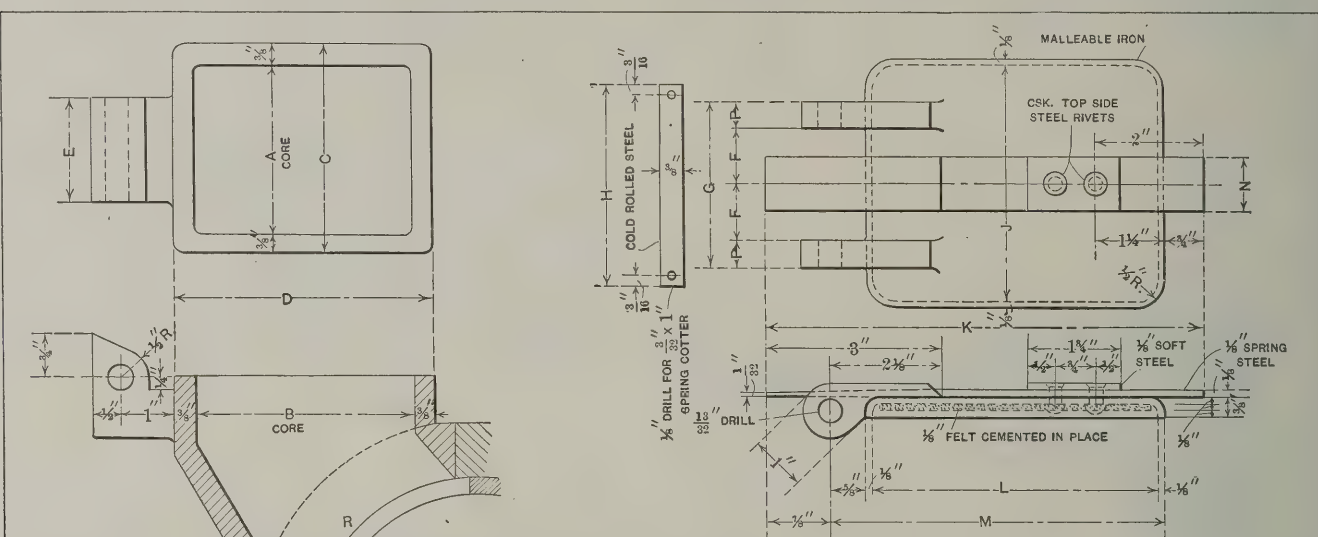
A Handy Truck for Moving Machines

The truck is run under the body of a machine, and handle *A* is pulled upward. This handle terminates in the cam *B*, which acts against bar *C* and forces the bar down. This bar is attached to the inner ends of the levers *D*, and the motion imparted to *C* raises the outer ends of these levers, throwing the lifting blocks, one of which is shown at *E*, against the body of the machine, and thereby raising the machine enough to clear the floor. In this position the machine may be readily wheeled to the new location, and by depressing the handle, the load is dropped. The high point on cam *B* is slightly flattened, so that the device will remain at that position until intentionally changed.

OIL-WELL DESIGN

By F. D. BUFFUM*

The accompanying illustration shows a design of oil-wells and covers that for several years has proved to be satisfactory and superior to grease- or oil-cups. It needs less frequent attention, is easy to fill, and the oil-well cannot be lost or stolen like an oil-cup. The design is inexpensive, the lubricant is in contact with a large part of the journal, and coats it with a film much better and more evenly than a cup, and without waste. It also feeds the lubricant automatically without any adjustment. The lid and hinge boss are made similar to the Master Car Builders Association's standard used in railway service. As long as the hinge boss and the other external parts of the oil-well mouth are made of standard dimensions, the lid design and the material can be varied considerably, just as in the case of the M. C. B. journal box. No part of the passage at *R* should be smaller than the entrance, and the bushing should be cored out at *S* to correspond with the dimension *A* in the table. The dimensions given are suitable for ordinary steel or iron castings. The oil-well should be located at the top of the bearing when practicable, and should be made deep and of large capacity, the dimensions shown at *A* and *B* being the minimum dimensions.



A	B	C	D	E	F	G	H	J	K	L	M	N	P	Size Rivet
4	5	4¾	5¾	1 15/16	1	3	3¾	5¼	8¾	6¼	7⅛	1	½	¼
3	4	3¾	4¾	1 7/16	¾	2½	3¼	4¼	7¾	5¼	6⅛	1	½	¼
2	3	2¾	3¾	13/16	7/16	1⅝	2⅜	3¼	6¾	4¼	5⅛	¾	⅜	⅛
1¼	3	2	3¾	9/16	5/16	1⅜	2	2¼	6¾	4¼	5⅛	½	⅜	⅛

Dimensions of Oil-well and Cover

These oil-wells are adapted to any kind of machinery especially heavy outdoor machines where cups are liable to be stolen, jar off or break, and also to plug up with dust in summer or freeze in winter. They can be used with either grease or oil, and, with the latter, are economical of the lubricant, because it is soaked up by the wool waste with which they should be packed when oil is used. This waste then feeds the oil to the journal by capillary action, evenly and continually, and without attention for long periods of time. There is nothing to regulate or adjust, and the journal is coated with a film of oil without spilling any. The main advantage, however, is in the saving of the operator's time in attending to the lubrication. To fill, all that is necessary is to hook open the cover, pour in the oil and slam the cover down again.

The easiest thing for the designer of any machine to do is to indicate a tapped hole and call for a grease- or oil-cup where lubrication is required, and, until a few years ago, when the writer went into the operating end of the business, he supposed that it was entirely satisfactory. However, he found that it didn't take much of a machine to require half an hour or more a day attending to cups. They have to be filled when they are empty and that is not always a convenient time. Labor occupied in filling and fixing them is an expense and a delay that has to be paid for, and a small sum daily amounts to a good deal in a year.

In looking for a more satisfactory substitute, the oil-well with spring-hinged cover, used on railway motor journals for mine locomotives and for their gear cases, appeared to be just the thing. These were made in a variety of designs, but the one that seemed to be the best and cheapest was adopted and improved in minor particulars. A few were used with great satisfaction to the machine operator, and their advantages were clearly demonstrated.

These oil-wells cost no more in the end than cups, if the outlet is large and is *cored* in the lining metal and not cut out afterwards. Valuing that metal at 30 cents per pound, the opening need not be so very big to save the cost of the well and cover, and the price of the cup which is saved helps out too.

The purpose of this article and of the table submitted in connection with it is to urge that manufacturers adopt *some* standard design and thus secure the advantages of interchangeability and low cost that the master car builders' standard obtained for the railroads. There is no advantage in having a lot of different designs and sizes, such as are now in use, when the adoption of standards would cut the cost down to no more than the 25 cents, at which the M. C. B. cover retails. To have a standard, all that is required is to retain the dimensions of the hinge boss and the outside of the oil-well. The cover design can be varied to suit the designer. He can make it thicker or thinner, with felt or without, and of cast iron or other material, and still have interchangeability. For larger covers, or for hand holes, the writer would suggest the regular M. C. B. standard.

* Address: Ellsworth, Pa.

* * *

INTERESTING TEST PIECES OF MONEL METAL

At the recent motor boat show in New York some interesting test pieces of monel metal were exhibited. This metal, which has the strength of steel, takes a finish like pure nickel, and is less corrodible than bronze, was shown in the form of a 1¼-inch diameter cold-drawn rod bent over flat, surface to surface, without fracture. Another ¾-inch rod, cold-drawn, was tied in a close knot with no fracture. Other test pieces of hot-rolled rods which had shown tensile strengths of 100,000 to 103,000 pounds per square inch, with yield points ranging from 76,000 to 81,000 pounds, were to be seen.

* * *

To produce a solder that will fuse at a low temperature, add six drops of mercury to each ounce of solder. With this, soft metals melting at a low temperature, can be soldered.

THE FACTOR OF THRUSTS IN MACHINE DESIGN

By WILL O. WYNNE

The successful and effective working of many mechanisms depends entirely upon the direction of the thrusts set up in them. The question of the direction of thrusts is a phase of the designer's work which is very often left to look after itself. Negligence in this respect sometimes results in the failure of a mechanism to produce satisfactorily the desired result. When designing a new movement, a thorough analysis of all of the strains and thrusts set up will sometimes reveal the possibility of counteracting the thrust of one member by that of another, thus producing a more self-contained arrangement, and possibly reducing, to an appreciable extent, the power required for driving the mechanism.

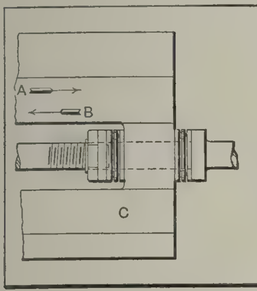


Fig. 1. Direction of Thrusts in Ordinary Carriage Construction

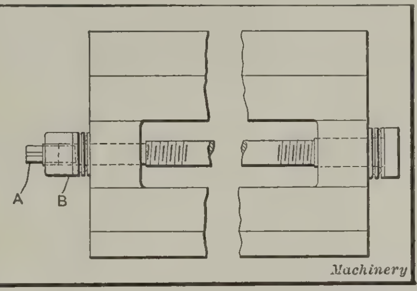


Fig. 2. Improved Design of Carriage Construction in which the Screw is always in Tension

Of course, there are many arrangements, theoretically incorrect, in which the thrust is not sufficient to affect the successful working of the mechanism. Such a condition of affairs is illustrated in Fig. 1. When the carriage on slide *C* is drawn, by means of the screw, in the direction of arrow *A*, the screw will be in tension, the thrust being taken by the collar on the outside of the slide *C*. When the direction is reversed, however, the carriage moving in the direction of arrow *B*, the thrust is taken on the ball washers on the inside of the slide. The screw is thus in compression. The disadvantage of this construction is not as apparent in small machines, but where heavy thrusts are set up, as in planers, it is obviously advantageous to arrange for the screw to be in tension irrespective of the direction of movement of the driven carriage. In addition to this, the construction as shown in Fig. 1 renders it rather difficult to introduce the usual form of lock-nut.

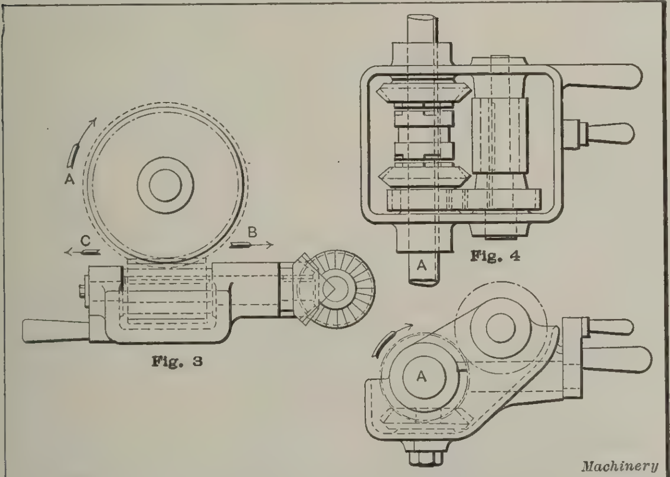


Fig. 3. Direction of Thrusts in Worm and Worm-wheel Design. Fig. 4. Worm-box with Reversing Mechanism

The arrangement by means of which the screw is always kept in tension is shown in Fig. 2, and is self-explanatory. This method allows the application of an exceedingly simple locking nut. The screw *A*, after the adjustment of the nut *B*, is forced against the end of the traversing screw; thus the thrust of the traversing screw, the adjustment of the nut *B*, and the locking of the nut by screw *A*, all act upon the same side of the thread of the traversing screw, forming a most effective lock.

In automatic trip motions, in which the feed is to be tripped while the machine is cutting, the question of direction of thrust is, in some cases, of paramount importance. This can be simply illustrated by a worm and wheel in which it is required that the box carrying the worm shall fall, throwing the worm out of gear with the worm-wheel, and thus disconnecting the feed. The worm-box, as commonly constructed, is shown in Fig. 3, and is usually pivoted at the apex of the bevel gears that impart motion to the worm-shaft. If the worm-wheel is arranged to rotate in the direction of arrow *A*, the thrust on the worm is in the direction of arrow *B*. This thrust acts on the pitch line of the worm, and the pitch line produced passes above the center of rotation of the worm-box; thus, the box is prevented from falling by the thrust of the worm. The greater the thrust on the worm, the greater also will be the tendency for the worm to be forced deeper into mesh with the wheel. If the direction of rotation is reversed, the thrust will be in the direction of arrow *C*, tending to throw the box downward, and the greater the thrust, the more effective the action when the support to the box is tripped.

An instance somewhat similar to the foregoing is that of a worm-box driven by spur-gearing, as is illustrated in Fig. 5. In this case, the box is hung on shaft *A*, which imparts motion to the worm-shaft and worm by means of spur gears *B*. If shaft *A* rotates in the direction of arrow *C*, the thrust of the spur gears on the box is in an upward direction, and this thrust will hold the box up when the support is tripped, thus necessitating some auxiliary motion to push the box out of gear. If the direction of rotation of the shaft *A* is reversed, the thrust tends to throw the box downward, and the mechanism has now all the elements of an effective automatic trip.

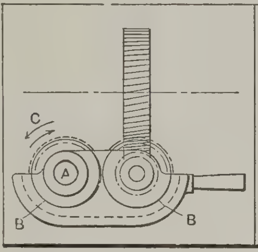


Fig. 5. Worm-box with Spur Gear Drive

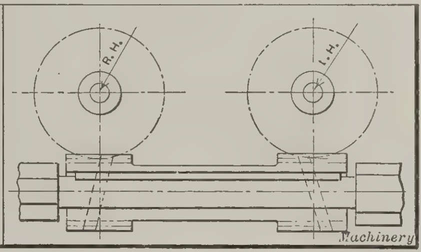


Fig. 6. Twin-screw Drive in which the Thrusts are Balanced

It is very often necessary to be able to trip the worm while feeding in either direction. In this case it is advisable, if possible, to mount the reversing mechanism in the worm-box, as shown in Fig. 4. As the rotation of shaft *A* is in the direction of the arrow, the driving pressure thus always tends to throw the worm-box downward.

The consideration of the automatic balancing of thrusts has led to the design of a planer drive, as outlined in Fig. 7. This arrangement has been used by the writer for some time. The drive, as shown, illustrates a large planer table driven by a double rack. It is generally known that with this style of drive, under ordinary conditions, it is practically impossible to equally distribute the drive between the two racks. This, however, is automatically accomplished with the drive arranged as shown.

The racks *A*, of ordinary straight tooth type, are bolted to the table; bull wheels *B* mesh with the racks and ride loosely upon a large stationary shaft fixed in the bed. In mesh with the bull wheels are separate rack pinions *C*, riding loosely on a long stationary shaft *D*, carried in brackets bolted to the under side of the bed. Keyed to these rack pinions are two separate helical gears *E*, with teeth cut at opposite angles. In mesh with these two wheels is a solid double helical pinion *F* keyed to the driving shaft *G*, but free to move endwise along the shaft. The shaft *G* is driven by the usual gearing, with which we are not concerned. When shaft *G* is rotated, the double helical pinion *F* drives the helical gears *E*, which, in turn, drive the rack pinions and the racks. The pinion *F*, due to its being of a double helical form, will continually be in a state of either compression or tension; thus, if at one instant the driving pressure on one rack became greater than on the other, the difference of pressure would immediately be transmitted to the pinion *F*, causing that pinion to move endwise, and to again equalize the pressures on the two racks.

Whereas, in the usual double rack drive, great care is necessary in mounting the gears on their respective shafts in order to try to obtain an even drive, this trouble is entirely eliminated and a perfect self-contained automatically balanced drive is obtained with the arrangement above described. It will also be seen that whereas the end thrust on the pinion, whether compressive or tensile, is all self-contained, the resulting thrusts on the single helical gears are taken on ball washers mounted between the pinions *C* and the brackets carrying the shaft *D*.

The same principle might be employed in the driving of a twin-screw planer, or, in fact, in any machine which is driven by two members, one member always receiving the thrust set up by the other. The application of this drive to a twin-screw planer is shown in Fig. 8. A short article bearing somewhat upon this subject appeared in MACHINERY, August,

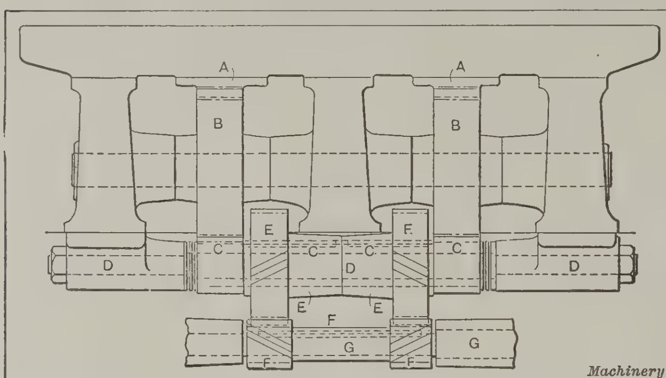


Fig. 7. Improved Form of Double Rack Planer Drive

1911, engineering edition, on page 943: "Points in the Design of a Power Elevating Cross-rail." While nothing whatever can be urged against the principle advocated in the raising and lowering of the cross-rail by means of which the thrusts are regularly balanced, using right- and left-hand screws, the construction, however, due to the possibility of automatic balancing, could be considerably improved in that the coupling for maintaining alignment could be eliminated.

After the alignment of the cross-rail has been obtained, the shaft carrying the worms can be rotated and moved endwise until the worms bear equally on both wheels, this position of the shaft then being fixed by means of a collar on each side of the central bracket, care being taken to have sufficient clearance between the worms and their brackets, as shown in the drawing. This construction, however, might fail to appeal to those who place little reliance upon a long shaft of small diameter under compression—among whom may be numbered

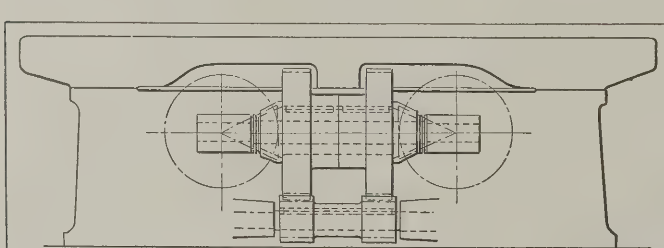


Fig. 8. Twin-screw Planer with Drive having Thrusts Equalized

the writer—although he is well aware that the shaft could be arranged to be in compression when lowering the slide.

This principle could be, and is, in fact, used advantageously under such conditions as shown in Fig. 6, in which the worms are solid with a tube that is free to move endwise along the driving shaft. This principle is the subject of several patents, but a little consideration will reveal the fact that this arrangement is by no means perfect. Similar examples could be cited and others will occur to all who are connected with machine designing, but enough has been said to illustrate the advisability of a little more consideration of a subject which is sometimes the sole basis of a satisfactory mechanism.

* * *

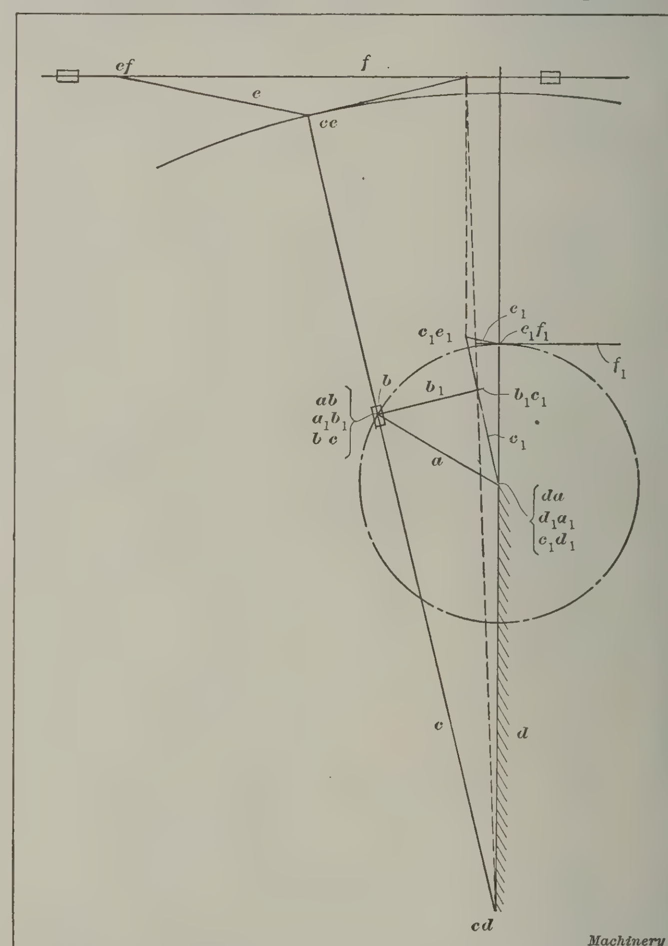
Saving a dollar in wages or in factory costs, and losing two in efficiency, is really not a money-making proposition, although lots of people seem to think it is.

THE PHOROGRAPH—A REJOINDER TO A CRITICISM

By FREDERICK H. MOODY*

In the criticism appearing in the February number, relative to the writer's article "The Phorograph," published last October, Mr. Sullivan is evidently laboring under a misapprehension of the possibilities of the phorograph system of analyzing mechanisms. Those who have used it are certain that if it had been given a fair trial on the drawing board, in comparison with the "instantaneous center" method, the criticisms offered would never have been made. The opinion of several users of the system is that there is no comparison in the simplification of the analytical work resulting from it.

In the original article, mention was made that the phorograph formed part of the instruction in the mechanical engineering course at the University of Toronto. In the early stages, the instantaneous center method is still employed, for it seems as if that method could not be improved upon from an instructional standpoint, as all the principles are presented



Quick-return Motion as analyzed by the Phorograph

in such a clear and logical manner that the relative movements of the parts are more readily understood by the student. However, this method has decided limitations in practice. For example, consider the difficulties of solving a problem by the instantaneous center method for a link attached at its ends to nearly parallel links; the instantaneous centers would be away off the board somewhere in space, making such a solution impracticable. It also requires a great deal more line drawing than the phorograph method. In the latter method, the area over which the operations are carried, so to speak, is kept within smaller compass. In consequence, while the fundamentals are taught by the instantaneous center method, that method is superseded by the phorograph in the later stages of the course.

Consider next some of the specific criticisms. The statement is made in the criticism that "the results are all correct except that in the quick-return motion illustrated, the velocity of the oscillating arm is represented by the line c_1d_1–c_1e_1, and it still remains to solve for the velocity of the ram in order to com-

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plete the solution." To call this an omission rather than an error would have been more to the point. As the writer's article was merely explanatory of the phorograph, rather than an effort to thoroughly analyze specific mechanisms, it was not deemed necessary to carry the solution to a conclusion. The accompanying illustration shows the same mechanism with the addition of the ram f, joined to its connecting link at ef. Points ce and c_1e_1 have the same motion. As a point in link e, the image e_1f_1 of the point ef, must be somewhere along a line through c_1e_1 parallel to e. Likewise, as a point in ram f, which has a horizontal motion, the image must be in d produced, as only such points have a horizontal motion. Hence, the image is at the intersection of these two lines at the point e_1f_1. The ram velocity at that particular instant is thus the length c_1d_1–e_1f_1. With regard to the original statement calling the quick-return mechanism a Whitworth, the writer stands corrected.

Exception is taken by the critic to the statement that the image found by the solution outlined, is not *on* the constantly-revolving link itself, *i. e.*, in the simple four-link mechanism, the point b_1c_1 is not on a. Near the bottom of the second column of the original article, there is the following statement: "The link a is considered as a large member of sufficient size to include the images in all positions." The line shown representing the link a is only a skeleton line connecting centers, the actual link comparing as regards size to the disk-crank commonly found on large stationary engines. This, of course is only a constructional assumption. The scaling methods suggested by Mr. Sullivan are good, representing natural developments in any method of graphical solution.

The line of reasoning outlined by the critic in his second to last paragraph, and in the first sentence of the last paragraph, emphasizes his unfamiliarity with the subject he is criticizing. The conditions mentioned, while from a casual inspection presenting much the same appearance, are fundamentally different, and require an intelligent knowledge of the application of the phorograph to obtain the correct solution, for it will be noticed in the first instanced case that the block is sliding on the stationary link on which all points are the same, while in the second case, the block is sliding on a movable link on which all points have different relative motions. If the solution originally outlined be carefully analyzed, it will be found to be perfectly correct and logical, embodying in a simple manner the phorograph principle.

Near the end of the criticism, there is this statement: "In Fig. 4 of Mr. Moody's article, it will be found difficult to project b_1c_1–c_1d_1 to a tangent from ce accurately." If the original article be correctly read, it will be found that no such move is attempted. The construction that was outlined may be seen by referring to the accompanying illustration, which in this particular is the same as the one referred to. Quoting from the original article: "The distance between b_1c_1 and c_1d_1 corresponds to the distance between bc and cd; so in order to obtain the full image of the link c, we must join cd and b_1c_1, producing this line to meet a tangent from the point ce. From this point of intersection, drop a perpendicular to cut a line through c_1d_1 and b_1c_1 produced, in the point c_1e_1. The line between c_1d_1 and c_1e_1 is the image c_1 of the link c, obtained by simple proportion, this method of obtaining it being simply a constructional means of so doing." The tangent at ce is at right-angles to c—a simple construction. No difficulty should be experienced through graphical errors in the other points, as the locating points are all a good distance apart, minimizing the possibility of error.

In conclusion, the writer wishes again to emphasize the fact that if the phorograph be first properly understood, its application will lead to simplification in the solution of problems commonly solved by the method of instantaneous centers.

* * *

A small tube and bulb containing mercury and so arranged that the rise of the mercury due to its temperature closes an electric circuit and rings a bell, may be effectively used as an alarm for hot bearings. The apparatus is attached directly to the bearing, and when several bearings are connected, an ordinary electric bell indicator can be used to show which bearing is hot.

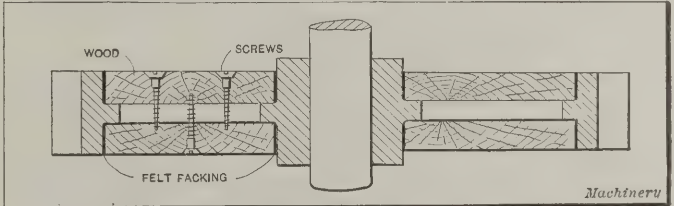
DATA ON ROPE-DRIVING

In a paper read by Mr. R. E. Hart before the Association of Engineers-in-Charge (England), the author stated in a concise manner the main requirements for a successful rope-drive. The main features of an ideal rope-drive are that the diameter of the pulleys shall not be less than thirty times the diameter of the rope used, and the driving and driven pulleys shall, if possible, be of equal diameter; but where this cannot be arranged, their ratios should not be greater than 5 to 1. The distance between the pulley faces should, if possible, be not less than 25 feet, and the drive should be horizontal, with the slack side of the rope on the top. The speed may be from 2000 feet to 4000 feet per minute. If the speed is too low the ropes are apt to slip, and if too high the action of centrifugal force affects the efficiency. There should be a distance of from 4 feet to 6 feet clearance under the ropes, and the ropes must, of course, not rub on anything. An allowance of 2 or 3 inches clearance between the bearing foundations and the sides of the pulleys must be made so as to leave room for the ropes to be put onto the pulley. The pulleys must also be accurately in line, well balanced, and the grooves exactly alike. All gears between the prime mover and the rope-drive should, if possible, be avoided; the ropes should be kept dry, properly lubricated, and not too tight. They should all be put on at one time, and the full load should be applied to them as soon as possible after they are in place. Carrier pulleys, rollers, and angular drives should be avoided as much as possible. Regarding the two types of rope generally used—namely, three-strand and four-strand—the former can be made more pliable than the latter, and it is also stronger; but these advantages are more than counterbalanced in the four-strand rope, because, compared with the three-strand, it stretches very much less, and it has a larger surface in contact with the pulley grooves; it is also capable of a stronger splice. A well-made four-strand rope is, moreover, nearly as strong as a three-strand, but it requires more skill to splice it. The general opinion now is that cotton is the best material to use for driving-ropes, and Egyptian cotton, though a little more expensive than American, is generally preferred.

* * *

A CURE FOR NOISY GEARING

A little kink for eliminating the noise of gearing is given in the *Practical Engineer* (London). Trouble was experienced from the excessive noise made by the gearing of a crane placed in such a position that the noise was highly objectionable. Several methods were tried to eliminate it. Grease and oils of all kinds were used with but temporary success. Finally the following method was tried: The annular space between



A Method for Eliminating the Noise in Crane Gearing

the hub and the rim was packed with wood. This wood butted tightly up against felt pads as shown in the engraving. The pieces of wood were secured to each other by ordinary wood screws, care being taken not to have the heads project. Good hardwood should be used, and rubber might be used to advantage instead of felt, except for exposed outdoor work. This method eliminated the objectionable noise from the gearing.

* * *

In a report by the secretary of the French Aero Club, relating to aviation in France during 1911, the following figures indicating the development of aeronautics are given. In that country alone 13,000 flights were made across country, and in total 1,625,000 miles was covered; the total time that aeroplanes remained in the air was 30,000 hours. The English Channel has been crossed thirty-seven times. The accident record has decreased, and during the year 62,500 miles was flown for every fatal accident.

INDUSTRIAL EFFICIENCY*

The word "efficiency" has been used somewhat to excess for some time past. A great many people are writing and talking of efficiency who do not seem to have a clear conception of what that word means. It is the special business of the engineer to study efficiency, but the fact that a man styles himself an "efficiency engineer" is not necessarily a recommendation. Recently a man prominent in the industrial field stated that it seemed as if everyone who had failed at everything else was advertising himself as an efficiency engineer. Now, it is possible to be entirely in sympathy with *bona fide* efforts to increase efficiency without being in sympathy with all this talk about efficiency by people who do not know what the engineer means by this word. A society has recently been formed for the promotion of national efficiency which has spent some time trying to find a definition of the word efficiency. This being the case, there is apt to be a great deal of misunderstanding on this subject.

What we want to do is not necessarily to change our methods of work, but to do our work thoroughly, and this cannot be done by merely talking. The author's work has sometimes been criticised because it is said to have been done too thoroughly—he goes too much into detail, etc. However, any work which has anything to do with engineering must be done thoroughly.

Possibilities for Greater Industrial Efficiency

With regard to industrial efficiency, it does not seem to be necessary to present a great many ideas, but it is necessary that the fundamental ideas and causes be clear. Some time ago, the financiers of this country thought that they had solved the industrial problem by the great economies made possible by consolidation into huge combinations. Large trusts were formed, and it was believed that by eliminating competition it would be possible to manufacture and sell a great deal cheaper than had been possible in the past. These expectations, however, do not seem to have materialized, because the continually increasing cost of living in this country seems to indicate that we need something more than able financiering to round out our theory of industrial economy. This has been a growing conviction on the part of students of our economic conditions for several years, but the most critical were not prepared for the admission, before the Interstate Commerce Commission, in November, 1910, by some of the most noted railroad financiers of the country, apparently seconded by Mr. Morgan himself, that they had done everything possible to reduce the expense of operating railroads, and that from now on the public must accustom itself to increasing freight rates. These financiers thus admitted that in the branch of industry in which the financial man is, perhaps, more nearly supreme than in any other, and in which competition has been practically eliminated, rising costs forced them to ask the public to bear a portion of their burden.

The student of economics asks if there is not something lacking in our system of industrial economy that makes such requests necessary, or even possible. If it is a fact that in any branch of industry every possible economy has been effected, and that in the future costs will be higher, we are confronted with a very serious condition, the far-reaching effect of which it is hard to foresee. It has been our boast in the past that with our labor-saving machinery and our improved methods, we had so reduced costs as to make the luxuries of today the necessities of tomorrow. If, in any branch of industry, we are forced to acknowledge that costs will in the future be higher, are we not pointing to the time when these necessities will again be luxuries?

The statement, which happily few believe to be a fact, that in any industry the minimum cost has been reached, and that hereafter costs must be higher, is such a serious one, and fraught with such serious consequences to our industries at large, that many of us feel like asking the great financiers who are backing this statement to speak for themselves only, for there are many engineers who not only do not agree with them, but who believe there are means of increasing efficiencies and reducing costs that the financier has as yet no conception of. These methods have been applied in isolated cases, and to a greater or less degree to a great variety of industries, and they have produced a better and a cheaper product; and the workers are better paid and better satisfied.

In making this statement, it is not intended to disparage the work of the financier, but to remind him that the civilization of to-day has not been built up solely by his efforts. In this process, the engineer and his able assistant, the skilled mechanic, have been even more integral factors than the financier, and until they hold up their hands and say the end is reached, that modern combination of engineer and mechanic, the mechanical engineer, respectfully asks that they withhold their cry of despair, and allow him to present what Mr. Brandeis calls his "Gospel of Hope."

Present Tendencies in the Development of Industries

Until within a few years, all mechanical knowledge was empirical. It had been gathered by cut-and-try methods through centuries, and was handed down with no written record. Yet, it is wonderful what great progress had been made. The master workman of a century ago was justly proud of his work and of the apprentices that went forth from his shop. With the perfection of the steam engine, which is the foundation on which our civilization is built, and which was the invention of a mechanic whose work has had a greater influence on the world than that of all the financiers that ever lived—with the perfection of the steam engine, the master workman obtained cheap power, and was enabled to increase the size of his shop. The increase in size of the workman's shop gradually developed the factory system of today, in which the foreman and workmen have no interest other than their daily wage, and where they are too often laid off without cause and without notice, to suit the plans of the owner. Is it surprising that, under these conditions, their interest in the training of apprentices should lag, and that the foremen and workmen should take but little trouble to train men who will shortly become their competitors?

The Use of Records

But this is not all. The owner too often puts all responsibility for the promotion of efficiency upon his superintendent and foremen, yet limits them in the wages they are allowed to pay, or the records they are allowed to keep. The records, as a rule, are just sufficient for him to make criticisms by, but not enough detailed to enable the foreman or superintendent to know where the inefficiencies are, or which of his men are most valuable to him. In one concern a man who had complete charge of all the cost records frankly avowed that he was not keeping these records for the benefit of the superintendent; he was simply keeping them so that he would know what was being done; he did not care anything about the superintendent. In other words, he was there to criticise, not to help. He had a lot of clerks to help him do the work. Now, he did not say so, but this is what was in his mind: Those records were to keep somebody from stealing something. In fact, there are too many records to keep somebody from stealing something, and not enough to help the man who has to do the work to do it right. The difficulty of keeping people from stealing things is not great; we do not have any difficulty in that. The records of cost and material should be kept to enable people to do the work right.

Having no individual record of his men, the financial head too often orders that all men of a certain class shall be paid the same wage, and for a long time it has been extremely difficult for the capable man to rise much above his fellows, no matter how much more, or better, work he did. What has been the result? The capable man, failing to rise above his class, has devoted his energy to raising his class, and by means of his union has forced his employer to raise the class wage, regardless of the work that was done. But let us not blame the financier or the owner too much for that. When he allowed his foreman or, perhaps, his superintendent to raise wages, he found that very often the brother-in-law, or the nephew, or somebody like that, got the high wages and the efficient man did not, and that has happened too often. When he found that out he said, "Well, we will pay machinists all the same wage." But when he made that statement, he put the strongest possible weapon into the hands of the men who wanted a

* Abstract of an address by Mr. H. L. Gantt before the American Society of Swedish Engineers, Brooklyn, N. Y., March 23, 1912.

union. They then said, "If we cannot get increased wages for the efficient man individually, we will get higher wages for our whole class," and they then banded together to get the union wages, and you cannot blame them.

The employer now complains bitterly; but has he not combined with his fellow to get all he could for what he had to sell? Are the workmen not playing the same game he has played, and playing it better? By forcing the capable man to remain in his class, the employer has held back the individual, but greatly strengthened the class, until today the employer with his combination on one side, and the workman with his union on the other, stand facing each other as two great armies, each trying to get the better of each other, by manoeuvering, if possible, but by fighting, if necessary. Without considering who is to blame for this condition, let us ask if there is any remedy.

The Causes of Industrial Unrest

While arbitration has certainly averted strikes, it has not settled anything, or diminished the desire of either party to oppose the other, and can only be considered as a temporary expedient. Collective bargaining has certainly increased the wages of the workman, but cannot alone offer a final solution of the labor problem, for wages cannot be increased indefinitely. The railroad presidents claim that the increase of wages obtained by this means necessitates increased freight rates, which, if granted, must necessarily, in a measure at least, increase the cost of living. Thus, neither arbitration nor collective bargaining, on which we have placed so much confidence in the past, gives promise of any permanent solution of our difficulties, and the time seems rapidly approaching when the friction of conflicting interests will seriously hamper our further development. We, therefore, naturally, ask why these interests conflict. The answer is plain; neither party has been willing to consider the interest of the other. The employer has too often insisted on paying the lowest wage, regardless of the service rendered, while the employe, through his union, has demanded the highest wage, regardless of what he gave in return.

I heard something in the last two or three days that quite astonished me. I have heard the same thing from three or four persons, but the last time I heard it from a rather unexpected source. I have heard a number of men make the statement recently that the financier—the capitalist—was getting too large a percentage of the earnings of the increase in wealth. A man told me that a millionaire friend of his in Wall Street had made that statement to him. Now, there is not any question that within the last fifteen years there has been a much greater percentage of the increased wealth harvested by those who already had wealth. The worker, the engineer, the producer, did not get the same proportion of it that he had gotten previously, and that is one of our troubles today. The very serious unrest in this country, England and the countries of Europe, is due to the fact that the workmen have made up their minds that they are going to get a larger percentage. Now, we have got to face that condition and find out what is the proper thing to do, and try to do it as soon as we can, and prevent what seems to be the impending conflict, which is due to the fact that both employer and employe have disregarded the great principle of equity, which is the foundation of all harmony.

In the commercial world it has long been recognized that transactions which do most to promote prosperity are those which are beneficial alike to buyer and seller. Does not the same law hold good in the industrial world in the purchase of labor? With the operation of such a law, the interests of the employer and employe become identical, and we have laid the foundation for their harmonious cooperation. Having done this, we are ready for the next step, namely, the promotion of efficiency in the utilization of human effort. The progress so far made in this direction has in many cases been in spite of a lack of equity in the relations between the employers and employes. Consider how much faster progress could be made if all men were assured of an equitable return for their efforts.

As a matter of fact, real efficiency is impossible without equity, for no man will continue to put forth his best efforts without a proper reward. The idea of doing work efficiently is comparatively new to people in general. It is only within very modern times that the best educated people have given any thought at all to the subject of physical work. The only serious subject requiring manual skill that was considered worthy of their attention was that of fighting, or war. As a matter of fact, it was Sir Henry Bessemer's search for a stronger metal with which to make field guns that gave us Bessemer steel. Until within a few generations, it has been very much more important to defend the wealth you had than to acquire more than sufficed for your daily needs. Hence the importance of defence. The time has come, however, when a man no longer has to defend his property with his skill or life, and can devote his energies to acquiring a surplus for himself and family. The great majority of men are ambitious to secure such a surplus, and are willing to work efficiently and industriously if they can be assured of an equitable compensation. The precise method of compensation is comparatively immaterial, provided efficiency is rewarded and not penalized, as is too often the case.

What has become of the ingenious Yankee, of whom we heard so much forty years ago? Are Yankees less ingenious today? Not at all; but our factory system of today too often fails to reward either ingenuity or efficiency, and these men have turned their attention to getting their advancement through their labor union. How much better it would be for the community at large if these men could devote their labors to the promotion of efficiency, and thus get their reward. A system of industrial economy based on industrial warfare is so evidently wrong that few will undertake to defend it, for it necessarily groups employers and employes into two hostile camps. Under such conditions, cooperation within each class is to be expected, and the combination of employers on the one hand and the formation of labor unions on the other are the only natural results.

Now, it seems that these segregations of interest which are practically mutual in their nature, are the cause of a great deal of our industrial difficulties. It is not out of place to dwell so long on the industrial unrest, because the great problem before us today, industrially, is the very problem outlined in the foregoing paragraphs. It is necessary to utilize the human efficiency in such a way that all the reward of the increased efficiency does not go to one class. The man who works wants his share, and it is, therefore, necessary to devise ways and means to give him a larger proportion of the results of his labor. Any scheme for the utilization of the energies of the community for the benefit of one class of people only, would develop an oligarchy which would ultimately be overturned by a revolution. England presents an example of the conditions that follow improper economic relations. It is felt in England that even though the coal strike be settled, they have not passed their worst danger. There is an industrial unrest there of which the coal strike is merely a symptom, and the whole country is stirred up a great deal more than is indicated by that strike.

The Task Idea

In trying to find a means for uniting the interests of the employer and employe, the task idea was developed; that is, the idea of putting before each workman a certain task to be performed in a given time, assuring him his regular wages if he could not perform the given task, and promising him a suitable reward in case he was able to perform the given task in the given time.* One of the important points relative to this method, frequently called "scientific management," is that the reward or bonus must be great enough so that the workman will feel that he is fully compensated for the extra exertion required to do the task. The bonus is usually from 20 to 50 per cent of the regular day rate. Task work does not necessarily mean more severe work, but it means more continuous work, but at the same time, work under more favorable conditions.

Another important point that should always be noted is that having set a task, the responsibility for its performance does

* The subject of task work and the methods employed were dealt with in the December, 1911, number of MACHINERY, in an abstract of a paper entitled, "Task Work—The Basis of Proper Management" read by Mr. H. L. Gantt before the National Machine Tool Builders' Association.

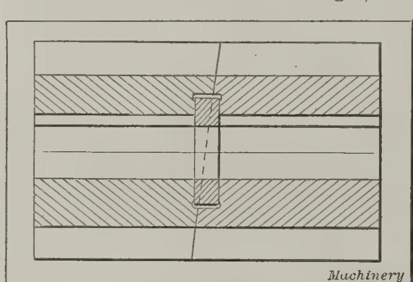
not rest upon the workman alone. Every case of lost bonus must be investigated by the management, and the reason determined. It seems very difficult to get people to grasp that idea and to go to that trouble. If a man does not make the bonus, they seem perfectly willing and content to let him lose it and pay little attention to him, but this is a great mistake and tends to discredit the system. The man is discouraged—it may not have been his fault; the machinery may have been out of order or the appliances he has been working with may have been unsuitable; the material may have been inferior in quality. All these reasons may have prevented him from performing his task. Frequently imperfections and defects in material bought have been found simply by investigating why the workman has been unable to perform his task; yet, that material may have passed inspection, but the imperfections have been such that they could not be located in that manner, although they would show up when the workman got ready to perform his work.

If, again, when some workman is unable to accomplish his task, a capable man, in whom he has confidence, tries to find out what the reason is, he will feel satisfied and try to earn his bonus the next day. Therefore, in the task system, next to the subject of the proper task comes the necessity of investigating every case of lost bonus and of determining the reason. If a proper scheme of management is devised, by which all the available knowledge is used to plan the work, and if the tasks are set in accordance, and the workman liberally compensated for the performance of the task, there is no question but that marked economy can be produced by this new method of management.

* * *

SIMPLE METHOD OF INTERLOCKING MILLING CUTTERS

The accompanying illustration shows a simple method for interlocking milling cutters. As indicated, the method consists simply in milling or planing off the ends of the two halves of the cutter at an angle, and providing recesses in the angular faces as indicated. The angular faces are not intended to bear tightly against each other, and, hence, do not need to be absolutely true, but the bearing is on a washer placed in the recess mentioned, as it is much easier to provide true bearing surfaces in that manner.



"Interlocking" Milling Cutters

The method was originated by the firm of J. A. Kühn of Frankfort a. M, Germany, and was recently described in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge.* It seems that this method has certain advantages over the ordinary interlocking methods on account of its simplicity. It may not be exactly right to call the method an interlocking one, as it is rather a case of "overlapping" milling cutters. The object in view, however, with both the interlocking method generally used in this country and the method shown in the accompanying illustration, is the same.

* * *

According to *Power*, Sir Hiram Maxim recently made a statement regarding the superiority of American workmen. It was his experience that in England, for example, while there are plenty of men to be hired at a salary of about 30 shillings ($7.50) per week, it was difficult to find a man at £5 ($25) a week for a position requiring care and intelligence. In Canada and in the United States he believed a positively different state of affairs to exist. In 1877 to 1880 he had charge of an electrical works in which a considerable number of young men were employed, and today nearly every one of them is in a high position. Young American mechanics are found studying algebra and geometry, while in England the penny novel takes the place of scientific books.

A SMALL MACHINE VISE

By CHESTER L. LUCAS*

Fig. 1 shows a small vise or clamping fixture which has proved valuable for holding miscellaneous pieces in the toolroom, as pins, screws, or small flat blocks, upon which some slight machining operation such as drilling or milling must be performed. This vise is made from a Starrett toolmaker's clamp and consists essentially of a jaw *A* which is held to the inside face of the end of the clamp by a fillister-head screw *B*. The other jaw *C* is a counterpart of the first, and, in making, the two are clamped together and holes drilled for the two dowel pins *D* which are more clearly shown in the line engraving, Fig. 2. These dowel pins are made a driving fit in the holes in the movable jaw of the vise and a sliding fit in the holes in the stationary jaw. Small spiral springs placed behind these pins insure that the jaws will open when the pressure on the movable jaw is released. Two vertical V-grooves are cut in the centers of the jaws so that round or square pieces may be rigidly held in an upright position. By cutting a socket in the back side of jaw *C*, to receive the clamping screw, the flat tip shown on the screw may be dispensed with, but it works very satisfactorily as shown. The object of using the two dowel pins, which, by the way, is the important feature of the fixture, is to provide a means for holding work perfectly true, the tendency otherwise being for the inner jaw to lift the work when pressure is applied behind the jaw. With this method of guiding the jaws, no trouble is encountered from this source. For holding the clamp and jaws on the table of the milling machine, two holes may be drilled through the center of the bottom part of the clamp. These holes are countersunk from the top, and flat-head screws may be passed through and into T-nuts or blocks in the T-slot of the milling machine table. When the clamp is wanted for regular work, the fillister-head screw *B* and the jaws are removed.

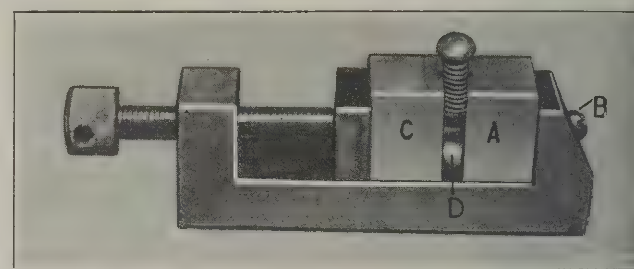


Fig. 1. Small Machine Vise, made by adding Jaws to a Toolmaker's Clamp

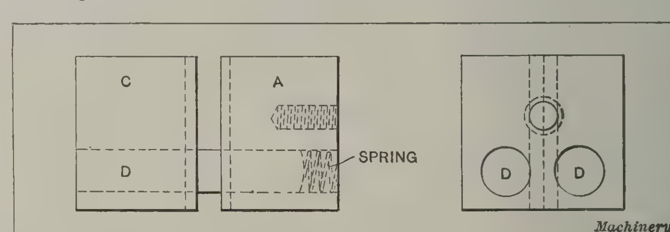


Fig. 2. Details of Jaws

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The Supreme Court of the United States will not reopen the Dick mimeograph constructive patent infringement case, and the decision of March 11 stands, affirming the right of the makers of a patented machine to prescribe what supplies shall be used with it. The gravity of the situation is generally recognized and Congress should immediately pass such legislation as is required to relieve an intolerable condition. Legislation is also required that will give inventors better protection and prevent the buying up and shelving of patents by corporations seeking to monopolize any line of manufacture and selling.

* * *

At the factory of the Wells Bros. Co., Greenfield, Mass., the 300 employes who do not go home to their lunches are supplied by the firm with hot coffee, which is provided free of charge.

* Associate Editor of MACHINERY.

UNUSUAL HOBBING OPERATION

The shaft seen to the left in Fig. 1 is used in the construction of the Amplex motor cars (built by the Simplex Motor Car Co.), for advancing the spark or varying the points of ignition in the engine cylinders. As the illustration shows, this shaft has four equally spaced spiral grooves which are

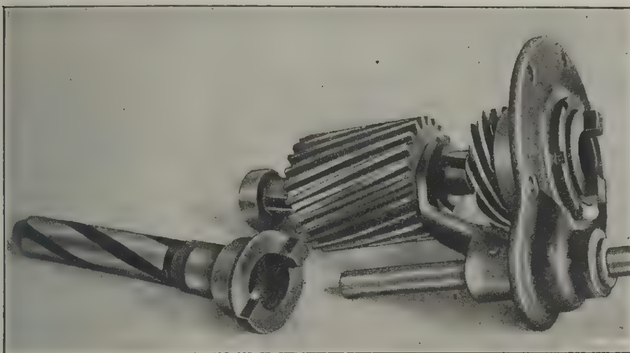


Fig. 1. Spark-advance Shaft having Helical Grooves which are cut by Hobbing—Shaft assembled with Shifting Fork and Timer Gear

¼ inch wide and ⅛ inch deep. When the shaft is assembled as shown in the view to the right, it is connected with the shifting fork and timer gear, and the right-hand end is equipped with a clutch which is coupled to the armature of the magneto. The four spiral grooves for giving this spark advance shaft a rotary movement, are cut by hobbing in a Lees-Bradner hobbing machine. The operation is both novel and interesting and presents some new features in the design and application of a hob.

The way the machine is arranged for this work is shown by the detail view, Fig. 2. The shaft is held at one end, by a draw-in collet inserted in the horizontal work-arbor, and the other end is supported by the regular tailstock center. The cutter-head containing the special hob is set at right angles to the axis of the work. This hob has four teeth, and the four helical grooves in the work are cut simultaneously. The four teeth are equally spaced and each tooth finishes its own groove. The hob and shaft rotate in unison, there being approximately one revolution of the cutter spindle for each revolution of the work spindle. In Fig. 2 is shown a shaft that has just been completed.

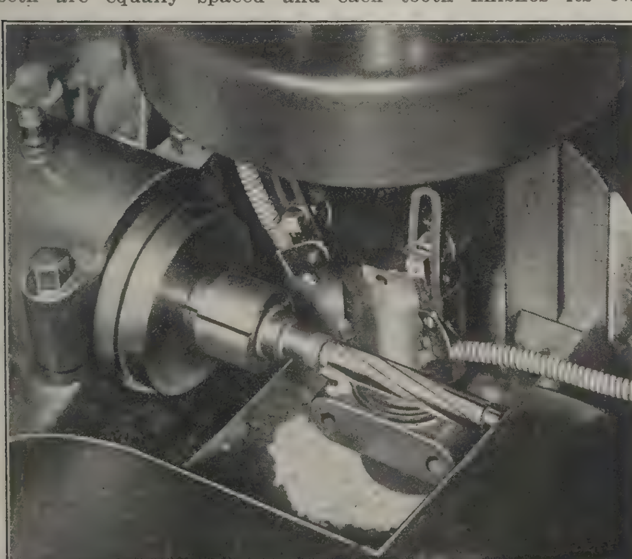


Fig. 2. Method of Hobbing Shaft in Lees-Bradner Hobbing Machine

The relative action of the work and hob, as well as the construction of the latter, are shown more clearly in the diagrammatical view, Fig. 3. As previously intimated, the hob is set in a perpendicular position, the four cutters and the axis of the work all being located in the same horizontal plane, as shown in the end view. The shaft to be splined rotates in the direction indicated by arrow w, and the hob, as shown by arrow h. In addition, the shaft has a longitudinal feeding movement to the left, and is geared to produce the angle of the helical groove that is required to be generated. The action of the hob and work is as follows: Cutter A cuts groove A_1 (see end view) and when the hob has rotated one-quarter revolution, thus bringing cutter B to the front, the work has also turned a corresponding amount (plus the rotation due to the geared movement), so that cutter B enters groove B_1. Another quarter turn brings cutter C into groove C_1 and in the same manner, tool D enters groove D_1. The geared movement previously referred to causes each cutter to follow a helical path on the work. When a cut is started at the end of the shaft, the gashes generated by the four cutters are at an angle owing to the rotation of the shaft, and in order to make the cutters follow the helical path thus started, as the work feeds longitudinally, it is necessary to have a correct movement; in other words, if a single gash were cut across the shaft, without the correct movement and with the cutter and work rotating uniformly, the angle of this gash would be zero, that is, the cut would be parallel to the axis.

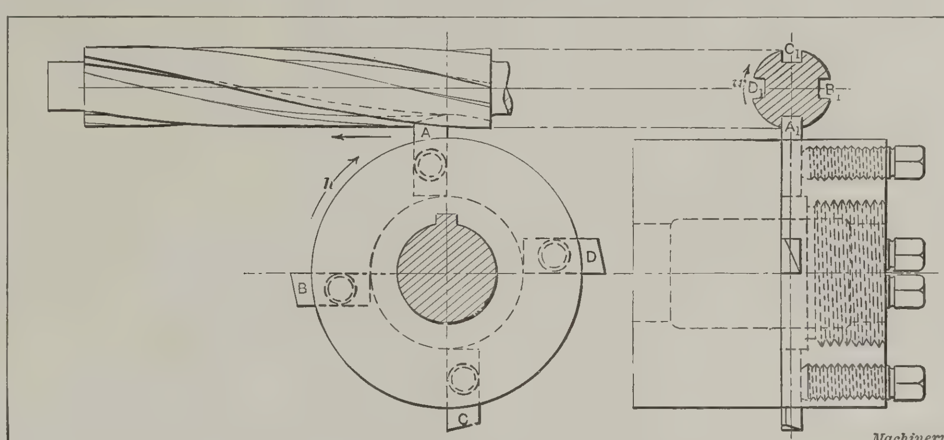


Fig. 3. Diagram showing Work and Four-toothed Hob used for Cutting the Helical Grooves

It will be seen that the hob is, practically, a four-tooth fly-cutter and each groove is milled to the proper depth by a single tool. The four grooves are finished in one passage of the work and the time required for hobbing a shaft is seven minutes. The length of the shaft is 7¾ inches, the diameter, ⅞ inch, and the material 0.020 carbon steel. The lead of the spiral is 11.568 inches and the spiral angle, 13 degrees 22 minutes. Each groove generated by this hob is similar to a

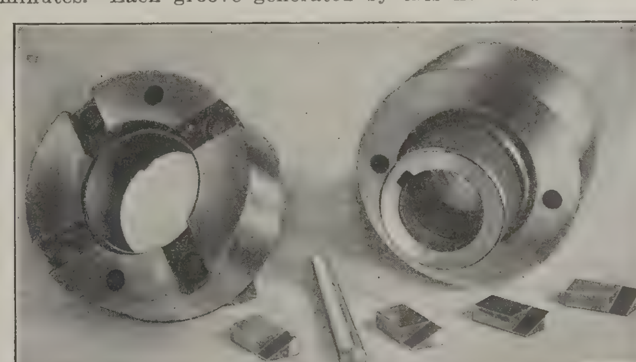


Fig. 4. The Component Parts of the Four-toothed Hob

helical keyway in that the sides on a cross-section taken at right-angles to the axis of the shaft are practically parallel to a radial line passing through the center of the groove. The groove differs in this respect from a theoretically correct thread groove, the sides of which are square on the longitudinal section.

The construction of the hob, as well as the form of the cutters, is shown in Fig. 4, which is a view of the hob before assembling. It consists of a body having a threaded hub over which is screwed the locking ring seen to the left. This ring

contains the tool slots which are ground to size and are accurately spaced equi-distant from each other, in order to secure uniform spacing of the spiral grooves on the shaft. It will be noted that these slots are offset so that the front or cutting face of each tool will be on a radial line. The cutters are made from high-speed steel and the cutter shanks are ground to fit the slots in the locking ring, so that they are interchangeable. The cutting edge is parallel to the axis of the hob and the under side of each cutter has a rather large clearance angle in order to clear the lower side of the groove. When a hob becomes dull, it is sharpened by simply grinding the tops of the teeth.

* * *

CUTTING SPEEDS AND FEEDS FOR TWIST DRILLS

The accompanying diagram originated by Messrs. E. G. Wrigley & Co., Ltd., of Birmingham, England, is published by the *Practical Engineer* (London). It gives speeds and feeds applicable to ordinary practice for high-speed and carbon steel twist drills, when drilling mild steel. As the values given

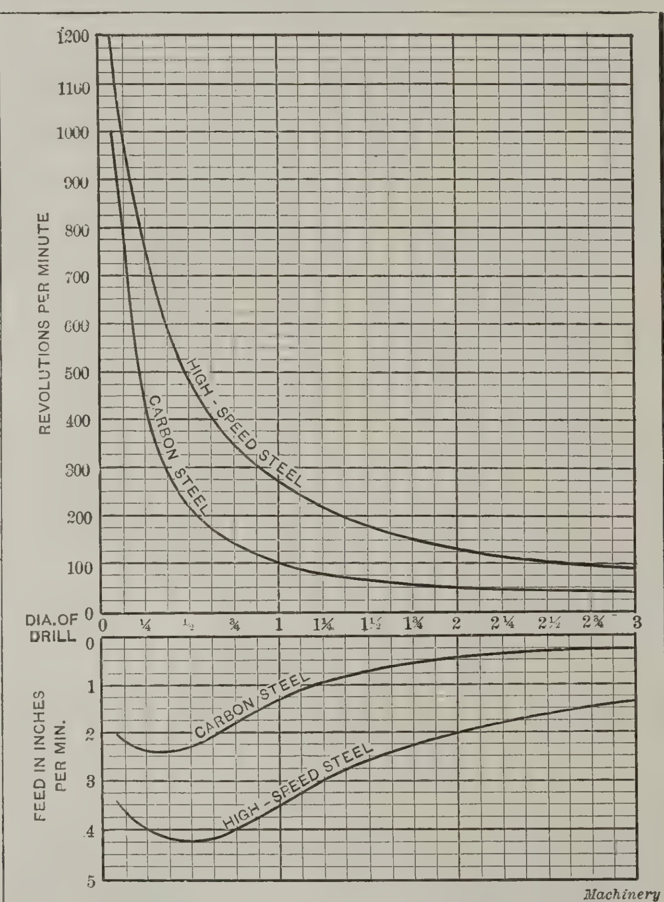


Diagram of Cutting Speeds and Feeds for Twist Drills

are not experimental or test rates, but intended for everyday practice, they may, of course, be exceeded under favorable conditions. It is, however, generally desirable to keep the cutting speed comparatively low, so as to avoid overheating of the drill point, and consequent waste of power.

* * *

The Kempsmith Milling Machine Co., Milwaukee, Wis., caseharden the gears used in the feed boxes of the Kempsmith milling machine. The gears are packed in cast-iron boxes about 12 inches long, 8 inches wide and 6 inches deep with a German casehardening compound. The boxes are provided with a cast-iron cover having a groove for sealing. The groove is filled with clay when the cover is applied and the cover is held in place by two keys engaging lugs at the ends. When the boxes are placed in the furnace they are turned upside down, the purpose being to hold the covers more securely and prevent the gases from escaping. The covers are provided with four lugs or feet at the corners, on which the box rests, and in the reversed position the cover is not likely to work out of shape. The practice works well.

EMPLOYER'S LIABILITY AND WORKMEN'S COMPENSATION*†

Under the common law and employers' liability statutes, employers are held for the consequences of accidents to employes, only provided the employer or his supervising agent is negligent; and not even in such case if the employe has been contributorily negligent or the injury has been due to the negligence of a fellow-servant or co-employe; or in case the hazard was of such a character that it belonged to the usual risks of the occupation which it is considered the employe assumes by accepting the employment. These three defenses are known respectively as the "contributory negligence," the "fellow-servant" and the "assumption of the risk" rules.

Purpose of Workmen's Compensation Acts

The purpose in workmen's compensation acts is to cause the employe, or his dependents in event of his death, to receive compensation on a reasonable basis, without regard to fault. The Court of Appeals of New York held a law making the employer directly liable for such compensation to be unconstitutional as "taking property without due process of law," that is, in this case without the employer having contracted to pay under such circumstances and without his having been guilty of a tort, that is, a wrong which would give the employe a right to recover.

The method of avoiding the effects of this decision, by offering to employers an opportunity to come under a workmen's compensation act voluntarily, it being made advantageous for them to do so, has taken several different forms, *viz.*:

In New York the option was given to employers to whom the compensation act did not directly apply, to avail themselves of its provisions by agreement with employes. There was no special inducement to do this, however, and the rates of premium to cover the risk under the compensation act were so much higher than rates charged by the same companies to cover the risk under the common law and the employers' liability act, that virtually no employers took advantage of the privilege.

In several states—California, Illinois, Kansas, New Hampshire, and Wisconsin—compensation acts have been passed of the usual type; that is, providing for payments of a definite percentage of the wages (usually with a minimum and a maximum for a certain number of weeks, and of a definite amount based upon the weeks in event of death) for all accidents occurring while at work, without regard to fault. Under these laws it was made optional with the employer either to come under the act or not to do so; but in case he did not do so, two of the usual defenses, *viz.*: the "fellow-servant" rule and the "assumption of the risk" rule were abrogated, and in most cases the "contributory negligence" applied only to reducing the damages. In some of these states, *viz.*, Illinois and Kansas, if the employes refuse to be under the compensation act, these defenses are available against him and his dependents.

In three states, Massachusetts, Ohio, and Michigan, laws have been passed offering to employers the election to insure their employes so as to provide compensation to them and their dependents for the consequences of all accidents occurring while at work, without regard to fault. In these states, also, in case the employer does not so elect, the defenses of the "fellow-servant" and "assumption of the risk" rules have been taken away, and also the defense of "contributory negligence," except that in Ohio and Michigan it may be used to reduce the amount of the verdict.

Respects in which Laws Differ

In other respects, the laws in regard to insurance in these three states differ very considerably. Thus in Ohio the insurance must be in a state insurance fund, charging premiums fixed by a board, with the privilege of assessing for more;

* Abstract of a paper read by Mr. Miles M. Dawson, attorney-at-law and consulting actuary, before the fourteenth annual convention of the National Metal Trades Association, New York City, April 11, 1912.

† For a list of articles on industrial accidents and employers' liability, which have previously been published in MACHINERY, see the note accompanying the article published in the November, 1911, number, entitled "The Prevention of Industrial Accidents."

and, of course, with the privilege of taking into account previous payments in fixing payments for future years. In Massachusetts, the insurance may either be in a mutual association of employers under state supervision or in any licensed mutual or stock insurance company. In Michigan the insurance may be in a state fund, in a licensed or stock insurance company, or by the employer himself satisfying the state board that by reason of his resources and the number of his employes, it will be safe to permit him to be the insurer.

In New Jersey, the law provides for the compensation of all accidents occurring while at work without regard to fault, and applies to all employers unless by written notice to a given state officer they elect to remain under the common law and the employers' liability act. If they do so elect, the "fellow servant" and "assumption of the risk" rules are abrogated, "the contributory negligence" rule can only be used to reduce the verdict, and the burden of proving "contributory negligence" is put upon the employer instead of, as previously, the burden resting upon the employe to prove that he was not contributorily negligent.

Under these different laws, elective in form, there have been very different results. Thus, as has been stated, exceedingly few employers accepted the provisions of the New York law.

In New Jersey, on the contrary, since it took an act upon the part of the employers to keep from going under the law, a very large proportion of them have accepted its provisions; but some large employers have refused to do so, among others the Standard Oil Company, while some other employers have obtained more advantageous rates by refusing to do so. There is no provision under the New Jersey law for mutual insurance. Consequently, a number of New Jersey employers have joined together to organize a stock company in which to insure themselves, hoping thereby to get lower rates.

In California, there is a good deal of complaint that the rates under the workmen's compensation act are materially higher than under the common law and employers' liability act, even with the defenses abrogated; and consequently many employers have not elected to come under the former. This complaint is also made in other states, notably Wisconsin, where, however, mutual companies are being organized under the encouragement of state authorities; and Ohio, where the stock insurance companies are making as strong a fight as possible to keep the business from going to the state insurance fund. The Michigan and Massachusetts acts have not yet taken effect.

In the state of Washington a compulsory insurance act took effect on October 1, 1911, requiring all employers to whom the act applies to insure with the state insurance fund. For the purpose of the fund they are divided into a good many classes, each of which must pay its own claims. In consequence, a few classes already show a deficit, but most of them show a surplus. The total premiums collected amount to about $500,000, the payments and reserves for sums payable hereafter on account of claims already arising amount to about 30 per cent, and expenses to about 15 per cent. The Washington law differs from the other laws in one other respect, *viz.*, that the amount payable in event of disability, *viz.*, from $20 to $35 per month during disability, and to the widow for herself and children, from $20 to $35 per month, varies not according to the wages, but according to the number of dependents.

In Montana, an act is in effect providing for certain rates of compensation to be paid to miners through the medium of compulsory insurance in a state fund, each employe, however, or the dependents of an employe killed by accident, having a right to elect, after the accident occurred, whether to accept this compensation or proceed under the common law or employers' liability law.

In the state of Nevada, notwithstanding the decision of the Court of Appeals of New York, an act was passed, requiring, subject to reduction of amount in event of "contributory negligence," all accidents occurring while at work which are not compensated under the common law or employers' liability law, to be compensated to the amount during disability of 60 per cent of the wages for a time until a maximum amount of $3000 is paid, and in event of death, a minimum of $2000 and a maximum of $3000.

Recommendations of Commissions

In addition to these plans, which have already gone into effect, bills have been introduced upon the recommendation of commissions, as follows:

In Congress a bill has been introduced to do away with liability at common law and under the employers' liability act, and to substitute a workmen's compensation act, calling for compensation for all accidents occurring while at work, without regard to fault. This will apply to railways only.

In Maryland a bill has been introduced by the commission which also seeks to repeal the common law, and employers' liability act, and to hold employers directly liable for compensation for all accidents occurring while at work, without regard to fault. This bill also makes provision for transferring the liability to mutual or stock insurance companies, and provides that if this is not done, all employers with less than $150,000 resources over and above all liabilities, or employing fewer than 1000 men, shall be required to insure in a state insurance fund. Provision is made for the compulsory insurance feature to apply to all employers in case the portion of the law, holding the employer directly liable, should be declared unconstitutional.

During the past year, the question of the constitutionality of some of these acts has been before the courts and decisions have been rendered as follows: In Massachusetts, the matter was submitted by the legislature before the act was passed, to the Supreme Judicial Court—which may be done in that state—and the proposed act was held to be constitutional. In Ohio the elective insurance act has been before the Supreme Court and has been held to be constitutional. In Washington, the compulsory state insurance act has been before the Supreme Court and has been held constitutional. In Wisconsin, the elective workmen's compensation act has been passed upon by the Supreme Court, and has also been held to be constitutional. In New Jersey, the lower court has passed upon the law and found it to be constitutional.

In Montana, the state insurance act, applying to coal miners, was upheld as constitutional in all respects but one, *viz.*, that it was discriminatory, and in violation of the rights of employers as depriving them of property without due process of law, in that, although an employer might have paid his premiums, his employes and their dependents might, at their own free will, sue him at common law and under the employers' liability act, and hold him responsible so that he would not receive any benefit from the insurance for which he had paid.

The benefits provided under these various acts vary as follows: Temporary disability, from 50 per cent of the weekly earnings, with a $4 per week minimum, and $10 per week maximum in Massachusetts, to 66 2/3 per cent of the weekly wages in Ohio, with a $5 minimum and $12 maximum. Six of the states fixed the percentage at 50 per cent, one at 60 per cent, two at 65 per cent and one at 66 2/3 per cent. The term of payment varies from 300 weeks in New Hampshire and New Jersey to the entire period of disability in Illinois (where the amount payable after eight years, however, is reduced), Ohio and Washington. The maximum amounts of total disability compensation when named in the laws, range in the neighborhood of $3000, except where compensation is payable throughout the disability, when no such limit applies.

In two states, New Jersey and Wisconsin, the employer, if under the workmen's compensation act, has no other liability. In other states his additional liability ranges from "intentional violation of a safety law" in Illinois, or "serious or willful misconduct of employer or his superintendent" in Massachusetts, to liability in all cases where the "employer is liable for damages under other liability laws" in Nevada. The employe is excluded from right to benefit on account of willful misconduct only in California, Illinois, Kansas (where it is limited to certain acts of misconduct), Massachusetts, Ohio and Wisconsin. In New Hampshire, intoxication also excludes, and in Nevada, wherever "contributory negligence" was solely responsible for the accident, that is, where it was wholly the fault of the employe injured.

In one state, Washington, where there is compulsory state

insurance, compensation is payable from the first day. In California, Illinois and Ohio the first week is excluded and in Wisconsin also unless disability lasts longer than four weeks, in which case the first week is also included. In Kansas, Massachusetts, New Hampshire and New Jersey, the first two weeks are excluded and in Nevada the first ten days, unless the disability last longer, in which case apparently the first ten days are also paid for. In all the states excepting New Hampshire, where to recover under the act calls for an action in equity (not requiring a jury) instead of an action at law, and New Jersey, where the court is directed to decide the matter "in a summary manner," an accident board is set up or a provision is made for arbitrators to make an award before the matter can be taken to the courts.

In the following states commissions have been appointed and are now at work upon bills to be introduced in the next legislatures, *viz.* Pennsylvania, Colorado, North Dakota, Missouri, Iowa, West Virginia, Nebraska, Connecticut, Rhode Island and Delaware. It is said that the Missouri commission has abandoned the task, no appropriation having been made. In Texas the governor was asked to appoint a commission to report to the legislature at its then session, but no appointment was made.

In Canada, all the provinces have now adopted workmen's compensation acts excepting New Brunswick and Ontario. In New Brunswick the employers' liability act was much extended in 1909 by modifying the defenses. The Canadian workmen's compensation acts hold the employer directly liable. In Ontario, the Chief Justice of the High Court has been appointed a sole commissioner to report a bill. The Canadian Association of Manufacturers and the representatives of workmen's associations have been before the commission and have joined in recommending a system of compulsory mutual insurance, through funds covering all sickness as well as accident during the early weeks, to which both employers and employes would contribute, and a fund covering death and disabilities beyond the first few weeks, due to occupation accidents only, to which employers will alone contribute. The Commissioner has just handed in a preliminary report, expressing favor for this plan.

European Laws Changed

In Switzerland, where for more than ten years past employers have been held directly liable for negligence, with the defenses abrogated, a compulsory insurance act has been passed, submitted to the people at a referendum and adopted by them. It provides for insurance against sickness as well as accident, covering the first few weeks, to which both employers and employes contribute, and for insurance covering death or disability beyond the first few weeks, due to occupation accident, to which employers only contribute. The state, however, makes contributions either directly or by meeting certain expenses in connection with each of these.

In Great Britain, no change has been made in the workmen's compensation act, which holds employers directly liable for the consequences of all accidents and some occupation diseases "arising out of and in the course of the employment;" but the principle of compulsory mutual insurance has been accepted with much favor, practically all the representatives in both houses of both the political parties voting for it, in the form of two laws, one requiring workmen to be insured against sickness and invalidity, and the other requiring them to be insured against unemployment. Toward these mutual insurances, the employers and employes both contribute, and the state also makes a contribution.

The main lines of the German system are as follows:

That accidents (during the early weeks of disability) should be compensated as well as all sickness, through sickness insurance societies to which employers and employes both contribute, and subject to their joint management.

That disabilities beyond the first thirteen weeks and all deaths due to accident while at work should be compensated through mutual associations of employers, to which employers only contribute and which are managed by them.

That as to both of these classes of associations, no more should be collected than is necessary to meet the requirements for the payments currently falling due, plus what is required for expenses, and a moderate amount in addition for the purpose of establishing a reserve, not intended to take care of future payments on account of claims already approved, but only to be called upon in event of a great and widespread disturbance of industry, so that many employes would be out of work and the payrolls of the employers low, in which case, if there were no such provision, obviously the rate of assessment might be very high.

The superiority of this system in economy of management, general efficiency, special efficiency in regard to prevention and the all-important respect of putting upon industry the smallest possible burden currently, was strongly supported both by representatives of employers and of employes, as well as by practically all who, from official or private viewpoint, have carefully investigated the matter.

It is proper here to say that none of the insurance plans so far introduced in the United States are of the same character. Thus the plan adopted in Washington, while dividing the employers into classes, leaves the management in the hands of a state commission. Moreover, the aim is to collect a sufficient amount to set up capitalized values for death claims and presumably, though not avowedly, also to hold sufficient reserves for payments thereafter to be made upon other claims. Certainly there is no indication that an "assessment" system, calling for no more money than is actually required for current payments, was in any sense intended.

The same is also true of the state insurance plan in Ohio. The law there does not require in definite terms the setting up of capitalized values, but from the nature of the system adopted, this is strongly implied. In Massachusetts, a distinct provision is made in the law for setting up capitalized value reserves and charging the state insurance fund with its unearned premium reserves, in the same general manner as would be applied to a private insurance company, whether mutual or stock. Under the state insurance laws of Montana and Maryland relating to coal miners, no special provision was made.

All of these appear to look for the plan to go into full effect from the outset, that is, the full burden falling upon industry from the beginning. Under the German plan, on the contrary, the idea was that the cost would be small at the outset, because only persons who were injured that year would be drawing money. It would be larger the second year, because then persons who were injured the first year and persons who were injured the second year would be drawing money, and in this way the cost would continue to increase for several years until an equilibrium was struck, which, if the risk remain precisely the same from year to year, would not be until from 25 to 50 years had passed.

This condition might be—and in many cases has been—very greatly modified by the introduction of excellent prevention, offsetting this natural increase by reducing the number of claims. A good illustration in steam railways, which started the first year at a cost of 0.39 per cent of the payroll, was 0.79 per cent the second year, 1.26 per cent the third year, and so on, reaching 1.80 per cent in the eighth year. This resulted in prevention so remarkable in character that there was an actual recession of the rate for several years, going down to as little as 1.26 per cent, notwithstanding that they were paying for persons who had been injured (and for the widows of those who had died) in every one of the twelve years previous. Since then, the rate has again increased, but for six or eight years past it has been about 1.80 per cent of the pay-roll—not higher than fifteen years before.

* * *

Calbraith P. Rodgers, the noted coast-to-coast aviator, was killed April 3 by a fall from his aeroplane, resulting from the attempt to perform a difficult spectacular evolution in the air over the beach at Los Angeles, Cal. Rodgers started for the Pacific Coast, September 17, 1911, from Sheepshead Bay, Long Island, and covered 3220 miles after many mishaps and accidents, but too late to win the $50,000 prize offered for the performance of the feat. Rodgers is the seventeenth victim of aviation this year, and the one-hundred and twenty-sixth since Lieut. Thomas E. Selfridge, the first, was killed near Washington, D. C., September 17, 1908.

DIES FOR RAISED LETTER NAME PLATES*

By CHESTER L. LUCAS†

Aside from the manufacture of the Sweetland chuck, for which the Hoggson & Pettis Mfg. Co., New Haven, Conn., is well-known, there is another line of work carried on in its factory that is of interest on account of the high degree of manual skill required to produce it. This work is the cutting of artistic steel stamps, a few impressions of which are shown in Fig. 1, and the making of dies for raised letter name plates, such as are shown in Fig. 3.

While it is the purpose of this article to treat especially of the methods used in the making of the name-plate dies, some

Fig. 1. Impressions of Artistic Stamps

of the stamp impressions shown are of considerable interest. It is difficult to illustrate such work to advantage. Of the impressions shown in Fig. 1, all of the script lettering is very difficult to cut in steel, for, of course, it must be cut "reverse," still maintaining its style. Monograms like some of those

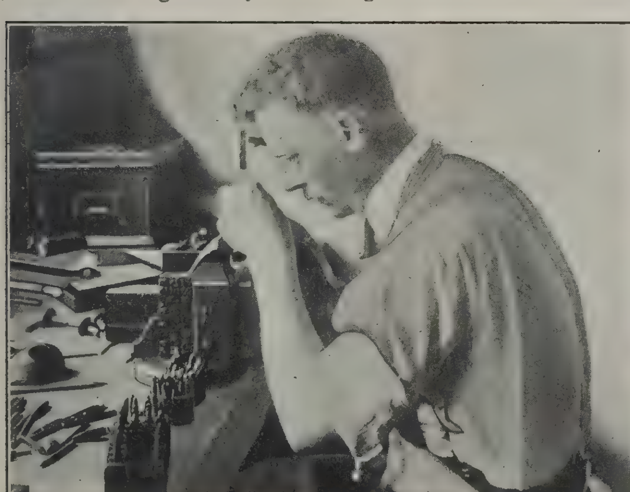


Fig. 2. Making Steel Stamps

shown present difficulties of their own, for the various lines must cross and re-cross without breaks or deflections from their true directions. The "Old English" style of lettering is also difficult to produce in steel, and when the letters of a stamp are minute, as well as of difficult shape, like the small "Tannewitz" stamp near the center of Fig. 1, the troubles of the workman are not imaginary. The illustrations of the stamp impressions shown are considerably larger than the originals. Fig. 2 shows a workman engaged in making one of these stamps.

The name plates or brass labels, as they are sometimes

Fig. 3. Specimens of Raised Letter Name Plates and Labels

called, are usually made of very thin brass or aluminum, approximately 0.005 inch thick. They are used as name plates for light machinery, such as graphophones, sewing-machines etc., and for fire extinguishers, tanks, etc., to which they may be soldered. Still another use is in connection with the mold-

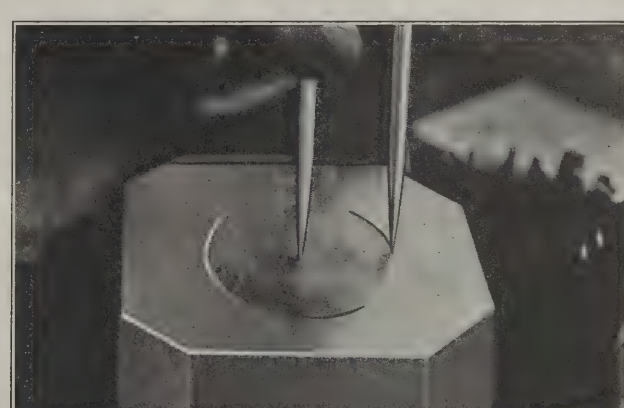


Fig. 4. Using the Cutting Dividers

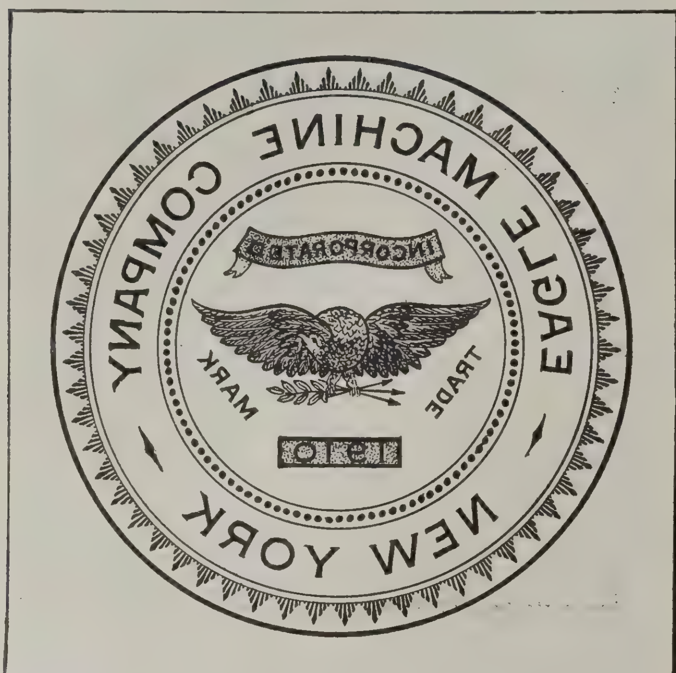
ing of rubber articles such as hot water bottles, when it is desirable to have lettering appear on the finished surfaces. As in other classes of die-work, the tools used for embossing these name plates comprise two parts, *viz.*: the die and the "force." In the majority of cases machine steel is employed for the dies, tool steel being used only for those dies which have a great deal of small detail or from which labels of thick material are to be made. If the die has been made from machine steel, the forcer, or force, as it is usually called, is made from soft white metal, but if the requirements of the work call for a hardened die, the force should be of brass or steel. Usually, however, machine steel dies and white metal forces is the combination employed. If the labels are to be used in mold-making, the reverse side of the plate must be

* For articles on kindred subjects, see MACHINERY, April, 1912, "Brass Engraving by Machinery"; January, 1912, "Steel Letter Stamping Dies"; and June, 1909, "Coin and Medal Dies."
† Associate Editor of MACHINERY.

just as good as the front side, for the letters are formed on the rubber by means of its contact with the reverse side of the label.

Making the Die

The steel block from which the die is made is first faced off carefully and its surface coppered or blued, so that the laying-out lines may be easily seen. Let us assume that we are two stamping units is to provide a means for properly spacing the impressions. After the first two impressions, but one impression is stamped at each blow, half of the punch being used as a spacer, after the manner of a spacing center-punch. As soon as the entire border of beads has been stamped in, a single beading tool is used to go over the impressions, leaving each bead perfectly shaped. After each of these two stamping



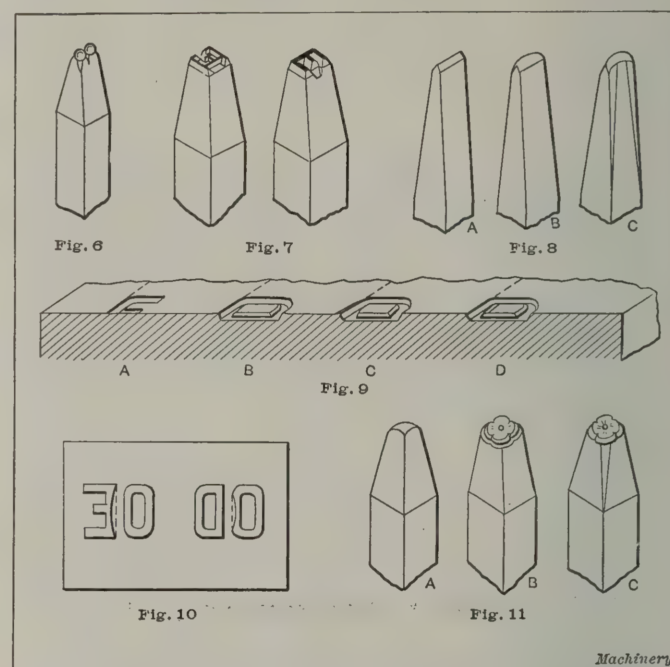


Fig. 5. The Face of a Name-plate Die. Fig. 6. A Double-bead Punch. Fig. 7. Comparison between a Die Letter and an Ordinary Stamping Letter. Fig. 8. Three Types of Lining Tools. Fig. 9. Illustrating Points in Stamping. Fig. 10. How Close Stamping displaces the Steel. Fig. 11. Three Steps in Making a Punch

to make a die for the design shown in Fig. 5. The reason for selecting this particular design is that it involves a number of the different methods of die-sinking that are not often employed on one design.

After the main lines of the design have been laid out on the die, faint circles are scribed with cutting dividers to guide the die-sinker in stamping the fancy border near the outer edge and the bead border between the lettering and the design. operations, the burr raised by stamping is faced off with a file.

Often the design is surrounded with a plain line-border. If the design is circular, such a border may be cut with the cutting dividers, but if rectangular or of other than circular shape it must be punched in with a lining tool or a straight-line punch in the manner shown in Fig. 12, the punch being moved ahead half its length after each imprint. Should it be necessary to have a wide flat border, it is best to chip out

Fig. 12. Stamping the Lines of a Design

Fig. 13. Making a Punch from a Master Block

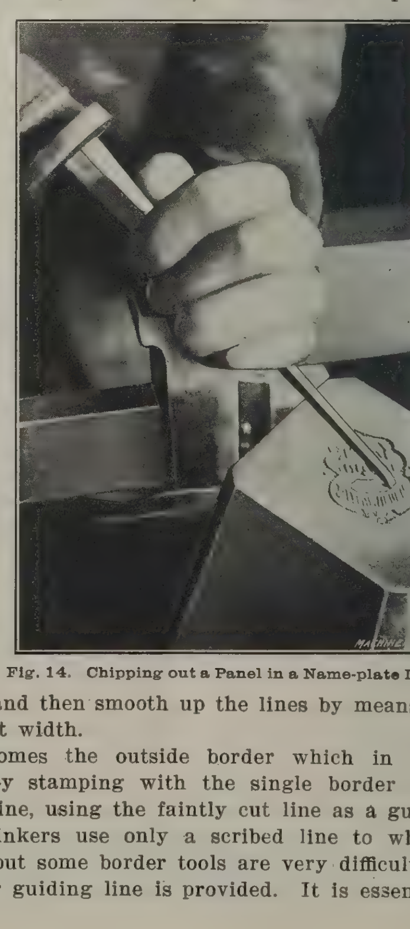


Fig. 14. Chipping out a Panel in a Name-plate Die

This operation is shown in Fig. 4. The cutting dividers are merely an old pair of dividers, one leg of which has been ground with a cutting lip. This tool is very convenient for cutting grooves. The plain line borders and other circles are not cut at this time.

In stamping a bead border like the inner border shown, a double punch is made use of. One of these double punches is illustrated in Fig. 6. The object in making the punch with most of the metal, and then smooth up the lines by means of a punch of the right width.

Next in order comes the outside border which in this instance is made by stamping with the single border tool around the border line, using the faintly cut line as a guide. A good many die-sinkers use only a scribed line to which to stamp a border, but some border tools are very difficult to use, unless a deeper guiding line is provided. It is essential

that the border shall "come out even," that is, that it shall be spaced uniformly at every part of the circle. It is customary to employ double punches only for bead or rope borders, because the units of other borders are so much larger that trouble would arise in spacing the last few units. Nine out of every ten borders of name plates are, however, either plain, beaded, or of rope pattern.

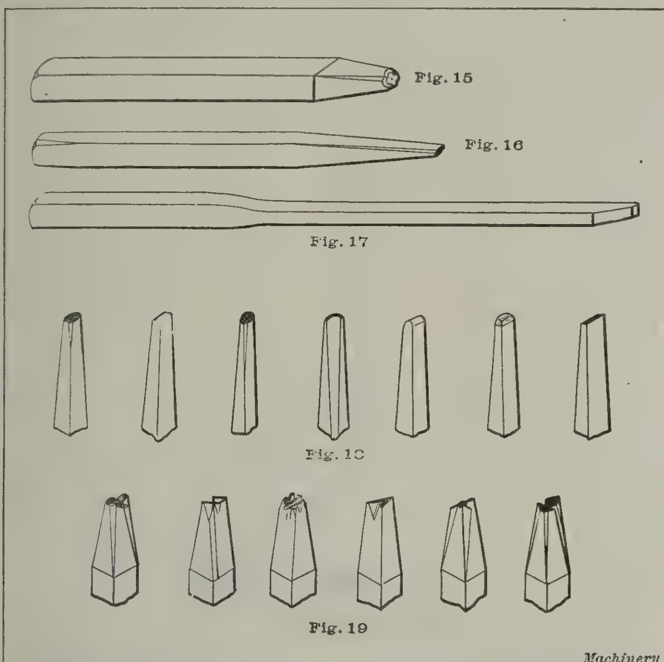


Fig. 15. Proportions of a Punch 3 1/2 inches Long. Fig. 16. Proportions of a Chasing Tool 4 inches Long. Fig. 17. Proportions of a Chisel 6 inches Long. Fig. 18. Various Styles of Chasing Tools. Fig. 19. Various Border Tools

Before stamping the last few units of a fancy border, the die-sinker usually measures the remaining space with his dividers and compares it with a section already stamped, to see if it will be necessary to space the remaining units differently in order to make them "come out even." Sometimes the last few units must be spaced either closer or farther apart

Fig. 20. Taking a Wax Impression to get the Effect of the Finished Work

Fig. 21. Working on the Design—Using a Chasing Tool

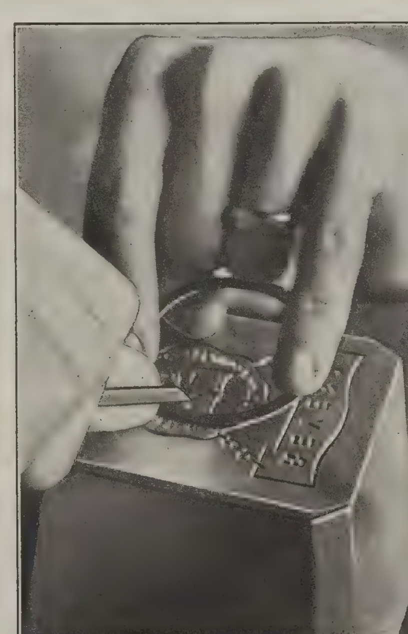


Fig. 22. Working on the Design—Using an Engraving Tool

to avoid having half a unit left over. This half-unit of blank space would be very noticeable if not distributed over several units. Referring to the design, Fig. 5, it will be noticed that the border has been spaced very evenly except between the points directly over the "L" in "Eagle," and the "H" in "Machine." Within this short distance the six units have been slightly spread to make up for the half unit that would otherwise have been left over. This slight discrepancy in spacing is not noticed by those not familiar with die-making. Samples of border tools are shown in Fig. 19.

Stamping in the Letters

The borders being successfully stamped in, attention is directed to the lettering. From the center point of the design, if circular, limiting circles for the letters are scribed. While great care is taken to make the limiting circles for the letters of correct dimensions, the letters themselves are only roughly spaced. If the lettering is different from any that the die-sinker has previously stamped, it is well to first stamp the letters lightly upon cardboard, although a very common way is to merely count the letters and spaces, and start the stamping with the central letter upon the central dividing line of the design, which in Fig. 5 runs through the "I" in "Machine."

In stamping in these letters, the eye is almost entirely depended upon for getting their positions right. The faces of the letters on the stamps are made different from ordinary stamping letters, in that they are not reversed and also that they are not sharp-faced, but have narrow flat faces. A comparison between steel stamping letters and die letters is shown in Fig. 7. In stamping, the stamp is held with the bottom half of the letter even with the line, being tipped slightly toward the stamper. After striking the stamp lightly in this position and having found it to be in the proper location relative to the line as illustrated at *A*, Fig. 9, it is refitted into the lightly stamped impression, tipped up straight and the other half of the letter struck in, the result appearing as at *B*, Fig. 9. If, however, the first impression is not in line or is crooked, it may be corrected by the stamp being moved slightly in the proper direction. Two of these corrected impressions appear at *C* and *D*, Fig. 9. The lighter that the preliminary stamping is done, the better. After all of the letters have been lightly stamped, they should all be driven in to a uniform depth of 1/64th inch, taking care to have all parts of the lettering of even depth.

All stamping of any kind displaces the stock immediately surrounding the letter stamped. Some of the metal rises above the surface of the die in the form of a burr, and some is crowded away at the sides, often distorting a letter that has been previously stamped. Especially is this true when the lettering is closely spaced. To overcome this trouble, it is best, after stamping a letter, to go back to the preceding letter and re-stamp it lightly. This will throw the displaced steel upward in a burr. If, however, the letters are very closely spaced, this re-stamping will simply push the metal back into the new impression, and to avoid this, the displaced steel should be cut away, as indicated by the dotted lines in Fig. 10, after which a tap with the stamp will finish the work.

As already mentioned, those lines which are not circular arcs must be stamped or traced with a straight-line punch or a lining tool. Lining tools are of three distinct varieties, shown in Fig. 8. *A* is for straight lines; *B*, for slightly curved lines; and *C*, for very sharp curves. If the faces of these lines must

be flat or curved, special lining tools may be made to suit the work. The panels in the central part of the design shown in Fig. 5, may be outlined and the two dashes at the ends of "New York" may also be stamped. Other parts like the arrows and the leaves may also be easily stamped by making one or two special punches, thus saving considerable time that would otherwise be spent in hand-engraving this part of the work.

Making Special Stamping Tools

Special stamping tools should be made of Jessop's steel, if possible, using square bar stock for all standard punches except those that are very large. Generally speaking, these stamping tools, exclusive of those for the die letters, may be divided into two classes: punches and chasing tools. The general proportions of these tools are shown in Figs. 15 and 16, and although every die-sinker has his own ideas, those shown will be found to be of about the average type. Moreover, while every die-sinker would like to have his tools of standard lengths, they are constantly subject to breakage, and if redressed are consequently shorter, until, if care is not taken, chasing tools and punches will be of "all lengths." The chisel in Fig. 17 is six inches long.

Chasing tools, a box of which is shown in Fig. 12, should be made about four inches long. They should be of various shapes, a few of which are shown in Fig. 18, and there should be several sizes of each shape. The sides are filed with very little bevel as they are made to do very little work, their chief use being in smoothing up the design in the die. These tools should be hardened and drawn to a dark straw color.

Punches should be made about three and one-half inches long and of much heavier steel than chasing tools, as they have to be driven into the die. While many designs must be originated, a good deal of time can be saved by using a master block like that shown in Fig. 13, to aid in making special tools. This block is hardened. A blank punch is filed so as to have its face

Fig. 23. Lettering a Mold for Rubber Heels

slightly convex as shown at *A* in Fig. 11; it is then driven into the proper impression which will form the design on the end, leaving it in the condition shown at *B*; and lastly, the steel around the design is filed away to the proper bevel and the punch, as shown at *C*, is ready to be hardened. After hardening, the temper should be drawn to a medium straw color, unless the design is deep, when it may be drawn still more.

Fig. 20 shows a die-sinker taking a wax impression of his work, in order to see how it is going to look on the finished name plate. The best and cheapest way to obtain this wax is to purchase a pound cake for thirty cents; a pound will last for years. Receipts for making this impression wax are given in MACHINERY'S "Shop Receipts and Formulas." The wax is used on the end of a short block of wood. The die-sinker cleans out the die, breathes on its face to form a film of moisture, and then drives the wax into the impression. Upon gently removing the block, the wax is removed and every detail of the work may be plainly seen. While stamping in the lettering, impressions are frequently taken to indicate those letters which are uneven in depth or crooked, so that they may be corrected.

After the stamping of the letters, borders and other parts has been finished, the next step is to cut any rings or grooves like those shown in the design in Fig. 5. If there are a large number of these rings, or if they are deep, it is best to set up the block in the lathe and turn them, but for dies that have only two or three such rings, they can be cut more easily with the cutting dividers. The reason for leaving the cutting of these rings until after the stamping has been finished, is to avoid distorting them by displacing the metal during the stamping.

Engraving the Design

The most difficult part of the making of a die of this character consists in engraving those parts that cannot be stamped. In the design shown in Fig. 5, this part is, of course, the eagle. The first step consists in facing off the surface of the steel very smoothly, after which the design is very carefully drawn. The outlines are then cut lightly with an engraving tool, and if the design is deep, chisels are employed for cutting out the bulk of the steel, as shown in Fig. 14. The general proportions of these chisels are shown in Fig. 17, and the shapes

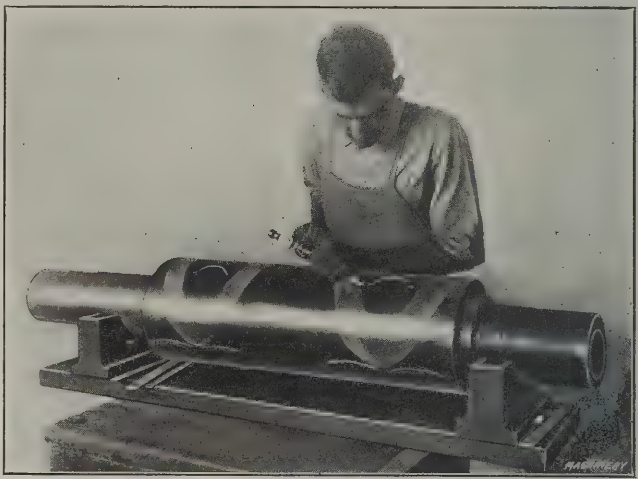


Fig. 24. Cutting the Pattern on a Calender Roll

most often used are the flat and half-round. The final finishing of the details is accomplished by means of chasing tools used as shown in Fig. 21, and by engraving tools as shown in Fig. 22.

Engraving tools of various shapes and sizes are employed for the different angles and curves of the design. The ring used in Fig. 22 protects the design from the under side of the tool, and is especially useful in sinking deep dies. Frequent wax impressions are taken to aid the die-sinker in perfecting the details of the design.

The very last step in the work consists in "matting" such places as the panels shown in the design in Fig. 5. Matting tools are varieties of chasing tools used in pebbling or matting parts of the die in order to form a contrast with the smooth parts. After matting, no filing can be done on the surface of the die, as this would injure the delicate finish left by the matting tools.

Specimen labels may be struck from the die before the top die, or force, has been made, by placing the die under a small drop press, or a screw press, laying the blank name plate upon the die, and placing either a piece of sheet lead, 1/8 inch thick, or a piece of leather belting, over it. By striking several blows upon this soft backing a good specimen of the work that will be produced by the die will be obtained.

Should the die require hardening, it should be done in the manner described in the article "Coin and Medal Dies" that appeared in MACHINERY for June, 1909.

Making the White Metal Force

While the most difficult part of the die is the engraving of the lower block, it is just as essential that the force which is used be fitted properly and that it fill the design in every detail, so that it will be possible to strike up labels or name plates that will be perfect on the reverse side as well as on the face side. This is important on dies of this character, because the metal from which the labels are made is very thin and will not be forced into the design unless it is backed up in every detail by the force.

White-metal forces are made by first fitting the face of the die with a temporary wall, usually made of pasteboard. Into this enclosure molten white metal is poured until it has reached the depth of approximately 3/8 inch. The white-metal force is then struck into the die under a drop or screw press, after which it is ready for use.

The labels themselves are struck up by holding the die in the screw press, the die block being held by screws in a bed-plate, and the white-metal force being held to a flat block in the ram of the press by means of the contact secured by a thin film of beeswax. The thin brass is cut into squares large enough to make the labels, and each of these squares is in turn laid upon the die and the ram of the press brought lightly down so as to force the brass into the design of the die.

If the work is of such a nature that the die must be hardened, the force should be of copper or steel, and as the making of such forces involves many different processes, this phase of the matter will be described in a later number of MACHINERY.

Figs. 23 and 24 illustrate phases of die-sinking operations in connection with rubber mold work. In Fig. 23 the workman is lettering a mold for rubber heels, the work being done in the same manner as the die work just described. Fig. 24 shows the way in which the outlines of rubber shoe patterns are cut on a calender roll with chisels. Afterwards the lines are smoothed with punches, and the surface of the roll filed smooth. Thus, when the plastic rubber is rolled under one of these calender rolls, the rubber sheet emerges from the other side of the roll with the patterns outlined on it, ready to be cut out and put together.

* * *

SPECIAL MEETING OF THE A. S. M. E.

A special meeting of the American Society of Mechanical Engineers was held in the auditorium of the Engineering Societies Bldg., New York, April 9 in honor of the commission of the German Museum of Masterpieces of Natural Sciences and Technical Arts, visiting America. An illustrated lecture prepared by Dr. Oscar Von Miller on the work of the commission, was read by Mr. Charles Whiting Baker. The lecture described the German Museum at Munich, Bavaria, its aims and methods. The method of the German Museum is to correlate and arrange machinery, apparatus, architecture, processes, industries, etc., in order of development and thus produce progressive historical presentations of the arts and sciences to date. This admirable conception has been carried out with characteristic German thoroughness, and the views illustrating the lecture, showed the arrangement of interesting mechanical groups, chemical apparatus, astronomical instruments, etc. Of special interest was the reference to means by which visitors can demonstrate the working of a machine or a chemical reaction by simply pressing a lever or knob.

The importance of preserving in convenient locations the progressive developments of the arts, can hardly be overestimated. The history of inventions thus shown in concrete form should serve in many cases to prevent inventors and manufacturers from making serious mistakes by developing old ideas over again and thus wasting time and effort needlessly. Museums developed on these lines become educational institutions of high order instead of show places for jumbled and unrelated things.

* * *

According to *Eastern Engineering*, screws are still made in India just as they were made hundreds of years ago, that is by winding two soft wires side by side around a mandrel. The wires are then carefully separated and one of them is soldered to the inside of a tube, which then will form the nut, while the other is soldered to a mandrel or rod. All the screws are left-handed, because they are wound over and over by the right hand.

* * *

Owing to the limited knowledge of many draftsmen as to the qualities of materials used in machine construction, there seems to be a tendency to specify better materials on drawings than are actually necessary for the part. Thus, frequently, tool steel is called for where machine steel, case-hardened, would serve the purpose equally as well—and sometimes better.

DIFFERENTIAL MECHANISM ON GEAR HOBBING MACHINES*

By WILLIAM NATISCH†

The writer has read many articles relative to gear cutting machines of different constructions, but has not seen any comparison made between a hobbing machine with differential mechanism and one without it. A great number of mechanics do not know how important it is to have a differential mechanism—or simply a "differential"—on gear hobbing machines. If we take time-saving and accuracy into consideration, a differential mechanism which combines the indexing and helical feeding movements of the table is absolutely necessary. We would not need this extra adjustment for the helical movement if there were no prime numbers between one and ten million.

When generating helical gears on hobbing machines without differential, the required ratio which combines index and feed gears must be calculated at least with 7 decimals, as otherwise a large error will result which will impair the accuracy of the gears. It frequently happens that the required ratio consists of prime numbers, especially when cutting right- and left-hand gears with one hob. To produce correct helical gears with their axes standing parallel to each other, the errors for the right- and left-hand spirals must be absolutely the same, otherwise there will not be a bearing on the whole length of the teeth. In fact, exactly the same conditions exist with helical gears as with spur gears. If, for instance, the teeth of one of two spur gears stood at an angle of only 5 seconds with its axis, the bearing would be at one end of the teeth only.

Furthermore, if the hobbing machine has a differential, it is not necessary to have a right- and left-hand hob when cutting any angle up to 30 degrees; on the contrary, a higher efficiency is obtained when using only one hob for both right- and left-hand spirals. The reason for this is very simple: if there is any distortion in hardening, the right-hand hob will be different from the left-hand.

It has been mentioned before that the ratio must be calculated to at least 7 decimals when cutting the gears on machines without differential. The belief of many mechanics that the ratios and errors obtained by formulas are alike for all hobbing machines, with or without differential mechanism, is entirely erroneous. There is a great difference between the two ratios. In the one case the ratio represents the value of the indexing and the helical movement, and the slightest change of the "driver," *viz.* numerator, will cause a great error if the "driven," *viz.* denominator, is not also changed in the same proportion. In the other case, *i. e.* with the differential, the ratio obtained refers to the angle or helical movement only, and adds or subtracts itself automatically to or from the ratio of the indexing gears. The indexing gears required for cutting helical gears are given on a chart and can be read off the same as for spur gears. This is impossible without the differential. The difference between the two ratios is explained in the following example.

Example:—Gear, 48 teeth; 10 pitch; 20 degrees; 1/16 inch feed per revolution of table.

Gear ratio of machine with differential for 20 degrees = 1.2052784.

If we deduct 1 from the third decimal which is 5, and omit the rest, we have 1.204 = ratio for 19 degrees 58 minutes 42 seconds; *i. e.*, 1 minute 18 seconds difference.

This shows how slight the error would be if we were to change the third decimal; in practice the change is made on the fifth decimal, and the error almost eliminated.

For the same pitch, number of teeth, angle and feed, the gear ratio for one of the machines without differential equals 1.2517385. If here we were to deduct 1 from the third decimal and omit the rest, the result would be that instead of generating teeth the material would simply be milled off from the blank. This is explained as follows: Gear ratio for 20 degrees is 1.2517385. When deducting 1 from the third decimal we obtain 1.250, which is the spur gear ratio.

* See MACHINERY, December, 1911, engineering edition: "Calculating Gears for Generating Spirals on Hobbing Machines."
† Address: Care of Schuchardt & Schütte, 90 West St., New York.

The Schuchardt & Schütte gear hobbing machines are provided with a differential which on the new type of machines is independent of the feed and indexing; in other words, when changing the number of teeth, or feed, or from right- to left-hand gear, no calculation is required. Thus the great advantage of the differential mechanism is that the helical movement is not disturbed whatever when the number of teeth is increased or decreased or the feed is changed. Suppose we intend to generate helical gears with 30, 40, 56 and 60 teeth, of which those having 40 and 60 teeth are left-hand, and those having 30 and 56 teeth are right-hand; the spiral angle is 15 degrees; the pitch is 10. The material is supposed to be cast iron; therefore, 1/16 inch feed per revolution of the table would be selected as the proper one. All the gears are to be cut with one right-hand 10-pitch hob. In calculating the change gears used when generating these gears on the Schuchardt & Schutte machine but a few minutes will be required, the following formula being used:

$$\frac{\text{Constant} \times \text{sine of angle} \times \text{pitch}}{1} = \text{ratio.}$$

$$\frac{0.3524 \times 0.25882 \times 10}{1} = \frac{912}{1000} = \frac{19 \times 48}{20 \times 50} = \frac{\text{driving gears}}{\text{driven gears}}$$

On machines not provided with a differential mechanism, every gear of the same pitch, with only a different number of teeth, must be calculated for separately, and the slightest change in the feed will require a separate calculation. A change in the formula must also be made, if right- and left-hand gears with the same number of teeth are cut with one hob.

The differential is also of great importance when cutting worm-gears with a taper hob. Worm-gears for worms with multiple threads ought to be generated with taper hobs if high efficiency is required. The writer believes that hobbing machines without differentials will disappear after the patent expires.

* * *

HANDLING A LARGE JOB OF MILLING ON A SMALL MILLING MACHINE

By CHESTER L. LUCAS*

The casting shown upon the table of the Van Norman duplex milling machine that appears in the accompanying illustration is the main casting for a wood screw threading machine, designed and built by H. P. Townsend, Hartford, Conn. The casting was first milled on the under side to provide seats

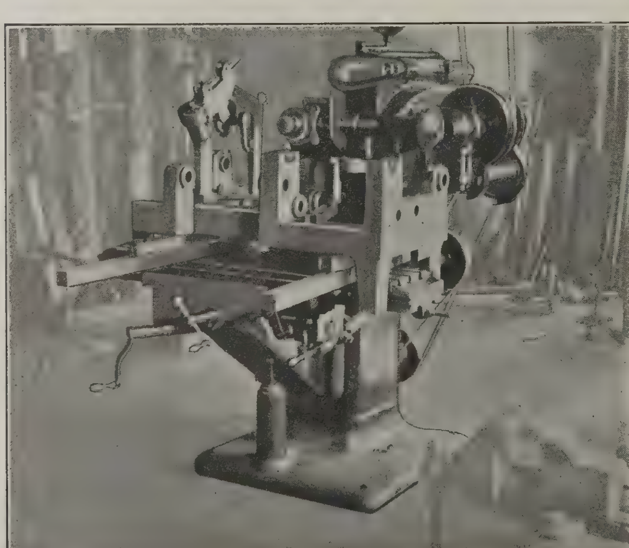


Fig. 1. The Work Set up for Milling the Tops of the Bearing Posts

to receive the parallels. The piece was then set up as shown, and by means of the vertical attachment the tops of the boxes and several bosses and raised panels that were located between the bearing posts on the bed of the casting were faced off. Next the casting was clamped on the table of the machine in a position at right angles to the one shown and the end of the casting faced off, after which the casting was reversed and the opposite end machined. In this latter position the holes that may be seen through the end of the casting and the bearing posts were bored and counterbored by means of suitable boring-bars. When setting up for boring the holes which were farthest away from the head of the machine, it was found that the overhanging arm was not long enough to support the end of the boring-bar; consequently an improvised bracket was brought into use and clamped to the end of the casting. By means of a bearing hole, which was in line with the holes to be bored in the main casting, the end of the

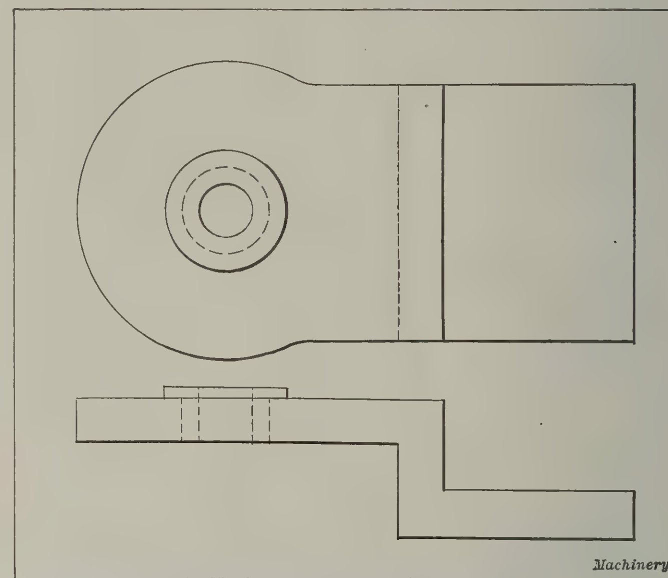


Fig. 2. The Bracket that was used to support the End of the Boring-bar when boring the Holes in the Bearing Posts

boring-bar was adequately supported and the job successfully finished.

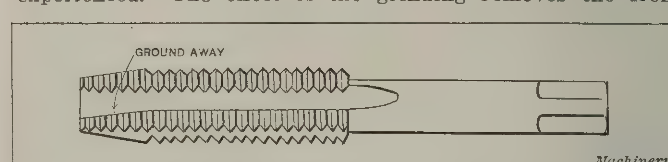
The fact that the table of this machine is wider and longer than that of other machines of its type, and that the table travel in both directions is also greater, together with the fact that the machine can be converted into a vertical milling machine in a few seconds, explains how this job was possible on so small a machine.

* Associate Editor of MACHINERY.

* * *

TAPPING HARD METAL

A useful kink for tapping hard metal is given in the *Practical Engineer* (London). When hard metal has to be tapped it is very common that the taps break; if the tap is ground, however, as indicated in the engraving, no difficulty will be experienced. The effect of the grinding removes the front



Method of Grinding End of Flute for Tapping Hard Metal

part of the teeth, so that the cutting edge presented forms a different angle with the thread than on the section not ground away. This method of grinding the tap proved successful in tapping very hard rolled steel plates.

* * *

CATERPILLAR ATTRACTION

Mr. Hickman, the self-made man and "super" of the United Street Railways, was enthusiastically explaining the construction and merits of his new journal-box to a friend who had dropped into the super's office:

"But I don't see how the oil gets up to the journal," objected the caller.

"Oh, that's easy; it's done by caterpillar attraction. You see the oil climbs up these wicks just like a lot of caterpillars going up a tree. Simple ain't it?"

* * *

A very disagreeable feature about some foremen is that if a piece of work goes well, it is "I," but if anything goes wrong, it is "You."—*Exchange.*

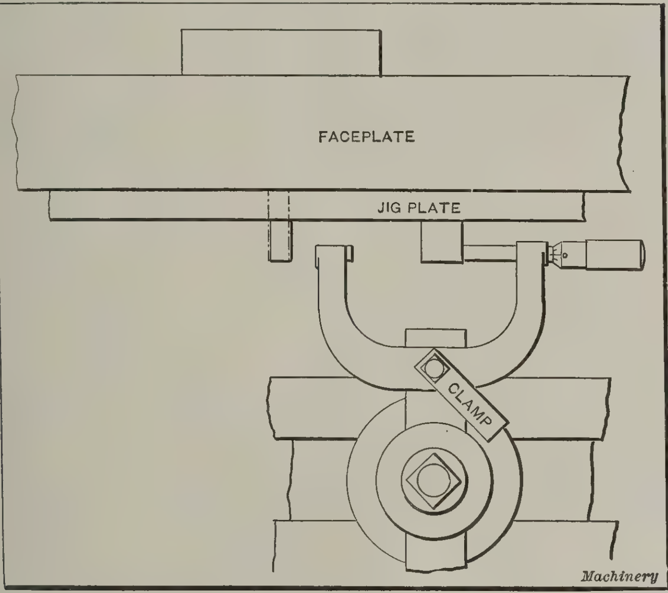
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

LOCATING HOLES TO BE BORED ON THE MILLING MACHINE—A COMMENT

In the April number of MACHINERY an article entitled "A New System for Locating Holes to be Bored on the Milling Machines" is published. The writer wishes to make some comments on the method there explained.

In doing any work, the fewer the liabilities of error the more accurate will be the results. The method referred to does not seem to fully take account of this indisputable axiom. In the layout, one begins with an edge on one side of the plate and then proceeds from a second edge which must be exactly at right-angles to it. If these two edges are at right angles, then the two lines *AA* and *BB* (shown in Fig. 1 in the April number) will be at right angles, but here is a possibility for an error at the very start.



Method of Adjusting Location of Center

The problem presented, as the writer understands it, is to locate with extreme accuracy the two centers *C* and *D* a given distance apart. There are two ways of locating a point; that is, by vision or by feeling, and in the method referred to the latter is adopted. Lines are scratched at right angles to each other; the three feet of the center locating punch are, by the sense of feeling, made to engage with these scratched lines, the center thereby being located at the intersection of the lines. Here, again, are chances for errors. The center plunger may not fit closely, its center may not be ground exactly concentric with the body of the punch, or the feet may not be exactly in their right positions. Furthermore, the punch may not be placed exactly as required. It is admitted, however, that the form of point used for scratching the lines seems to be very good, and the two lines scratched by it would show a very clear point of intersection.

The writer also fails to see the value of the indicator illustrated and questions the advantage of a hole and plug over the visual system. Of course, the taper hole in the milling machine spindle may be perfect, but it is not likely to be, except when the machine is new. In using the indicator, the writer would revolve the milling machine spindle, and not the sector as explained, in order to be more likely to have the center of revolution of the spindle established in so doing.

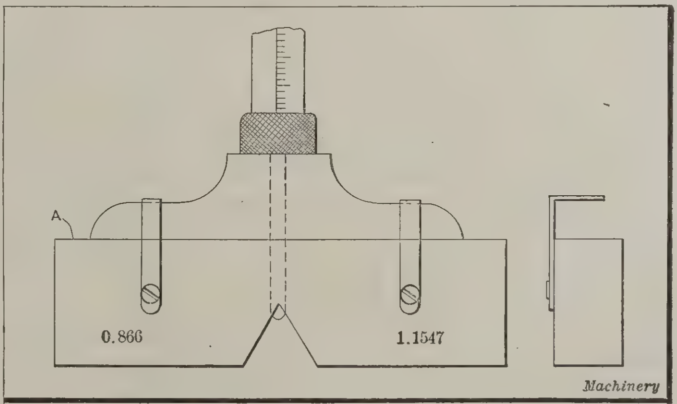
If the piece of work were, say, 10 inches long and square, the writer would locate and bore the hole in the lathe. The faceplate would first be trued off; that should be done at a time when the job could be finished before night, as for very accurate work the escape of oil in the bearings of the lathe over night will affect the accuracy. Should it be required to have the point *D* located a given distance from side *F*, line *AA* could be laid out by means of a try-square, the accuracy of which is easily determined, allowing about 0.005 inch for grinding after the two holes were bored. Line *BB* could be drawn with a height gage.

After locating point *D* by means of a common center indicator, a parallel should be bolted to the faceplate so as to allow the sliding of the plate along it after the first hole is bored. Assume that the two holes are 2 inches apart and each is to be ½ inch in diameter; before boring the first hole set a pair of dividers to 2 inches, and from center *D* scratch a line across *BB*, so as to approximately locate point *C*; then bore the first hole to gage and fit it with a plug, the plug projecting say ½ inch. Now loosen up the holding clamps or bolts and slide the plate along the parallel and with the indicator locate the second hole *C* and bore it to ¼ inch diameter; then fit a plug into this hole and measure with a micrometer the distance over the outside of the two plugs. If the reading should be 2.375 this would indicate that the setting is exact, but this would seldom happen, and the error found may be 0.005 inch over this dimension, which means that center *C* is located 0.005 inch too far away from *D*. The error being known, it can now be corrected without further trial, and to do this the micrometer is clamped to a tool held in the toolpost, as shown in the accompanying illustration. The reading of the micrometer is brought to zero and the point of the micrometer screw is brought into contact with the ½ inch plug. Then loosen up the clamps and feed the plate 0.005 inch by means of the screw, reclamp the plate, and bore the second hole to a ½ inch diameter. The centers now will be located exactly 2 inches apart. If there be any errors they will be found rather in the production of the holes than in the locating of the centers.

It may be merely a personal peculiarity, but the writer always trusts the "feel" of a pair of calipers rather than a stiff gage or a micrometer; but the great advantage of the latter lies in that it tells exactly how great the error is instead of merely denoting that there is an error. NEW LONDON

TOOL FOR MEASURING THE WIDTH OF THE POINT OF U. S. THREAD TOOLS

The accompanying illustration shows a tool for measuring the width of the flat at the point of U. S. thread tools. The device consists of a block of steel, say, 1 inch by ½ inch, with a 60-degree V-groove, and a hole for the rod of a depth gage. There are also two flat springs to hold the depth gage to the block. In making the block, a ¼-inch plug gage is laid



Tool for Measuring the Width of Flat on Thread Tools

in the vee, and the top surface *A* of the block on which the depth gage base rests, is ground until the gage, when in contact with the plug, reads 0.625 inch. To measure the width of the flat of a tool point, set the gage at zero, slip it under the springs, and run the rod out ½ inch. Now insert the tool to be measured in the vee and measure to its point with the depth gage. The amount that the gage reads over ½ inch, multiplied by 1.1547, equals the width of the flat of the thread tool. If it is required to set the tool for any desired width,

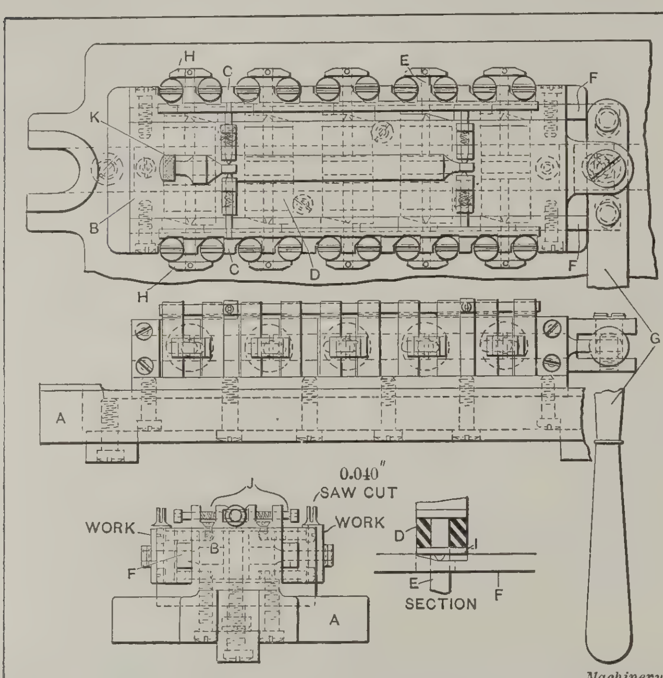
multiply this by 0.866 and set the tool to ½ inch plus this product.

Revere, Mass. GUY H. GARDNER

[The accuracy of the rules given above for setting this tool can easily be ascertained by anyone who knows the first principles of the solution of triangles. A tool similar to the one described, but somewhat more elaborate in its design, and intended exclusively as a thread gage for the width of flat on thread tools, was illustrated and described in MACHINERY, April, 1907.—EDITOR.]

A MULTIPLE MILLING FIXTURE

The milling fixture shown in the accompanying illustration was designed for holding the small pieces illustrated, which were made from a cast composition. As the parts produced were not of exactly the same size, it was necessary to provide some means so that the clamping members would hold all the parts rigidly. We had some rubber in our works which, upon testing, was found to have considerable resiliency; this gave me the idea that we could overcome the difficulties presented in clamping by using rubber collars as an equalizing medium to provide for the variations in the diameters of the work.



A Multiple Milling Fixture for Holding Pieces of Varying Diameters

The fixture shown in the accompanying illustration consists of a base casting *A* to which a central block *B* is held by screws. The two jaw strips *C* which are milled out, as shown, to fit the work are, in turn, fastened to the block *B*. This center block *B* is bored out to receive the rubber collars *D* and draw-in spindles *E*. The two sliding bars *F*, of rectangular section, are milled to fit a slot in the jaws *C*, and are operated by the handle *G*. The clamps *H* are pinned to the draw-in spindles *E* provided with a head against which the rubber collar *D* is compressed by the pressure plates *I*. These pressure plates are provided with projections which operate in the beveled slot in the sliding bars *F*.

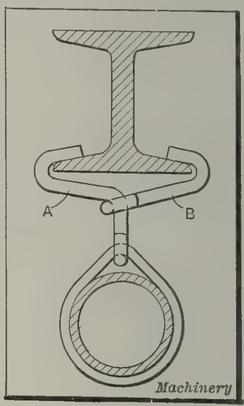
As the handle *G* is fulcrumed in the block *B* and is pivotally connected to the sliding bars *F*, it will be seen that by moving the handle *G* to the right, the sliding bars *F* are moved in opposite directions to each other. The resulting action of the tapered portion of these slides forces in the pressure plates *I*, compressing the rubber collars *D* against the collars on the draw-in spindles, and thus operating the clamps. It is, therefore, evident that by interposing these rubber washers, compensation is made for any variation in the diameters of the work.

The mechanism shown at *J* consists of two strips which extend along the entire length of the jaws, and is used for lining up the pieces parallel to the fixture after they have been placed at random in the jaws. To operate this device, the rod *K* is pushed in which forces the longitudinal strips against the work bringing them all in line, so that they can be clamped, and the cut taken. This fixture makes a very compact device and can be adapted to a large range of small work, which is difficult to hold in an ordinary fixture.

V. W.

SIMPLE PIPE HANGER

About two years ago the writer was requested to design some pipe hangers for a 4-inch steam pipe supported from an I-beam in the factory. The hanger as shown in the accompanying engraving is very simple, as it is made entirely from ⅜-inch iron rod. The clamp grips the beam more strongly, the greater the weight that is applied to the hanger. Being made without bolts, it is simpler to put in place than many of the pipe hangers one sees regularly about the shops, and there are no holes to drill. Part *B* should be made short enough so that it will act as a fulcrum for hook *A*, as otherwise the hooks will not grip the I-beam properly. This is really the most important point to be considered in the making of this simple hanger.

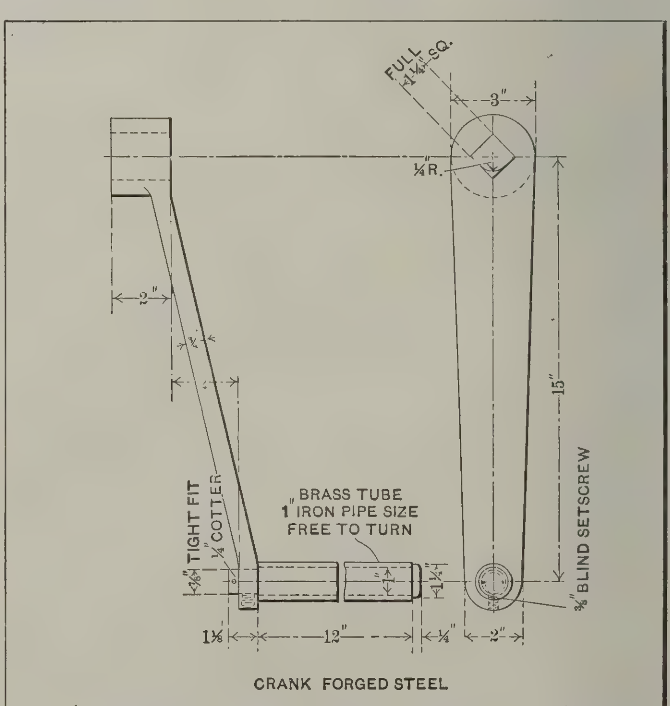


Simple Pipe Hanger

S. Boston, Mass. JOHN WALSH

PROPORTIONS OF HAND-CRANKS

The proportions of hand-cranks given in the December number of MACHINERY, interested me very much. While not attempting to criticize the proportions and design there given, I would like to submit a more suitable crank for out-door work. Hand-cranks are used in all climates and under various conditions, and are subject to much abuse. A handle twelve inches long is about right for a one-man affair, but who can tell whether one or two men will operate the crank? Twenty-five pounds is a good "all day" allowance as a working load



Proportions of Hand-cranks for Out-door Work

for one man, but it is an easy matter for him to exert seventy pounds for a short time.

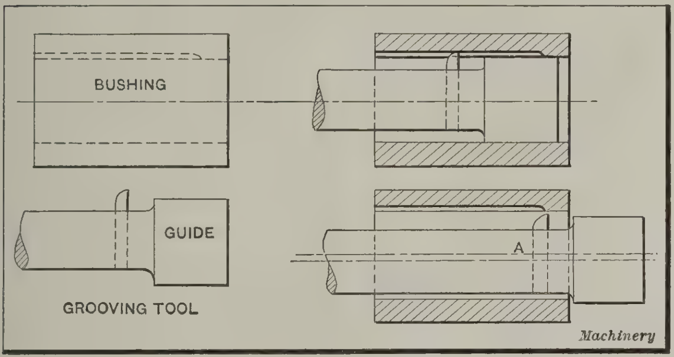
In general, the class of men who use hand-cranks, do not know what good judgment is, and too often use the handles of hand-cranks as seats when tired. To prove the lack of knowledge displayed by men of this class, I will cite an instance that came under my notice. A hand-lever of the walk-around type, with a five-foot lever arm, was used for opening

and closing a valve. One man was all that was needed, but three men were crowded onto the handle to raise the valve. Not knowing that the valve was raised to the full travel, they continued to work until the valve struck a positive stop, and thinking the stop a nuisance, pushed still harder and snapped the chains.

Another good point is to have the handle offset a slight amount; this places the man's body away from the end of the crankshaft, and lessens the liability of jamming it at every turn of the crank. A piece of brass pipe makes a good grip, as exposure to inclement weather will not cause it to split or warp. When it is necessary to use two men on a crank, it is preferable, if possible, to have two cranks placed 180 degrees apart. This gives a much steadier action at the other end than if two men are placed on one crank. C. P. W.

CUTTING OIL-GROOVES IN BUSHINGS

The tool shown in the accompanying engraving is used to cut oil-grooves from one end to within ¼ inch of the opposite end on the inside of the bushings. A good clean job is secured in a very short time. The illustration indicates how the work is accomplished. The tool consists of a piece of machine steel, one end of which is turned to fit the hole in the bushing, this end acting as a guide. The other end



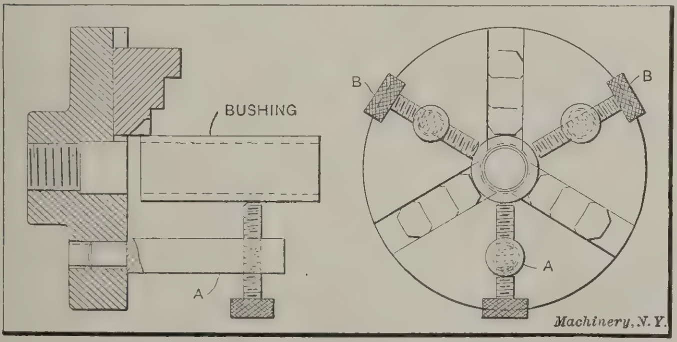
A Convenient Method of Cutting Oil-grooves

is turned smaller in diameter, and in it is inserted the cutter used to cut the groove. Three cuts with three different settings of the cutter were required to complete each bushing. The cutter is made a drive fit in the hole in the arbor. The tool is pushed through all the bushings to be grooved after each setting. The distance from the end of the guide to the cutter determines the distance that the end of the groove will be from the end of the bushing, the illustration showing at *A* how the tool is relieved from the cut before the groove has been cut clear through the bushing. The whole job was done on an arbor press.

Springfield, Ohio. A. J. DeLille

GRINDER CHUCK FOR HOLDING LONG WORK

A chuck which can be used for holding long bushings when grinding them internally is shown in the accompanying illustration. This is an ordinary three-jawed chuck in which



Chuck for Holding Long Bushings when Grinding Internally

three holes are drilled and tapped through the body for holding three studs *A*. Screwed into these studs are three knurled screws *B*, which are used for supporting the work.

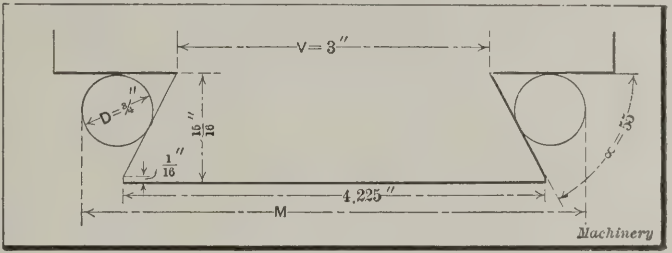
In operation, the bushing to be ground is chucked in the regular way by letting the jaws of the chuck grip ¼ inch from the end, thus leaving sufficient clearance for the wheel to pass through the bushing. The three knurled screws *B* are then brought to bear lightly on the work, so that they will hold the bushing securely without springing it. The outer end of the work can be trued in the chuck by operating these knurled screws. When the studs are not necessary for supporting the work, that is, when the work is not very long, they can easily be removed. William H. Vockell

Cincinnati, Ohio.

FORMULA FOR GAGING DOVETAIL SLIDES

The following rule may be used for finding the dimensions over the wires or plug gages when measuring dovetail slides as indicated in the accompanying illustration:

Add 1 to the cotangent of one-half of the dovetail angle, and multiply by the diameter of the plug gage. Add the



Notation used in Formula for Gaging Dovetail Slides

product obtained to the "vertex" distance of the dovetail. The sum is the required micrometer reading.

Expressed as a formula this rule takes the following form (see illustration for notation):

$$M = (1 + \cot \tfrac{1}{2}a)\, D + V.$$

In the example indicated by the dimensions in the illustration, we find:

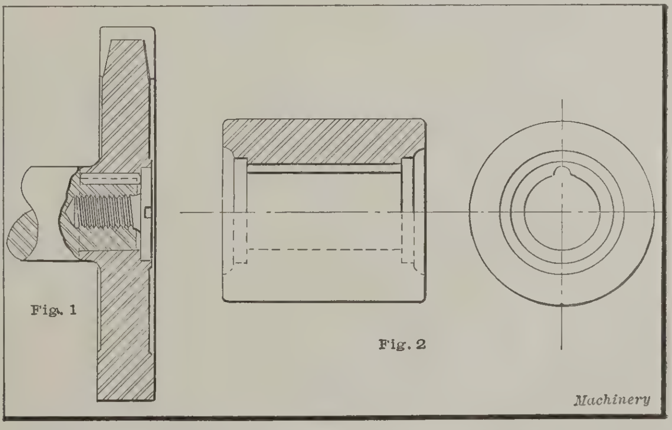
$$M = (1 + \cot 27\tfrac{1}{2}°)\ \tfrac{3}{4} + 3 = 5.191 \text{ inches}$$

The derivation of the formula is based on the first principles of trigonometry, and anyone familiar with this kind of mathematics can easily prove it for himself.

Revere, Mass. Guy H. Gardner

FASTENING SMALL MILLING CUTTERS TO ARBORS

In the article in the February issue, "Device for Fastening Threaded Milling Cutters to Spindle," a very good and satisfactory method is described. In the accompanying engraving is shown a method extensively used in the plant where the writer is employed, for fastening T-mills to arbors, and also



Figs. 1 and 2. Method of Fastening Small Milling Cutters to Arbors

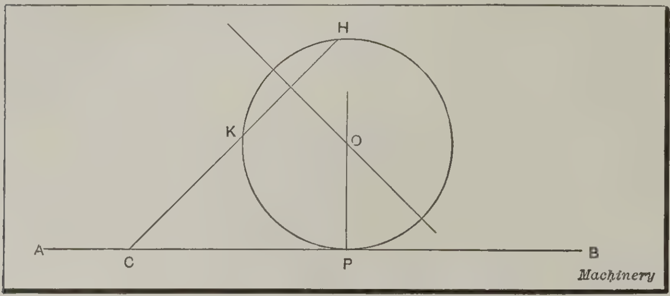
for mounting and using shell mills as end mills. In Fig. 1 a T-mill mounted on the end of an arbor is shown. It is prevented from rotating on the arbor by a round key, and is held in position by the screw in the end of the arbor. This method was adopted after several other methods of constructing T-mills were tried. By making the holes in the cutters of standard size, and using a uniform length of hub, a large range of work can be covered with but few cutters and arbors. For instance,

the same cutters may be used on arbors having No. 9, 10 or 11 shanks; in fact, only a few sets of these arbors are used in the plant which the writer has in mind, while a large variety of mills are used, including regular shell mills, made as shown in Fig. 2. These mills are made alike at each end, thus giving a choice of a right- or left-hand mill. They are easier to grind than an ordinary end mill, and last twice as long, there being two ends to dull before grinding is necessary. Of course the arbors on which these shell mills are used are longer than those used for T-mills. T. COVEY

A GEOMETRICAL PROBLEM

In the March, 1912, number of MACHINERY appeared a brief article by Mr. C. W. Hinman entitled, "A Geometrical Problem." Below is given a solution of this problem which eliminates the construction of a parabola.

As will be remembered, the requirements are to draw a circle that is tangent to line AB and that passes through the points H and K. Draw a straight line through H and K and let C be the point of intersection between this line and the line AB; then the point of tangency P, is found in accordance with the well-known geometrical proposition that



Solution of the Geometrical Problem

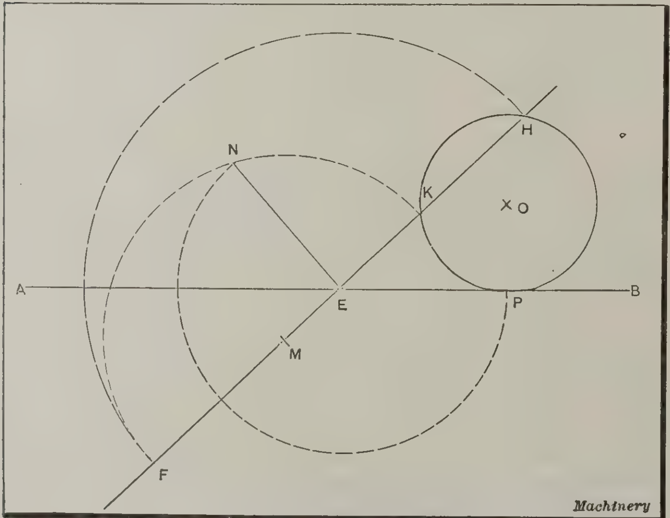
$$CK \times CH = \overline{CP}^2$$

Hence, line CP should simply be made the mean proportional between CH and CK; this determines the point P. The required circle now must pass through the points H and K, and be tangent to AB at P. The center O of the circle is then easily found by means of well-known geometrical methods.

Moscow, Russia. R. POLIAKOFF

ANOTHER COMMENT ON "A GEOMETRICAL PROBLEM"

In the solution of "A Geometrical Problem" proposed by Mr. C. W. Hinman in the March, 1912, number of MACHINERY, the draftsman is confronted with the necessity of constructing a parabola before solving the problem. This makes the solution of little practical value to the ordinary draftsman, although it may be of interest mathematically. A simple and practical solution of the problem is, however, possible.



Complete Construction necessary for Determining the Mean Proportional

In the accompanying engraving let K and H be the two points through which the required circle is to pass, and AB the line to which it must be tangent. Draw a line through H and K and prolong it indefinitely, crossing line AB at E; make EF equal to EH; bisect line KF at M; with M as a center draw a half-circle FNK, and erect a perpendicular EN; then make EP equal to EN. Point P is now the point of tangency, and by any well-known method for describing a circle through the three points, the required circle can now be constructed.

The proof of the accuracy of this method is based on the fact that, according to a well-known geometrical proposition,

$$EK \times EH = \overline{EP}^2$$

If, according to the construction, EP is the mean proportional of EH and EK, this requirement is filled. Now, EN is a mean proportional between EF and EK, or

$$EK \times EF = \overline{EN}^2$$

But EF equals EH, and EN equals EP; hence,

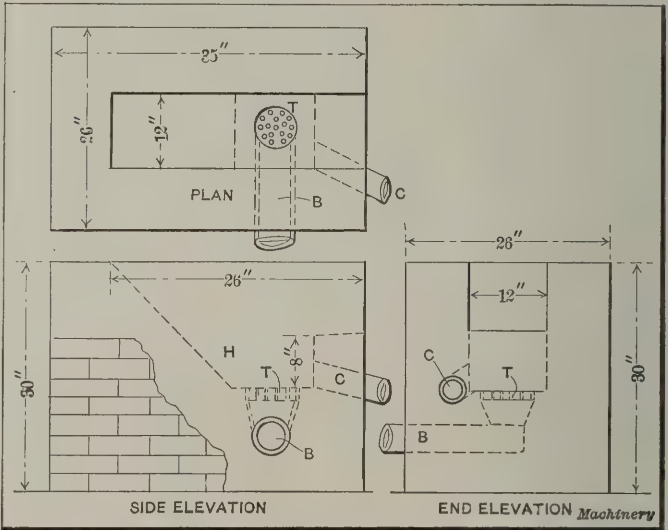
$$EK \times EH = \overline{EP}^2$$

Consequently, P is the point of tangency with the circle passing through H and K, tangent to line AB. A. M. S.

[A solution similar to that just given has also been submitted by Mr. George W. Burley, Sheffield, England; Mr. Samuel McAnally, Stratford, Ontario; and Mr. George W. Hammond, Manchester, England.—EDITOR.]

WELDING NICKEL-CHROME STEEL

The following is offered in reply to C. L. L.'s question in the February number of MACHINERY, relating to the welding of nickel-chrome steel. There are no physical or chemical reasons why nickel-chrome steel should give trouble in welding in an ordinary forge fire. There may be mechanical reasons for having difficulty with these steels, but these are wholly caused, and can be controlled, by the person doing the welding. Broadly speaking, nickel and chromium increase the susceptibility of the steel containing them, to heat treatment, which includes not only hardening and tempering, but forging and welding as well. It seems sufficient to say that these steels weld as readily as any carbon steels of the same "temper."



Blacksmith's Forge, especially Suitable for Heating Steel for Welding

It is generally recognized by all blacksmiths that the lower the carbon contents of steels, the easier they weld. That this is true is readily seen when two pieces of iron, which are free from carbon, are heated to the proper welding temperature and then brought into contact; they instantly weld perfectly. The carbon steels in general use, and with which the average blacksmith is familiar, usually contain about 0.25 per cent carbon. Nickel-chrome steels are made in grades of 0.08 to 0.15 per cent carbon, and 0.16 to 0.25 per cent carbon, and higher. The grades containing the higher percentages are seldom met with by the blacksmith, as these are generally used for structural purposes, though they too can be welded by carefully heating to slightly lower temperatures than used for carbon steels of the same carbon percentages.

With the lower carbon grades of nickel-chrome steels it can be readily seen from the carbon contents that these should weld without the slightest difficulty. In general, these steels should be heated to 2300 or 2400 degrees F., but the heating

should be done slowly, because of the denseness of the grain and to insure an even distribution of the heat throughout the piece. The forge fire should be clean and of ample volume to completely surround the steel to be welded. Use care that a good bed of clean fire is kept between the tuyere and the steel. See that the air blast does not strike the latter directly, while heating, as under these conditions the steel will burn before the proper welding temperature is reached. More trouble is caused in welding with dirty coal fires than from any other reason.

The accompanying illustration shows a modified blacksmith's forge used for heating small pieces for welding; *B* is the blast pipe, *C*, the cleaning flue, and *T*, a small tuyere perforated with a number of one-half inch holes. The hearth *H* is made eight inches deep and the fire is always kept up to the top of this hearth. This insures a good, clean, clear fire at all times, and keeps the steel to be welded far enough away from the blast to prevent burning. Pea-coke is generally used in a forge of this kind. This forge can also be used for heating high-speed steel for hardening with excellent results. If the directions given are followed carefully, there should be no difficulty whatever experienced in welding nickel-chrome steels. E. D. ALLEN

Latrobe, Pa.

VALUE OF DIFFERENTIAL OR PLANETARY GEARING

Properly designed and properly made differential or planetary gears offer an excellent means of reducing the speed of rotating shafts. In the summer and fall of 1905 the writer designed a mechanism in which the main shaft made 120 revolutions per minute and was to drive another shaft at 12 revolutions per minute. To accomplish this, a planetary train of four gears was used, one gear of 48 teeth meshing with one of 20, and one of 44 teeth meshing with another gear of 20 teeth. These gears have been in almost constant use for the past six years, and the 20-tooth gears have in that time made over 230,000,000 revolutions. The most remarkable fact about this train is that it has run these six years as quietly as if it were a worm-gear arrangement, and has never given any trouble except once, through an accident, when a loose piece of metal fell into one of the larger gears breaking some teeth.

The gears with 44 and 48 teeth were of cast iron, while the 20-tooth gears were made of machine steel, but not hardened. The satisfaction derived from this drive speaks in favor of the use, in the proper place, of properly constructed planetary gears, as a simple speed reducing mechanism. To give such satisfaction, however, the gears must be properly cut so that they will run smoothly together, and retain the same distance between the centers. The diameters of the gears must be correct to within 0.0005 inch. One particular feature of this job was that the writer cut all of the gears with one gear cutter, cutting all the teeth to exactly the same depth. They were cut with a special cutter. The writer is of the opinion that if the gears had been cut with ordinary involute teeth, they would not have given the same satisfaction.

An improper method of making a planetary gear speed reducing device is to place the larger gears side by side and then make the driving pinion in one piece, so as to mesh with both, its length being equal to the total width of the two gears. This is a poor method even if the two large gears vary only one tooth, because the pinion will not be in proper mesh with both of the gears, and the drive is apt to be noisy.

Springfield, Mass. FRANCIS W. CLOUGH

"PATENTED" ON MACHINES

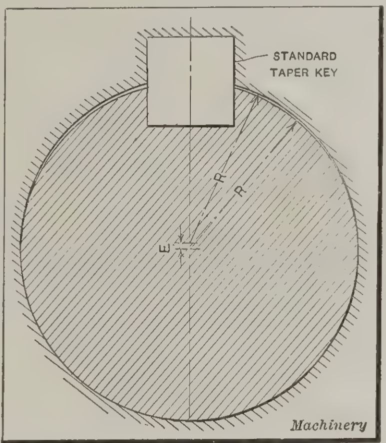
I am interested in your remarks on "Status of Patented on Machines" in the April number. A friend of mine in Wisconsin some years ago began to make slot machines such as were popular for some time for gambling purposes. The machines were going like "hot cakes," and he wanted to prevent anyone from imitating his machines, which were not patented and on which he did not expect to secure a patent. He used a Yale lock to fasten the door through which the owner of the machine was to secure access to the inside of the machine to remove coins, etc. Yale locks are patented. The locks were countersunk in the frames of the slot machines, only the key-holes showing. There was no chance to show the patent notice of the Yale locks, so the following was placed on the machines; "The locking devices on this machine are patented under Nos. ———."

This statement conveyed the impression that the slot machines were patented and avoided any interpretation of the patent law which would apply in marking as patented an article not patented. The impression lasted long enough for the manufacturer of the machine to prevent competition until such a time as the machines were adjudged gambling devices by the police and then destroyed. After that his competitors did not want to make the machines anyway.

Norwood, Ohio. ALBERT STRITMATTER

METHOD OF BORING HOLES IN KEYED PULLEYS

When large pulleys or gears are fitted to shafts in any other way than by a press or shrinkage fit, there must necessarily be some difference in diameter between the bore and the shaft. If a taper key is used, the shaft is always forced to one side of the bore, and the pulley or gear becomes eccentric. In many cases this may not do any harm, but it certainly is of no advantage; and unless the play between the bore and the shaft is small, it is likely to cause trouble. Furthermore, if there is too slight a difference between the bore and the shaft, the wheel will frequently stick, especially if it is to be pulled over a considerable length of the shaft. This condition is especially exasperating when making emergency repairs.



Fit between Shaft and Bore when Method outined is followed

The accompanying illustration shows a simple way of avoiding both difficulties. The idea is not new, but has been used by two or three companies to the writer's knowledge for more than ten years. Nevertheless, the method is one which is not generally known. After the pulley is bored, it is shifted in the chuck or on the faceplate, an amount as represented by *E* in the illustration; then, without changing the setting of the tool, the hole is rebored. The first hole should be exactly equal to the shaft diameter. Then, after the taper key is driven home there will be an exact fit on the lower half of the shaft, instead of a fit theoretically along one line only, which would be the case if the bore were circular, and larger in diameter than the shaft. The main reason for this method of boring the pulley is, however, the ease with which even a big heavy wheel can be put on or taken off.

The exact dimension *E* cannot be given, because it would vary considerably in different shops. It depends on the size of the shaft and the grade of the work. However, the writer would say that on heavy gears, pulleys, etc., 1/32 inch is not too much. There will be an open space between the shaft and the bore on the keyseat side anyway, and it is difficult to see why a 1/32 inch space at the top would be any more objectionable than a 1/64-inch space. The extra cost of this method of boring is small in comparison with the advantages obtained. Next to a press fit this method provides theoretically and practically the most satisfactory means for fitting a shaft to its bore. F. D. BUFFUM

Ellsworth, Pa.

ROLLING BLUEPRINTS

Trivial as it may seem considerable energy is lost by mechanics, engineers, architects, and others on account of the fact that blueprints are almost invariably rolled with the face

in. A moment's consideration of the subject will convince the least observing of men that such is the case, but why it is so done is unanswerable except that it seems to be intuitive, just the same as putting money inside of a pocket-book instead of outside of it. The reason for putting money in a pocket-book is obvious, but protection in the case of blueprints is fallacious as the back of the paper is as necessary as the face.

The objection to rolling a print with the face in is that it is a very difficult matter to make it lie open properly when unrolled for reference. Weights or thumb-tacks, or four hands are then in demand, when if the print has been rolled face out it may be unrolled and placed on a board or held in two hands without trouble. Try rolling a blueprint both ways and be convinced. You will not be likely again to roll a blueprint face in. C. H. Casebolt

St. Louis, Mo.

[The same reason for rolling blueprints face out applies to the rolling of magazines for mailing. If rolled with the title page out when mailed, the unrolled copy will soon settle down and lie flat on a table with the title page up. Machinery has been mailed for the past few months with the title page rolled out.—Editor.]

DRAWING AN ODD-SHAPED CUP

In answer to the question on drawing an odd-shaped cup in the "How and Why" columns of the March issue of Machinery, the following solution is offered. By this method four operations would be required to complete the drawing of the cup and Fig. 1 illustrates the successive drawing operations. The first operation consists in drawing from the center of the blank a cup-shaped depression 5/8 inch diameter and 1/4 inch

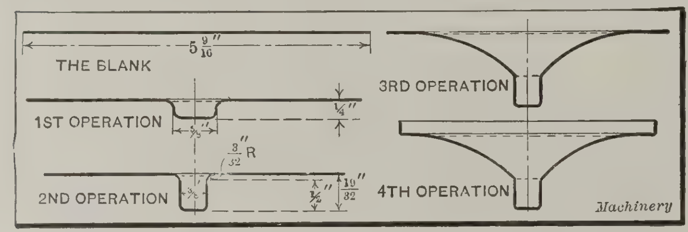


Fig. 1. Results of the Four Drawing Operations

deep, as shown. The die for accomplishing this part of the work is shown in Fig. 3. This die is an ordinary drawing die with a spring blank-holder and needs no further explanation. The second operation consists in drawing the cup-shaped depression to the depth of 1/2 inch, and at the same time reducing

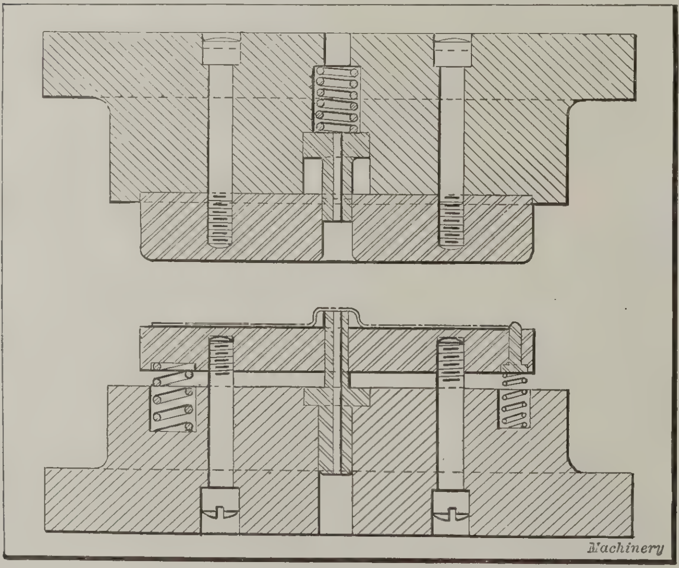


Fig. 2. The Second Operation Die

the diameter to 3/8 inch. The tools for this work are shown in Fig. 2. While this is a somewhat unusual type of die, it has worked out very successfully on similar work. The spring blank-holder should be supported by very weak springs. The third operation consists in forming the central part of the shell by means of the dies shown in Fig. 4, and the same dies are used for the fourth operation of turning up the flange at the outside edge by simply adding the ring shown in Fig. 5.

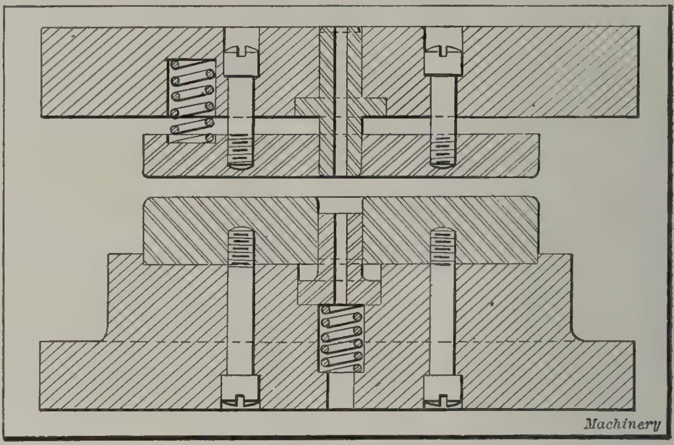


Fig. 3. The First Operation Die

This ring slips on over the lower half of the third operation die, and for this reason it is essential that the outside of this

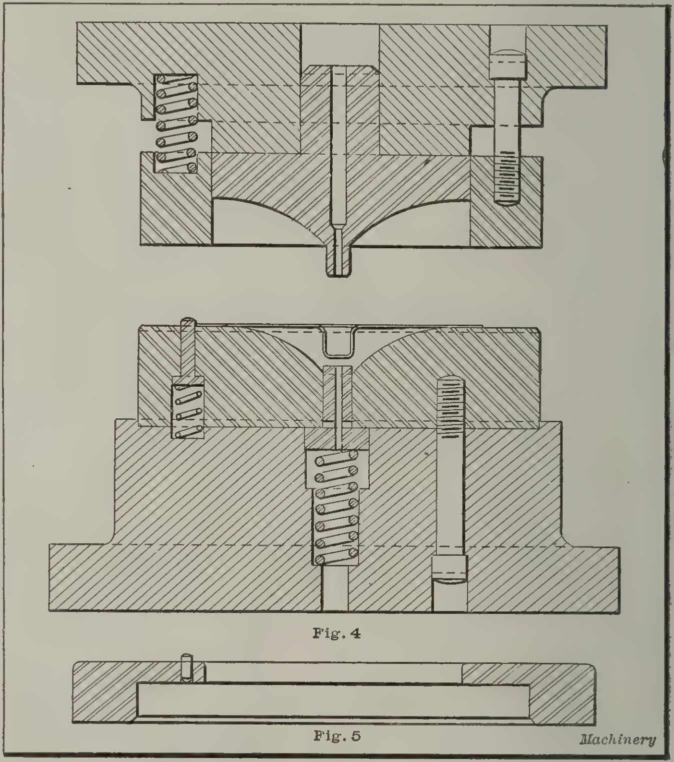


Fig. 4. The Third Operation Die. Fig. 5. The Ring used on the Third Operation Die to perform the Fourth Operation

part of the die be absolutely concentric with the depression in this die.

Thomas Alma

REMOVING BURRS FROM METAL PRODUCTS—REJECTED WORK

Referring to the inquiry of D. A. H. in the February number regarding economical methods of removing burrs from metal products, we break up discarded emery wheels and put them into a revolving iron cylinder having internal projections. We put in about an equal amount of sawdust with the broken emery pieces and then the parts from which burrs are to be removed. The tumbling of the parts with the sawdust and emery quickly removes all the burrs that should be allowed on any punched work.

On parts for electrical apparatus that are rejected by inspectors it is our practice to treat them individually so as to bring them up to the standard where it is possible. In a great many cases the stock is of so much more importance than the labor that we find it pays to treat the parts individually.

West Lynn, Mass. Thomas A. Wry

A REVOLVING-HANDLE SCREW DRIVER

The accompanying illustration shows a sectional view of a revolving-handle screw-driver which is found useful for assembling work. It consists of a crank shaped shank *A* made from drill rod, a brass sleeve *B*, a steel thrust button *C*, and a hard wood handle *D*. To assemble these parts the brass bushing *B* is slipped over the shank *A*, after it has been

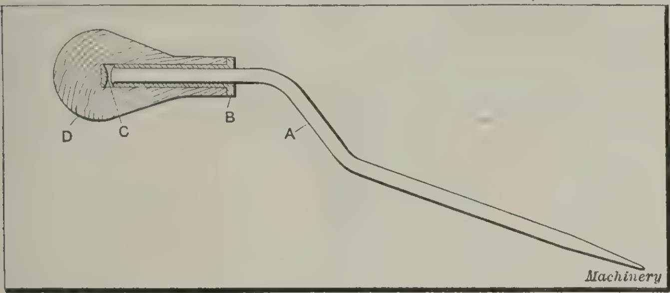


Fig. 1. A Revolving-handle Screw Driver for Rapid Assembling of Work

bent to the required shape; then the shank is upset on the end. Thrust button *C* is now slipped in place on the handle and the brass bushing with the shank in it is forced in. The hole in the handle should be deep enough to leave about 1-64 inch play between the end of the shank and the thrust button.

The screw-driver is operated by simply holding the knob

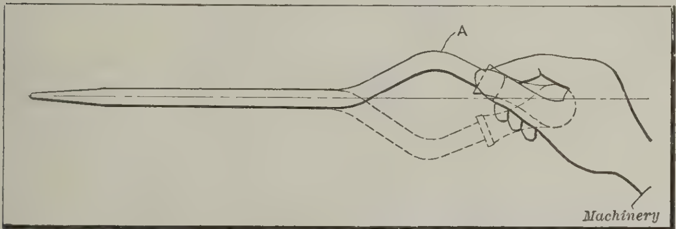


Fig. 2. Illustration showing the Method of Operating the Screw Driver

of the handle against the palm of the hand and gripping the small portion of the shank with the fingers of the same hand and twisting it around without moving the wrist. After a few minutes' practice this screw-driver can be worked with great speed in both directions. J. E. U.

BALL AND ROLLER BEARINGS IN MACHINE TOOLS

In reply to your criticism in the February number of Mr. Henry Hess's remarks on the application of ball bearings to the main spindle of machine tools, it might be interesting to cite the fact that several eminent tool builders in England have already, with apparent success, put them to this use. Messrs. Kendal & Gent, of Manchester, are producing a hexagon turret lathe which takes bars up to 3 inches, the headstock of which is fitted throughout with ball bearings. They claim to have reduced the power consumption per unit of metal removed about 50 per cent. Messrs. Parkinson & Sons, of Shipley, are fitting ball bearings to milling machine spindles. Messrs. Alfred Herbert, of Coventry, are using them on the spindles of automatic chucking machines and turret lathes. This firm, before finally adopting ball bearings for the spindles, gave them a test extending over several years on some of the shop machines. The machines worked satisfactorily under heavy forming cuts.

The type of bearing used in every case is that known as "single track journal," which has, of course, no provision for adjustment. In the writer's personal experience, he has found that if a ball bearing is fitted, no adjustment is needed for the simple reason that a bearing of ample proportion practically does not wear, and ball-bearing makers are now turning out so perfect a product that the clearance between the parts of a journal bearing is only just sufficient to insure free running —not exceeding, at any rate, that of a well scraped bush bearing.

In the case of thrust bearings of the ball type, where thrust is taken by the balls in both directions, it is absolutely unnecessary to provide adjustment. If adjustment is found to be needed, this is only a proof that the proportions have been undercalculated, and the remedy, therefore, is obvious. The initial adjustment should be made in construction by the makers and in such a way that it cannot, by any means, be tampered with by the user.

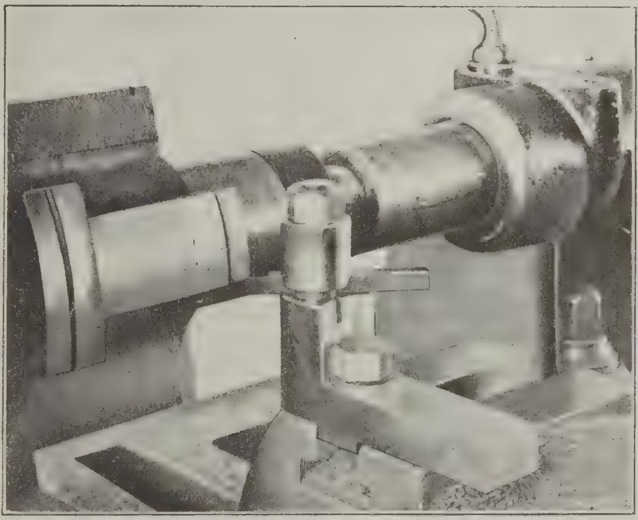
Some months ago the writer designed a lathe headstock of the all-geared type, in which the journal pressures were entirely taken care of by the ball journal bearings, and the end thrusts, by double ball thrust bearings. The body of the headstock formed an oil bath, which was necessary to lubricate the gears. At the same time, the spray from the oil was sufficient to keep the ball bearings in good condition, rendering quite unnecessary the provision of other means for lubrication; in fact, the headstock was entirely without lubricators. In this particular case, the diameter of the spindle would have been excessive for the load and speed, and ball bearings gave a means of getting over a very troublesome proposition.

The writer has a very strong conviction that in ten years, so far as machine tools are concerned, practically every bearing of importance will be a ball bearing. The days of bronze and babbitt are numbered. A fifty per cent reduction of the power bill is not to be lightly considered, particularly in these days of coal strikes.

A method successfully applied in a grinder head was the fitting of a long bush behind the ball bearing, this bush having a little more clearance than the balls in the ball bearing. The idea was that the solid lubricant with which the shaft in the bush was oiled would act as a deterrent against vibration, for before vibration could take place, the grease would of necessity have to be squeezed out. A SUPPORTER OF HENRY HESS

A TOOL-HOLDER FOR THE LATHE

The accompanying illustration shows a tool-holder which holds square turning tools or cutting-off blades made from high-speed steel. The holder consists of a stud held in the L-block which is fastened to the cross-slide, as shown. The cutting tool is retained by a collar, which, in turn, is acted upon by



A Lathe Tool-holder of Rigid Construction

a nut. As can be seen, this holder is provided with a slot in which cutting-off blades can be rigidly held. Another good feature about this holder is that there is practically no overhang at all, thus enabling heavy cuts to be taken without chattering. CHARLES K. TRIPP

West Lynn, Mass.

PACKING BOX NAILS

I have just seen what seems to be an improvement in the use of packing-box nails—*viz.*, the employment of paper disks about ¼ inch thick under their heads. These disks or washers are used in order to lessen the jar on the contents of the box, and to prevent damage to the box itself during transit. When opening, the ordinary pliers or the special nail-pulling devices draw the nails without mauling the box cover. The disks are furnished perforated ready for use.

Dresden Germany ROBERT GRIMSHAW

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

ORIGIN OF COTTER-PINS

A. C. C.—I am desirous of securing information in regard to the origin of the use of cotter-pins as well as the derivation of the word itself. How far back does the use of cotter-pins date? In what country did they originate, and wherein lies the significance of the word cotter-pin?

This question is submitted to the readers.

DIAMETER OF STEEL BALL

A. J. C.—Please give a formula for solving this problem: If a steel ball 0.718 inch diameter weighs 380 grains, what must the diameter of a ball be to weigh 383 grains?

A.—The cubic contents of spheres are to one another as the cubes of their diameters. Therefore, the relation between two balls is expressed by the proportion $x^3 : y^3 = a : b$, in which x and y represent the diameters of the balls and a and b the given weights. From this we obtain the expression $x^3 : 0.718^3 = 383 : 380$; clearing for x yields

$$x = \sqrt[3]{\frac{0.718^3 \times 383}{380}} = 0.720 \text{ inch},$$

the required diameter.

PORTABLE BORING BAR

J. H.—I am foreman of the machine shop of a large factory manufacturing tinware and sheet metal goods, and have a number of stamping presses to keep in repair. I have now the job of repairing a broken crankshaft. The bearings for the shaft are badly worn and need reboring. I wish to rig up a boring bar and bore out just enough to true up the bearings, which are about 3 inches diameter and 18 inches apart. Can you refer me to the design of a simple boring bar that can be rigged up for the purpose of boring out the holes in the press frame while in position?

A.—The situation described is typical of many repair jobs requiring the reboring of two or more holes dead in line. The regular portable boring bars designed for reboring engine cylinders are generally too heavy and cumbersome for machinery repair work, and even if a given situation is such that an an engine boring bar could be used, the cost and time required to obtain one are generally prohibitive for emergency repair work. Suggestions are invited describing simple portable means which can be provided by almost any machine shop for efficiently boring holes from 2½ inches diameter up, and employing a traversing bar or traversing tool head.

DESIGN OF DROP-FORGING DIE

A. C. F.—I desire to make drop-forging dies for the piece shown in Fig. 1. This piece is to be a steel forging, and the

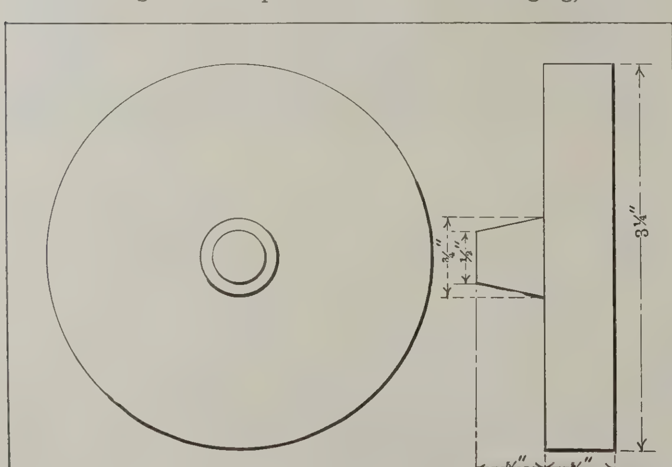


Fig. 1. The Forging to be made

principal point on which I require information is the proper shaping of the breakdown in order to distribute the stock so that the raised projection at the center may be brought up easily; also advise me what size bar steel to use and to what lengths the bars should be cut for forging.

Answered by J. W. Johnson, Revere, Mass.

A.—The drop-forging of the piece shown can be easily accomplished by making the breakdown in the manner shown in Fig. 2. The outline of the breakdown should be laid out about ⅛ inch smaller than the finished forging is to be, and the corner should be well rounded at the parting line. The face of the breakdown should be wider than it is ordinarily made, in this instance being two inches wide in order to

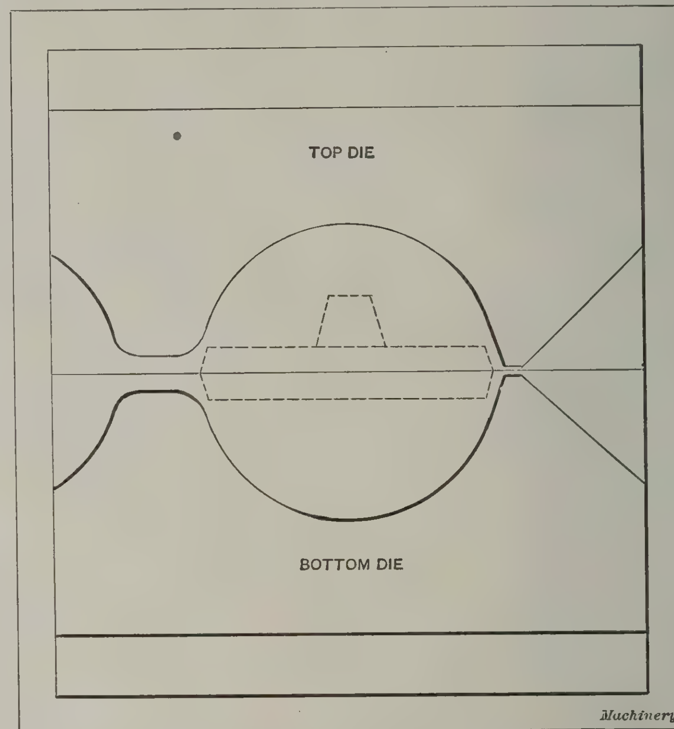


Fig. 2. Showing the Outline of the Breakdown

facilitate the rapid breaking down of the stock. In cutting the face impression in the die it should be remembered that the impression that is to form the projection on one of the faces of this piece should be cut in the upper die on account of the fact that the metal is more easily forced up than down into a depression.

The dimensions of the stock should be very close to 3 inches by 1 inch, and in cutting the bars for forging, the lengths should be just long enough to make four pieces. The first piece forged will leave the bar in the condition shown in the upper view in Fig. 3. It will be noticed that the gate to the breakdown is cut away so that one-half of the outline of the

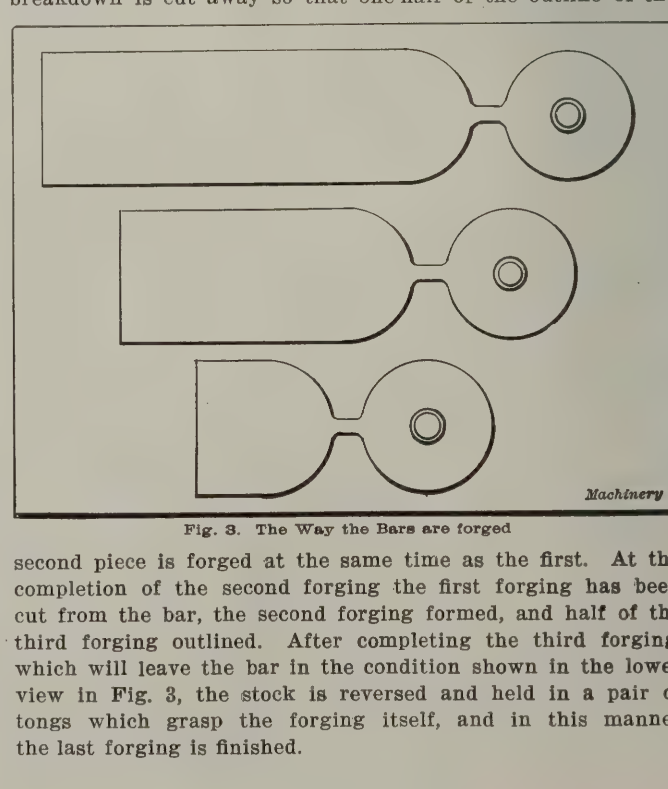


Fig. 3. The Way the Bars are forged

second piece is forged at the same time as the first. At the completion of the second forging the first forging has been cut from the bar, the second forging formed, and half of the third forging outlined. After completing the third forging, which will leave the bar in the condition shown in the lower view in Fig. 3, the stock is reversed and held in a pair of tongs which grasp the forging itself, and in this manner the last forging is finished.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE FELLOWS HELICAL GEAR SHAPER

Spur gears with helical teeth have long been used in Europe in place of ordinary straight-tooth spur gearing. They are also coming largely into use in this country, particularly for automobile engine gears. The advantage claimed for them is that they run more quietly than old-fashioned spur gears. The difference in the action of the two forms is this: With the spur gear the tooth makes contact with its mate instantaneously along the full width of the face. With helical-tooth gears, on the other hand, the teeth do not come into engagement with each other for the full length at once. Contact is made at one end of a pair of teeth first, then a little further in from the end, then a little further still, and so on to the other end of the tooth; and by this time the next pair should be making contact at the front end. Thus it comes about that the teeth are making contact all the time and are going out of contact all the time, the engagement being continuous instead of intermittent. This tends to make the action smooth and regular.

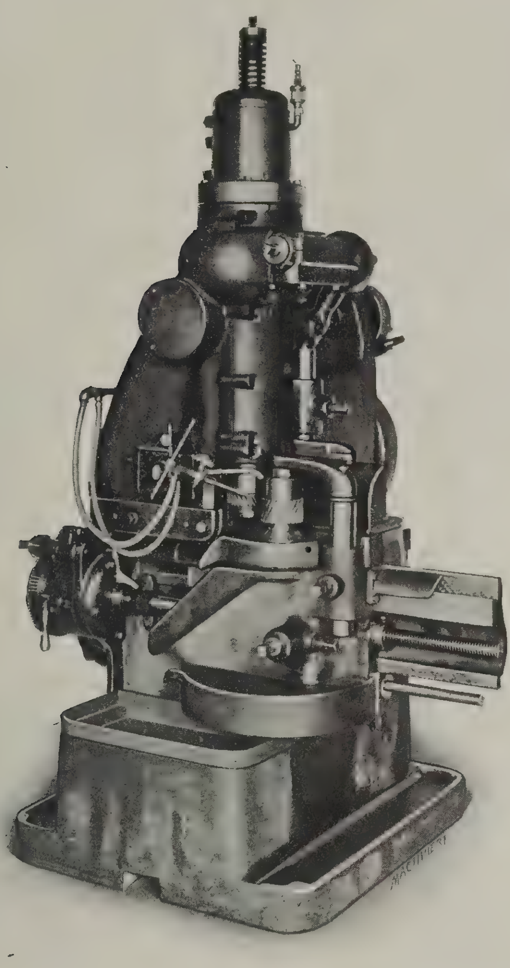


Fig. 1. Helical Gear Shaper built by the Fellows Gear Shaper Co.

The Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt., some time ago began a series of experiments and investigations on the problem of a simple and accurate process for cutting these helical gears. As the result, a helical gear shaper and a hardened and ground helical gear shaper cutter, have been produced, which extend the accuracy and output of the gear shaper process, to the cutting of helical gears.

Principle of the Helical Gear Shaper

The principle of the shaper's operation is identical with that of the regular gear shaper for spur gearing. Fig. 3 shows a helical gear of steel or other metal rotating in engagement with a blank made of putty, wax or some other plastic substance. It is evident that the teeth of the generating gear will mold, in the plastic blank, teeth of the proper shape to engage with it or with any other gear of the same pitch and helix angle. If the plastic blank could then be hardened, it would be a serviceable gear for use in an actual machine. The practical problem, of course, is to adapt this molding process to the cutting of hard metal gears. This may be done as shown in Fig. 4 where the generating gear is of high speed steel with the tooth outlines sharpened to a cutting edge. This gear, or gear-like cutter, is rotated with the metal blank as if they were in mesh with each other the same as in Fig. 3. In addition, the cutter is given a cutting stroke with a helical motion, which sweeps its cutting edge through the exact space occupied by the tooth surfaces of the generating gear in Fig. 3, and the cutter generates helical teeth in a metal blank, in exactly the same way that the gear molded teeth in the plastic blank; any gear so generated and having twelve teeth or more, will mesh with any other gear of twelve teeth or more, cut by the same cutter.

Special Features of the Machine

Two views of this new helical gear shaper, are shown in Figs. 1 and 2. The only change in the design, as compared with the gear shaper previously built by this company, is the provision of a helical guide for giving the twisting motion to the cutter spindle as it is reciprocated up and down for the cutting and return strokes. Fig. 5 shows the cutter spindle, guide and cutter removed from the machine. The guide, as may be seen, is a solid block of cast iron, which is planed by special machinery to a helix of the proper lead. The mating guide (see Fig. 6) is seated in an enlarged hub bolted to the face of the index wheel. It is of large dimensions and has planed and scraped helical surfaces. It is split in the middle

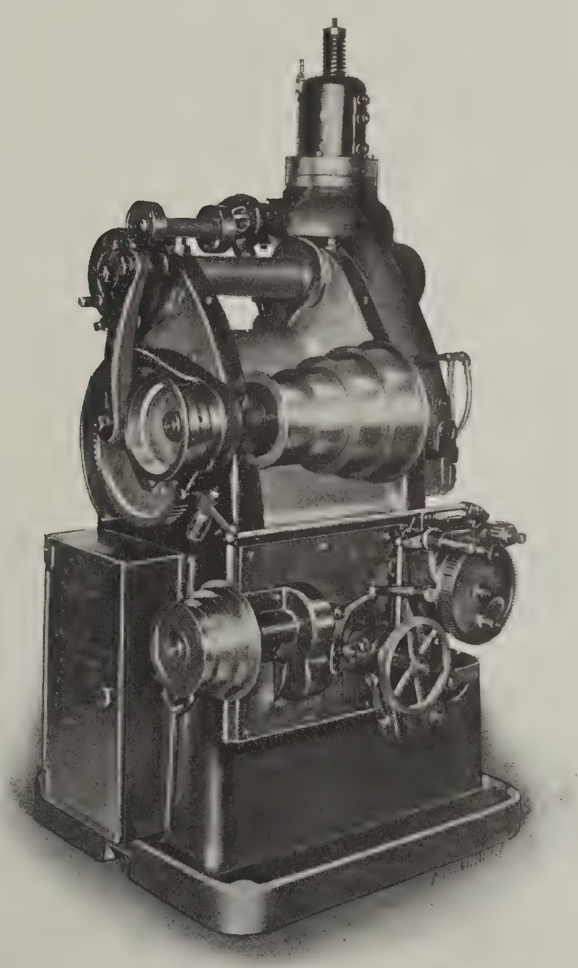


Fig. 2. Rear View of Helical Gear Shaper

and is provided with an endwise adjustment for taking up the wear. The bearing surfaces are so generous, however, that the wear is negligible. The location of the helical guides in the machine is plainly shown in Fig. 8, where the internal member is seen projecting beyond the hub in the upper index wheel.

This guide mechanism is worthy of particular study. Change gears have been invariably employed for obtaining the desired helix angle in previous designs of commercial helical gear-cutting machines. This is convenient where constant changes

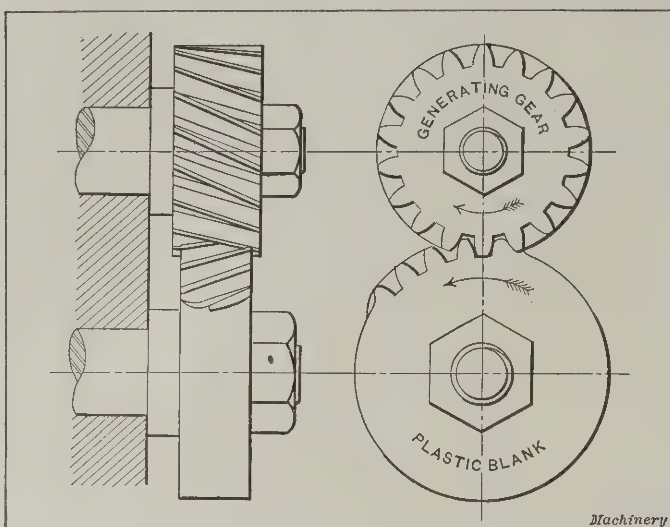


Fig. 3. Diagram illustrating Molding-generating Principle

in helix angle are to be made, but it is a disadvantage as a manufacturing proposition. The control of the motion is elastic and complicated. Furthermore, the change gears usually have to be reset for each new number of teeth cut, even though there may be no change in the helix angle, and often the machine is so designed that a change of feed cannot be made without a re-calculation of the helix change gears. The result is that it may be impossible to do more than approximate the desired helix angle, so that two gears of different numbers of teeth will be found to have slightly different helix angles when the attempt is made to run them together, this being due to approximations in the gearing for the two cases that were different in amount or direction.

With the helical guide mechanism of the helical gear shaper, the cutter is directly connected through the spindle to the

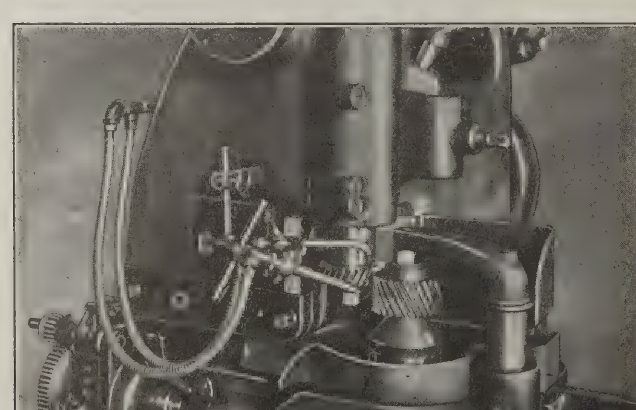


Fig. 4. Detail View of Helical Gear Shaper

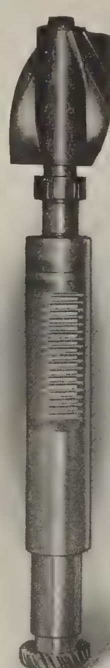
guide which determines the lead of the helix. The control of the motion is direct, rigid and positive. The mechanism is independent of the feed, cutting stroke, indexing or any other function of the machine. It is made of the exact helix desired in the first place and never changes. By means of special machinery, any number of guides of any angle can be made, all exact duplicates of each other. The helix angle of the gears likewise never changes, so that this source of error is removed. Only ten or fifteen minutes is required to change cutters or guides when changing from one helix to another or from a right-hand to a left-hand gear.

A pair of helical cutters used on this machine, is shown in Fig. 7. Like the straight, spur-gear shaper cutter, the helical cutter is hardened before finishing the tooth outline, so that all error from change of shape in the fire is avoided; and it is ground to shape by a generating process after hardening. Every curve on these cutters is a generated curve that is not copied in any way and is formed without the use of templets or master tools. With original curves generated in place on the cutter after hardening, great accuracy is secured.

General Description of the Machine

Aside from the special features previously referred to, the machine is practically a No. 3 Fellows gear shaper of the well-known design. The machine is naturally divided into the following parts: The cutter drive; helical guides; relieving mechanism; index and feed mechanisms. The separate sections will be described briefly.

The cutter drive is operated from the four-step cone pulley seen in Fig. 2. A pinion at the rear end of the cone pulley shaft meshes with a large gear shown at *A* in Fig. 9, which is provided with a graduated crank slot for crankpin *B* operating connecting-rod *C*. The upper end of *C* is pivoted to a wrist-pin



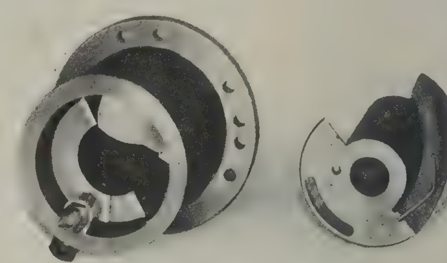


Fig. 6. Mating Helical Guides for Cutter spindle

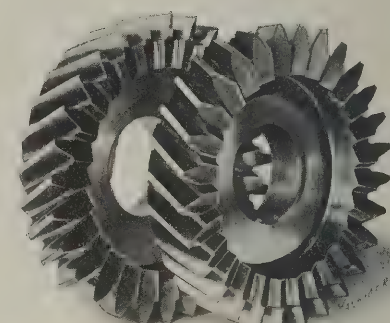


Fig. 5. Cutter-spindle and Helical Guide

Fig. 7. Helical Gear Cutters

in casing *D* which has bearings for worm *E*. This worm engages worm-segment *F* keyed to rock-shaft *G*. The rock-shaft at its other end carries spur gear segment *H* meshing with rack teeth cut in spindle sleeve *J*, Fig. 11. By means of these connections the cutter spindle *K* and cutter *L* are reciprocated. Adjustment of crankpin *B* in the graduated slot, adjusts the length of the stroke to agree with the graduations. The turning of worm *E* adjusts the position of the stroke to agree with the location of the face of the gear being cut, and screw *Y* clamps this adjustment.

The helical guides, illustrated separately in Figs. 5, 6 and 8, are shown in place in Fig. 11. The fixed guide *M* is seated in the extended hub *N* of the upper index wheel *O*. The movable guide *P* is keyed to cutter spindle *K*. Guide *M* is split into longitudinal sections adjustable on each other by means of screw *Q*. This allows the adjustment to give the proper closeness of fit.

The relieving mechanism operates as follows: Crank gear *A* is keyed to shaft *R* which extends through to the front of the machine where it carries a double-throw cam *S*. Cutter spindle *K* and all the attached mechanism is mounted in the head casting *T* which, as shown most plainly in Fig. 9, is free to swivel through a short arc about the axis of shaft *G*. At the beginning of the cutting stroke, cam *S*, bearing on roll *W*

(see Fig. 11), throws this cutter head forward into the position shown for cutting. On the return stroke, the cam bears against spring support roll *V* on the left, swinging head *T* free and relieving the cutter from the work. On the cutting stroke, the head is swung against positive stop *W* which brings it always to the same position.

As explained in connection with Figs. 3 and 4, the cutter

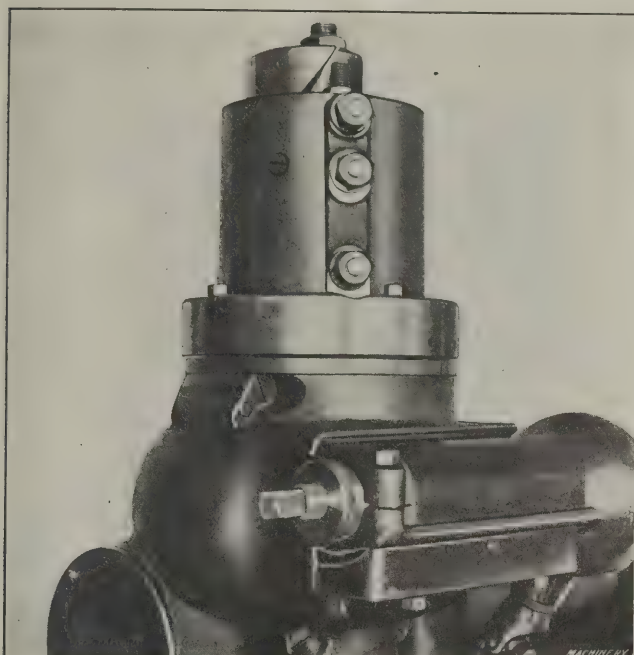


Fig. 8. Detail View of Hub containing Helical Guides

and work are revolved in mesh with each other as if they were a pair of gears. Index wheel *O* for the cutter, and the work index wheel, revolve continuously during the cut, a single revolution of the latter sufficing to complete the work in ordinary cases. They are connected by change gears set for the desired number of teeth.

Four points should be noticed with reference to this index motion: First, it is continuous, steady and slow in movement; second, there is but one revolution per cut, which greatly increases the life of the index mechanism; third, the index

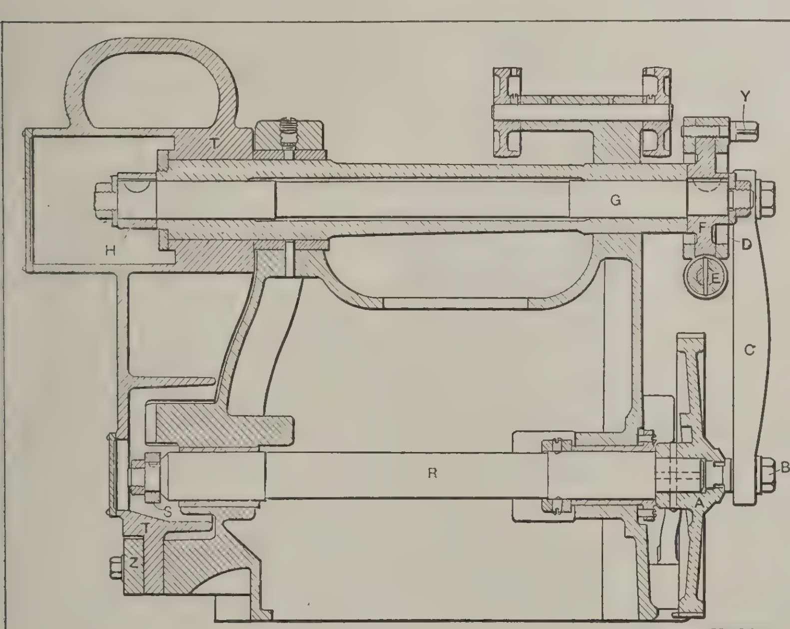


Fig. 9. Vertical Section, showing Drive for Cutter-spindle and Relieving Mechanism

worms revolve so slowly that it is possible to make them self-locking so that the helical thrust of the cutter does not disturb their connection; and fourth, the index mechanism is independent of either the cutter drive or helix mechanism, and is thus free from the irregular action of the former or the complication inherent in the usual design of the latter.

The standard reverse taper work arbor of the gear shaper is retained, thus tying the work, arbor and spindle into a solid whole and giving the entire structure great rigidity. As shown also in Figs. 1 and 4, an outboard support is provided for the work arbor as well as a work support clamped directly to the main frame of the machine. These provisions hold all work firmly, support it against the thrust of the cutter, and permit the machine to "get out" of the cutter all there is in it. Two heavy streams of oil are directed on the cutting edge, cooling the tool and giving a fine, smooth finish on steel work.

The feed mechanism is identical with that of the regular gear shaper. It comprises the rotary motion for the index mechanism, together with means for feeding the cutter in to depth at the beginning of the cut and stopping the feed when the cut is finished. It is entirely automatic in its action.

The double-cut mechanism furnished with every machine, is invaluable when the coarseness of the pitch or the hardness of the material makes it necessary to take a roughing and a finishing cut. The adjustment of a clamp-screw in a graduated slot, determines the amount of stock left for finish.

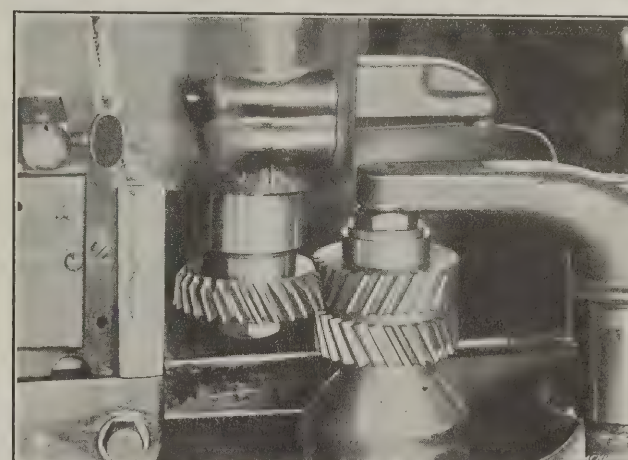


Fig. 10. Cutting a Herringbone Gear

When set for the double cut, with the feed thrown into operation, the following sequence takes place automatically: First, the cutter is fed in to roughing depth. The work then makes one full revolution with the cutter at roughing depth. The cutter next feeds in to finishing depth, and the work makes one full revolution at this depth. Finally, the feed is stopped and a bell rings to call the operator.

Cutting Special Forms of Helical Gearing

The helical gear shaper, like the spur gear shaper, will cut teeth in to a narrow recess. It is therefore easy to cut teeth to a shoulder or to cut cluster-gears with two or more diameters on the same piece. This same feature makes it possible to cut solid, double helical or herringbone gears. With this design of gearing, it has been necessary hitherto to leave a wide space between the two sections for the cutter to run out into, or else the gear has been made in two pieces which are cut separately and fitted and fastened together afterwards. One of these expediencies wastes space, the other time. With the helical gear shaper, a herringbone gear can be made in one solid piece with a narrow groove between the two sections. One-quarter or five-sixteenths inch will do, depending on the pitch or helix angle. The teeth are cut in to this narrow recess from either side. Fig. 10 shows such a gear with the right-hand teeth already formed, and the cutter at work on the left-hand teeth. Where the mating gear is to be cut in the same way, a simple locating fixture brings the teeth on each side of both gears, into position so that a full bearing is obtained on each side of the recess.

Specifications of No. 30 Helical Gear Shaper

The maximum capacity of this machine for cutting helical gears is as follows: Outside diameter, 18 inches; face width, 4 inches; diametral pitch in cast iron, 6; diametral pitch in

steel, 8. It can also be arranged for cutting regular external spur gears, having a maximum outside diameter of 24 inches; face width, 4 inches; diametral pitch in cast iron, 6; diametral pitch in steel, 7. The strokes per minute are 45, 64, 100 and 140. The strokes per inch of pitch diameter of the gear blank are 216, 286, and 418.

In the construction of the machine, particular attention is paid to such vital parts as the index wheels and worms, guides, cutter ram, work spindle, bearings, etc. The materials used are carefully selected for the service required of them. The

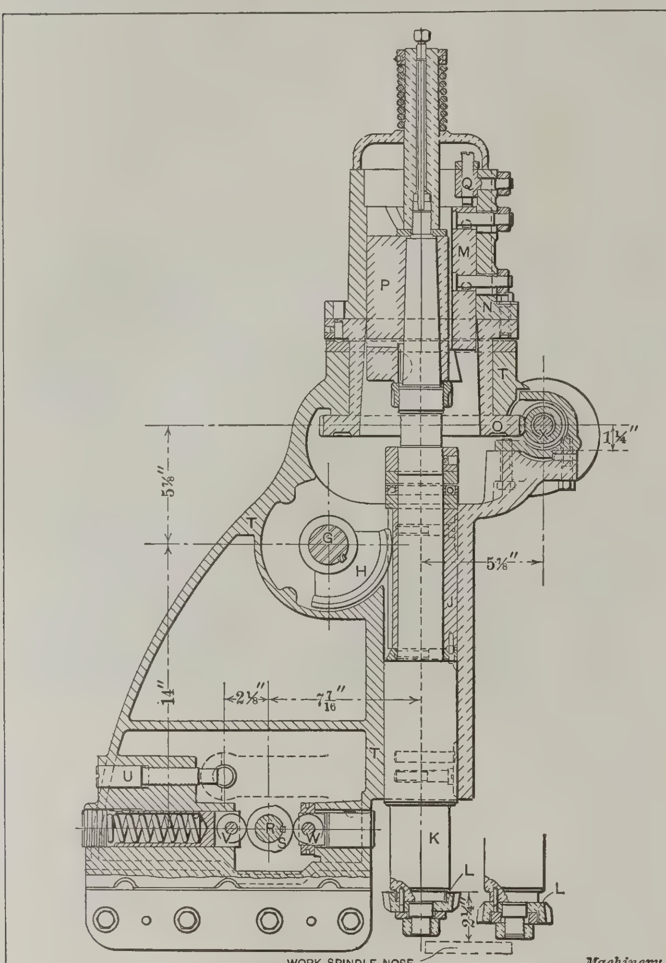


Fig. 11. Section through Cutter-spindle

cutter spindle is hardened and ground. The fast running bearings are lined with phosphor-bronze.

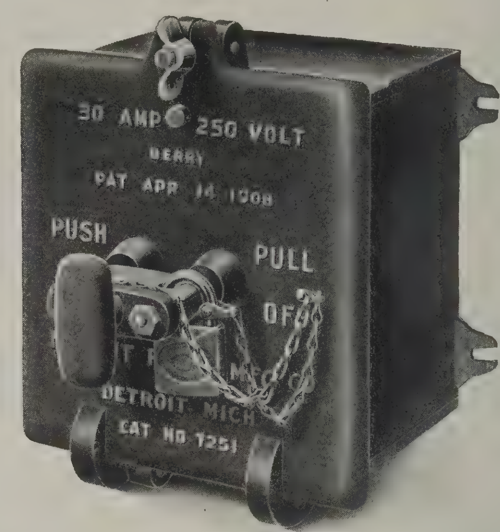
In addition to the machine, the following equipment is furnished: Oil pump and all connections; flexible tubing; two oil nozzles; countershaft complete with tight and loose pulleys; change gears for spacing all numbers of teeth from 12 to 50, and from 50 to 450, excepting the prime numbers and their multiples; one pair of right- and left-hand helical guides of any helix angle specified, up to 30 degrees; all necessary wrenches, etc.

DETROIT SWITCH WITH SAFETY LOCK

Those who read Professor Hutton's article in the April number on the "Prevention of Industrial Accidents," will recall the reference to a safety lock for electric switches, to prevent the unauthorized closing of a switch when repairs are being made along some part of the circuit. The Detroit Fuse & Mfg. Co., 1400 Rivard St., Detroit, Mich., has just brought out an "ironclad" fused switch which is equipped with a padlock for locking the switch in the "off" position, to prevent a circuit from being closed at the wrong time.

The switch is operated by means of a plunger-actuated mechanism with rods projecting through the cover of the box. This mechanism is controlled by a handle on the outside of the switch, and it carries the fuses. The mechanism is attached to the inside of a rubber-gasketed hinged door, and the fuses may be replaced by opening this door. All current-carrying parts are "dead" when the door is open, and the "live" connections are all at the bottom of the switch box, so that it is impossible to make accidental contact with them.

The cover of the switch can be clamped shut by an eye-bolt and wing-nut which engages lugs as shown. A drilled rivet is fastened to the cover, and by running a car seal through this rivet and a hole in the wing-nut, the switch can be sealed to prevent tampering with the fuses. By means of the padlock and clamp shown, the box can also be locked in the "off" position. This feature makes the switch ideal for the control of



Switch with Padlock for Locking it in the "Off" Position

elevators, special machinery or any electrical service where it is desirable at times, to prevent an unauthorized person from closing a circuit. When repairs are being made to a motor, power circuit or lighting circuit, the one making them can lock the switch in the "off" position and secure absolute protection. The padlock and clamp are attached to the switch cover by short brass chains.

POWERFUL HYDRAULIC JACK

The United States government has recently purchased from the Duff Mfg. Co., of Pittsburg, Pa., a hydraulic jack capable of lifting a load of 500 tons. This jack is to be used in the Washington Navy Yard. It is of the independent pump type

Duff-Bethlehem 500-ton Hydraulic Jack

and is composed of two separate parts, one of which contains the water reservoir with its pump chambers, and the other the ram or lifting mechanism.

Flexible copper tubing capable of withstanding a pressure of 10,000 pounds per square inch, connects the two members as the illustration shows. With this arrangement, the ram can be placed in any position where there is room enough for it, while the pumping mechanism can be located at a sufficient distance to allow the operator plenty of working room.

The pump is an improved duplex type, providing an accumulative stroke on the upward motion of the pump piston, and

a working stroke on the downward movement. The pump is so arranged that a light load can be lifted five times as fast as a heavy load. This differential speed is automatically spring controlled, and requires no regulation of valves by the operator. The high speed is used for loads up to 35 per cent of the jack's capacity. In lifting loads greater than 35 per cent of the total capacity, the spring controlled valve automatically opens at the predetermined pressure per square inch, and the pump becomes single acting, working on the down stroke only.

Another feature of this jack is the gage, which shows the exact lifting pressure that is being applied. This gage acts as a scale and registers in tons the weight that is being lifted. The jack is simple in construction and has no parts to get out of order.

CLAMPS FOR MACHINE TOOLS

The clamping of castings or forgings to the table of a planer, milling machine or other tools, frequently requires more time than the actual operation of machining the work. Furthermore, a great deal of unnecessary time is often consumed

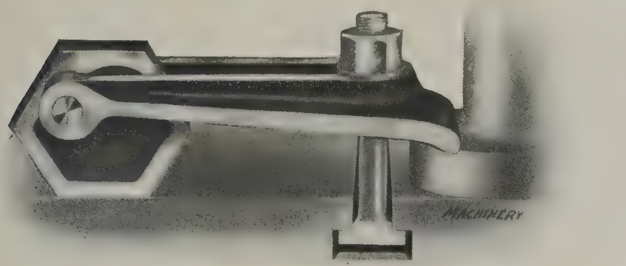


Fig. 1. Clamp Eccentrically Pivoted to Hexagonal Block

because of the lack of proper clamping facilities, as every machinist knows. Schuchardt & Schütte, Cedar and West Sts., New York, have placed on the market the different styles of clamps shown in Figs. 1, 2 and 3, which are designed to reduce the time required for setting up work.

The construction and application of these clamps is so clearly

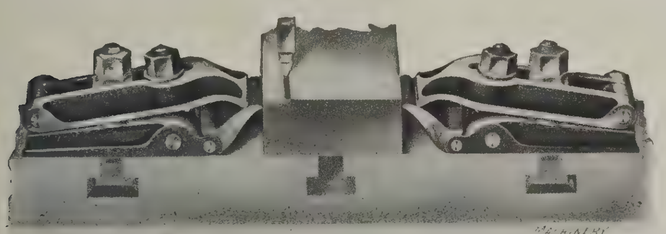


Fig. 2. Type used for Side Clamping

shown by the illustrations that a description is scarcely necessary. The type illustrated in Fig. 1, has a clamp or claw which is pivoted eccentrically to a hexagon block, with the advantage that six different heights may be obtained by simply rotating this block. The design illustrated in Fig. 2 is intended especially for side clamping, whenever the nature of

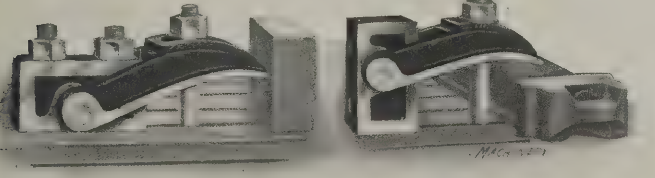


Fig. 3. Combination Clamp for Side and Top Clamping

the work is such that clamps on top would interfere with the movement of the tool. This clamp has two bolts, one of which holds the base while the other tightens a hinged upper member which wedges a hinged claw at the end against the side of the part to be machined. The clamp illustrated in Fig. 3 may be used for side clamping, as indicated to the left, or for top clamping as shown in the right-hand view. This clamp is, in some respects, a combination of the two types previously referred to. The outer end of the clamp is pivoted to a rectangular packing block, in such a way that four different heights are available. These clamps are made in a number of different sizes.

MAGNALAMP FOR MACHINE TOOLS

Operators of machine tools frequently have trouble in adjusting an electric lamp so that the light falls on the right spot. The device illustrated in Fig. 1 is designed to overcome this difficulty, as it can be attached to the machine (as shown in Fig. 2) or work by means of an electro-magnet which con-

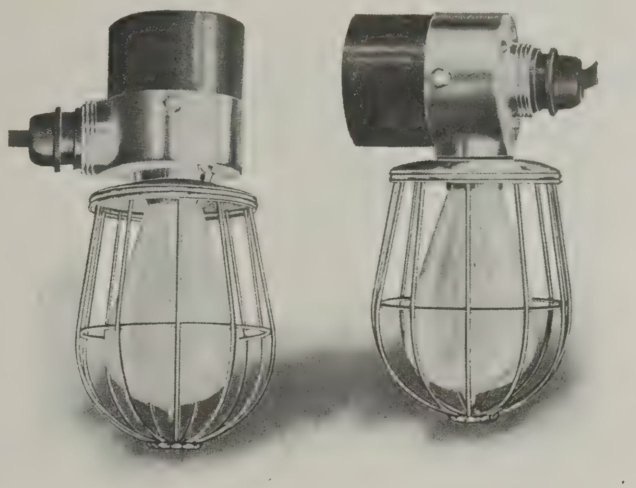


Fig. 1. Electric Light with Magnet for Attaching it to Machine or Work

tains an ordinary incandescent light bulb. It can be applied to iron, steel or any structure that is entirely or partly composed of iron and steel, and the magnetism causes it to stick tight enough to withstand considerable pull. The light bulb extends either from the end of the cylindrical magnet, as shown in the view to the left, or radially from the side, as indicated in the right-hand view, and its position can easily be changed. The same current supplies the lamp and magnet, although the latter consumes a very small amount of energy. The current is controlled by a quick-acting switch operated by a knurled disk which forms the central pole-piece of the magnet. When this knurled pole-piece is turned in a clockwise direction, the switch is opened or closed with each snap. This switch cannot be operated when the magnet is in use. After the current has been turned on and the lamp is lighted, the magnet can be de-energized (so that the lamp may be placed or removed) by pressing the little push button seen extending from the side of the casing above the magnet. By releasing this button, the magnet is instantly brought into service again. After the lamp has once been lighted, it remains lighted, irrespective of whether the magnet is energized or not; consequently, it is never necessary to be without light.

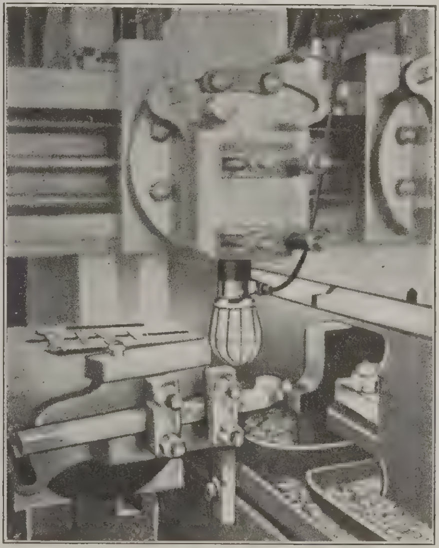


Fig. 2. Magnalamp attached to Planer

This lamp should be supplied with direct current, and it is furnished for the two standard voltages of 110 and 220 volts. This lamp is also supplied with a counterbalance device when it is to be used as a permanent lighting fixture. With this equipment, it serves as an ordinary drop-light when not at-

tached magnetically, and it can be quickly adjusted to the required height. The magnalamp is made by the Sachs Laboratories, Inc., 103 Allyn St., Hartford, Conn.

LODGE & SHIPLEY HEAVY FORGE LATHE

The Lodge & Shipley Machine Tool Co., Cincinnati, O., has recently designed a lathe for taking very "heavy" cuts in connection with the rough turning of shafting and forgings. The power and cutting capacity of this machine is shown by a recent performance, which is said to be safely within the capacity of the lathe for continuous service. A 0.45 carbon steel axle was reduced 1½ inch in diameter by a single cut, with a 9/64-inch feed per revolution, and a surface speed of 63 feet per minute. The lathe is unusually massive, as the accompanying illustrations show, so that it will withstand continued service of the most severe nature.

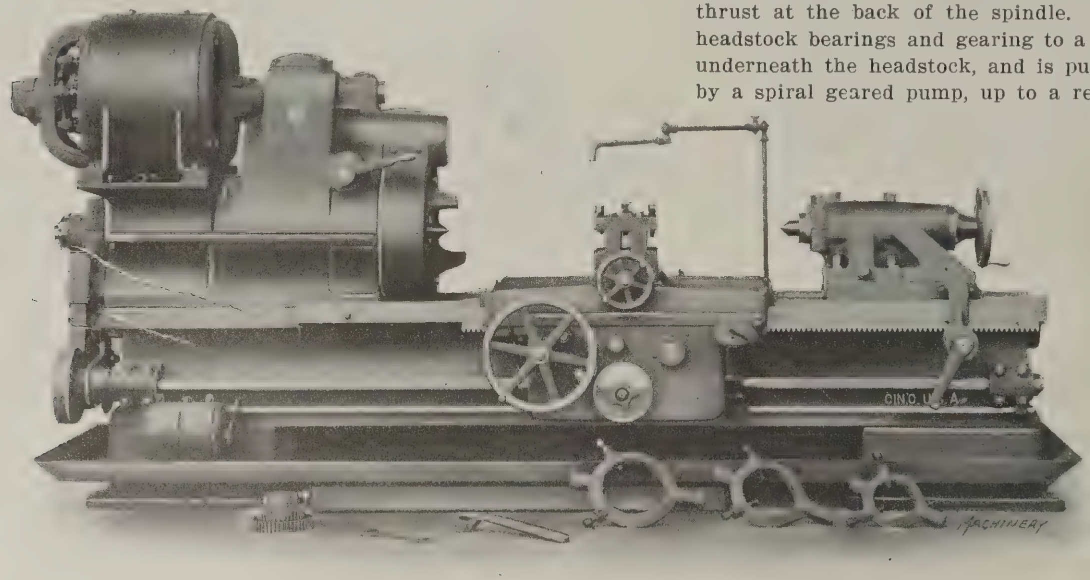


Fig. 1. Powerful Motor driven Lathe built by Lodge & Shipley

The actual swing over the carriage is 15 inches, and the swing over the bed 30½ inches. The arrangement of spindle speeds is such that the lathe is adapted only for turning work between centers; that is, the speed range suits only diameters which will swing over the carriage. The spindle speeds provide for turning at a rate not to exceed 140 feet per minute on 3-inch diameters, and not less than 61 feet per minute on 15-inch diameters.

The headstock is designed to receive a 30-horsepower direct-current, variable-speed motor, having a speed range of from 400 to 1200, but any type of motor can be applied and of any horsepower up to 40. There are two gear ratios, which, with the motor range of 3 to 1, give spindle speeds varying from 15.6 to 173 revolutions per minute. Any ratio of gearing may be provided to accommodate motors of higher speeds or to give the driving spindle any desired slower speed. The reducing of the spindle speed will, of course, increase the gear ratio. The driving gears within the headstock are of steel, and are hardened and heat treated. The lightest driving gear is 4 diametral pitch. The front spindle bearing is of large diameter and gives a projected area of 60 square inches.

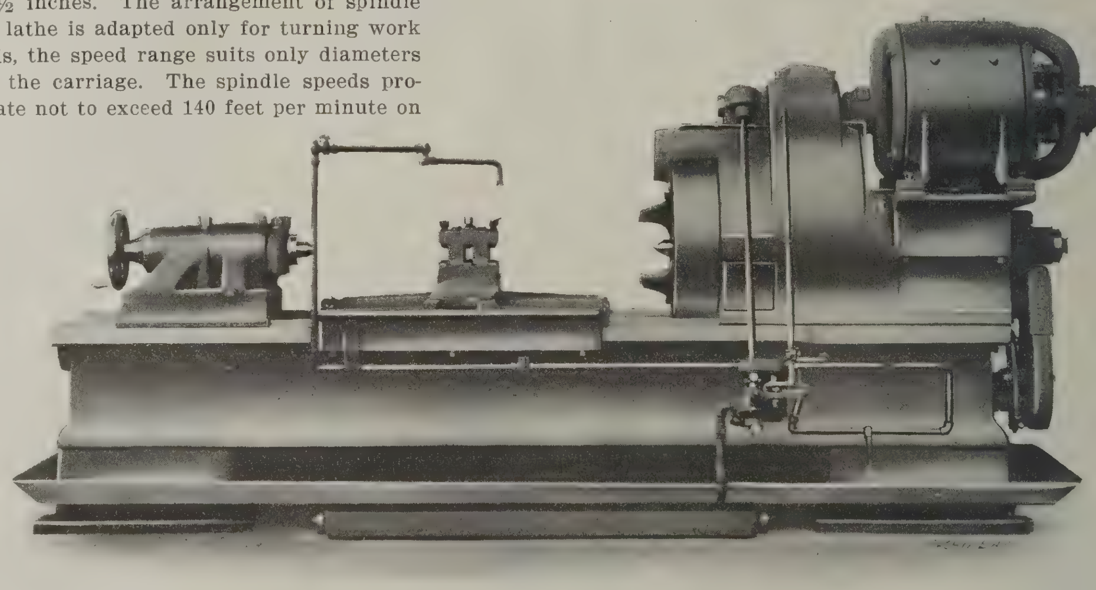


Fig. 2. Rear View of Forge Lathe showing Separate Pumps for Oiling Headstock and Supplying Lubricant to Cutting Tool

The spindle bearings are of standard composition metal. All other headstock journals are bronze bushed. The back spindle bearing is also of large diameter and gives a projected area of 47 square inches. The machine is provided with a compensating faceplate drive. The faceplate is 22 inches in diameter and is made of steel, as are the dogs which act as drivers. These drivers can be adjusted radially on the faceplate to accommodate driving dogs of various capacities and lengths. The driving shafts within the headstock are supported on both sides of the gears, thus eliminating all overhang.

Forced lubrication is provided for all of the driving gears and journals, including the main spindle bearing and the thrust at the back of the spindle. The oil drains from the headstock bearings and gearing to a reservoir cast in the bed underneath the headstock, and is pumped from this reservoir by a spiral geared pump, up to a reservoir at the top of the head, from which it is piped to the various bearings and gears. The spindle is solid, and runs against a solid, hardened steel plug at its back end, to oppose the tremendous thrust.

The centers are No. 6 Morse taper, and the one in the headstock is fitted into a hardened steel bushing forced into the spindle. The headstock is 48 inches long overall, and has covers which entirely enclose all the driving gears. The machine will deliver, with a 30 horsepower motor, about 19,500 pounds pull on an 8-inch shaft, and with a 30 per cent overload of motor, about 25,000 pounds. This would ordinarily create a pressure of 400 pounds per square inch on the spindle bearing, but the driving pinion is so placed that the pressure of the cut is opposed by the driving pinion itself; consequently this amount of pressure per square inch is greatly reduced.

The tailstock arbor is of large diameter and length, and is reamed for No. 6 Morse taper. It is made of tool steel. The tailstock has a long bearing on the bed, and a locking pawl engages a rack cast inside the bed.

The smallest gear in the apron is 3½ inches in diameter, and the finest pitch used, 5 diametral pitch. The smallest face of any gear in the apron is 1½ inch wide. All apron gears are of steel, and all bearings are bronze bushed. The friction

for locking the feed is placed on the outside of the apron to insure close inspection of friction faces at all times. The apron is double webbed, giving support at both ends of all studs. A rear view of the apron is shown in Fig. 3. The handwheel is 18 inches in diameter, and is geared so that one turn moves the carriage about ⅞ inch.

The carriage is very long, and the entire length bears on the bed. The total area of bearing surfaces on the bed is 245 square inches. It is gibbed both front and rear, and also under the inside V's. The bridge is extremely wide and strong, the tool-block is steel, and rests on a cast-iron cross-slide. It has one center slot to accommodate tools 1¼ inch by 2½ inches, and two open sides for tools of the same dimensions. Serrated and hardened tool-steel plates are secured to the tool-block to give the tool a long bearing. The cross-slide is very long, and has 168 square inches of bearing surface on the top of the carriage. The cross-feed screw is of large diameter, and is placed as high as possible to resist the action of the cut. There is an oil trough cast entirely around the carriage, and this trough is placed below the inverted dovetail so that the lubricant from the cutting tool will not flood around the sliding surfaces. The carriage drains at the four low corners, back into the drip pan under the bed.

A separate and very substantial pump is provided for the cutting compound, which is geared positively from the headstock, and this pump will deliver a ¾-inch stream of lubricant to the cutting tool at the rate of 16 gallons per minute. Instead of the usual flexible tubing there is telescopic tubing, (see Fig. 2) with proper stuffing boxes to take care of the longitudinal traverse of the carriage.

The bed is very wide at the top and unusually deep. It is mounted on cabinet legs, and has a heavy steel oil pan the entire length. This oil pan does not rest upon the floor, but is high enough to permit a cast-iron drip pan, mounted upon rollers, to be run under it. The lubricant from the chip pan is drained directly into the cast-iron pan and is pumped from this again to the cutting tool. This method separates the chips from the lubricant, and the chip pan itself is always comparatively dry.

The feed rod is of large diameter, and has two keyseats diametrically opposite for driving a steel bevel gear in the apron. The rod is driven by plain change gears, and four changes of feed are provided as follows: 1/16, 3/32, 9/64 and

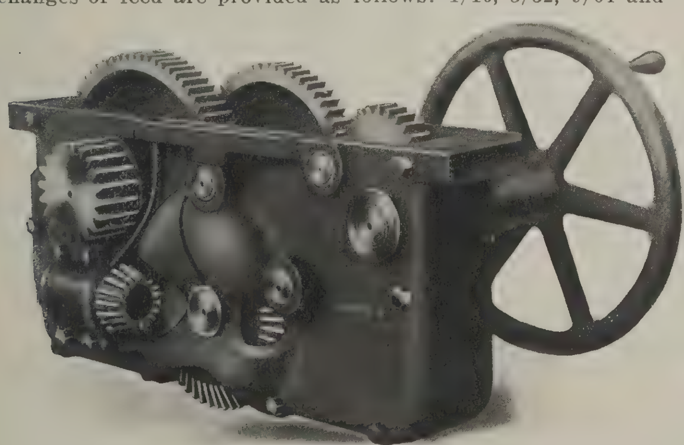


Fig. 3. Rear View of Forge Lathe Apron

3/16 inch per revolution. The feed gears are steel, of wide face, and coarse pitch. The motor controller rod extends along the front of the bed, and is operated by a handle near the top of the carriage.

BICKNELL-THOMAS CLUTCH

The Bicknell-Thomas Co., of Greenfield, Mass., is now manufacturing a roller grip clutch which contains few parts and is self-adjusting for wear and varying load conditions. It requires a small amount of space and is easily engaged. The construction of the clutch is shown in Figs. 1 and 2. Inside of the body *A*, which is free to rotate upon the shaft, there is a hardened steel bushing *B*, which is keyed to the shaft. A hardened steel cam-ring, which may be seen to the right in Fig. 1, is loosely mounted on the end of the clutch body. Fitting into slots in the body *A* and interposed between the cam-ring and bushing *B*, are three hardened steel rolls *D*. One end of a flat coil spring *E* is attached to body *A* and the other end

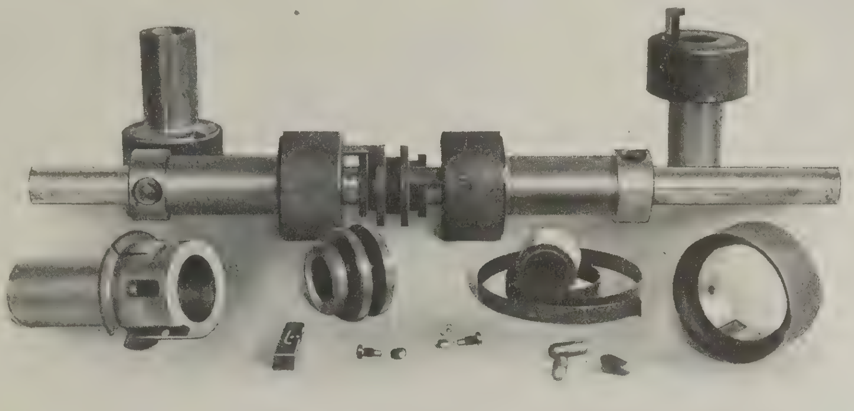


Fig. 1. View showing Single and Double Bicknell-Thomas Clutch and Component Parts

to the cam-ring, which is held onto the body by a screw and roll *F*. On the inside of the cam ring and directly over the rolls, there are cam surfaces. The clutch is operated by shifting slide *G* which causes the coil spring *E* to slightly rotate the cam-ring upon the clutch body. As the result of this rotary movement, rolls *D* become wedged between the fixed

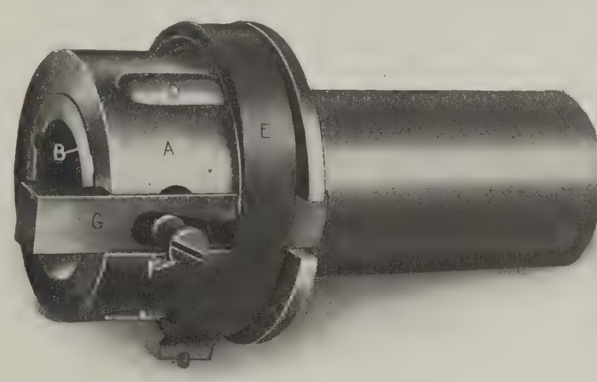


Fig. 2. Single Clutch with Cam-ring Removed

bushing *B* and the cam-ring, thus causing the clutch and shaft to rotate as a single unit. A single clutch is composed of only sixteen parts, including the oil cup, shifter, thimble and collar, and all parts are interchangeable.

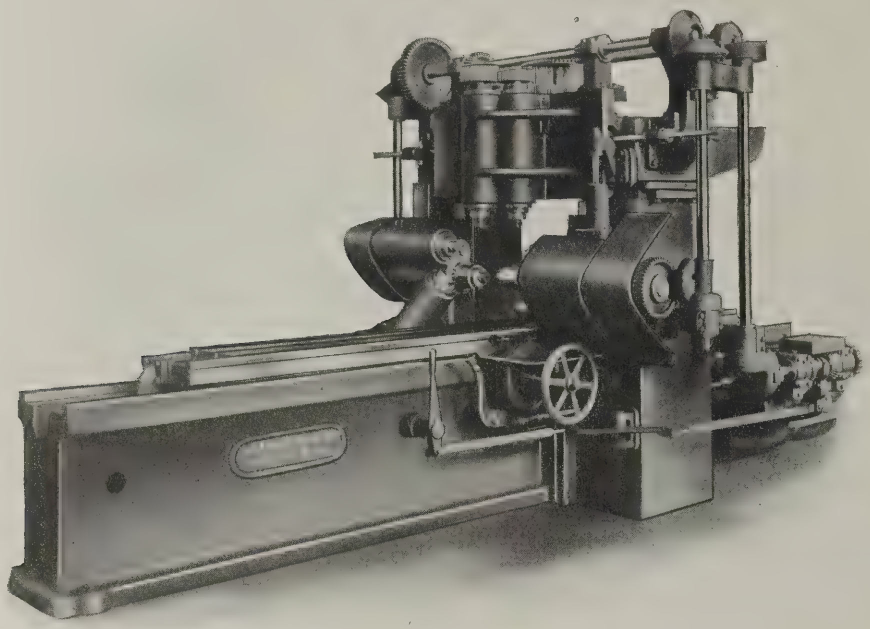
BEAMAN & SMITH NINE-SPINDLE MILLING MACHINE

The nine-spindle milling machine illustrated herewith is a special design recently built by the Beaman & Smith Co., Providence, R. I., for automobile manufacturers. This machine finishes, in one operation, three sides of as many "T-head" cylinder castings as the table will accommodate, thus greatly increasing the rate of production and giving a uniformity to the work that is impossible when each casting is machined separately.

The construction of the machine is similar, in many respects, to the regular planer or horizontal type, except for the arrangement and number of cutter spindles and the necessary changes in the driving mechanism. A saddle on each upright carries three spindles, five of which are in a horizontal position parallel with the platen, whereas one is at an angle of 45 degrees with the platen, as the illustration shows. In addition, three vertical spindles are carried by the saddle on the cross-rail. The saddles on the uprights have vertical movements and the one on the cross-rail, a horizontal movement.

The work-table has a maximum traverse of 10 feet, 10

inches on the bed, and it is 17 inches wide and 10 feet long. It has quick power movements in either direction, varying from 3½ to 14½ feet per minute. The table is operated by a screw which engages a revolving bronze nut, and the thrust is taken by ball bearings. An automatic stop is provided, and the feeds are so arranged that the desired rate can be secured for any spindle speed. The feed movements are positive in either direction, being transmitted through gearing contained in a conveniently located feed box. Nine changes are available, varying from 1 to 6 inches. The spindles are of crucible steel and run in hard bronze boxes. The 45-degree spindle has a 2-inch endwise adjustment and the others have a 1½-inch adjustment. The ends of the spindles are made to fit cutters according to specifications. The spindles all operate in unison and the speeds vary from 17 to 69 R.P.M. The front bearings are 3 inches in diameter, 4 inches long, and means are provided to compensate for wear. The rear bearings are 2½ inches in diameter and 4½ inches long.

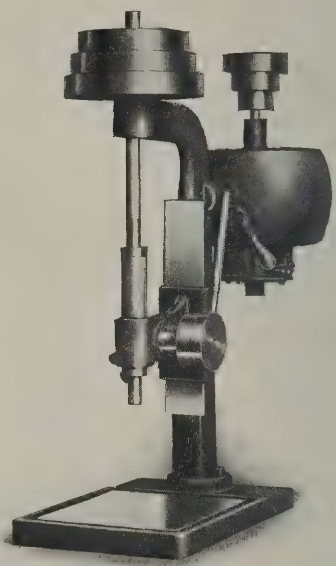


Special Beaman & Smith Nine-spindle Milling Machine

This machine is driven by a 7½-horsepower motor through gearing having a ratio of 23 to 1. The distance between the uprights is 31 inches and the maximum and minimum distances between the ends of the horizontal spindles are 15 3/8 inches and 5 7/16 inches, respectively. The minimum distance from the top of the table to the ends of the vertical spindles is 18 1/16 inches and the maximum, 19 9/16 inches. The distances between the centers of the spindles in each saddle are fixed, the positions of the spindles being governed to suit requirements. The weight of the entire machine is approximately 20,000 pounds. All fast-running shafts have bronze-lined boxes; the bearings are finished by grinding; the sliding surfaces are scraped, and all the gears, many of which are of steel, are cut from the solid.

WILLEY 12-INCH SENSITIVE DRILL

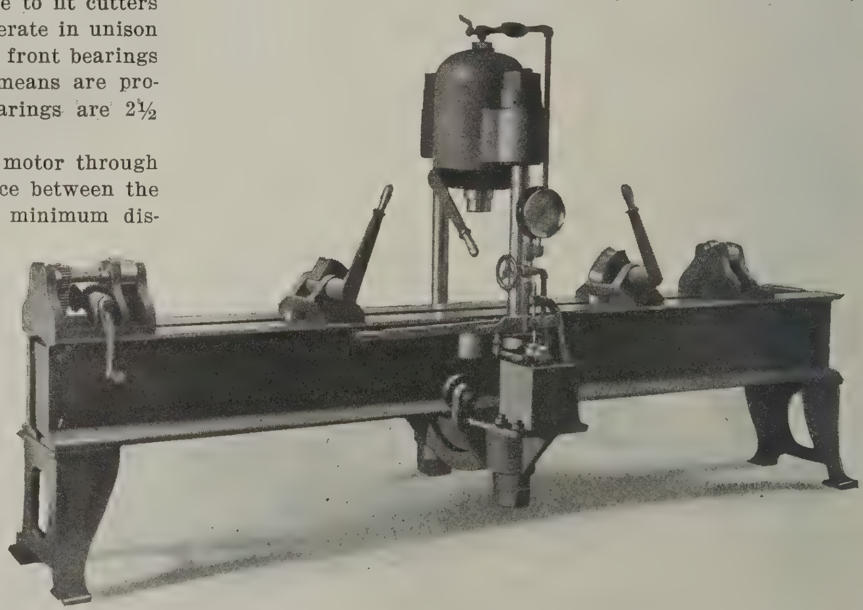
The Willey Machine Co., Jeffersonville, Ind., has brought out a new design of 12-inch sensitive drill. This machine is of the bench type and is driven by a motor which connects with the spindle by a belt operating on the three-step cone pulleys shown. Three changes of speed are available. The motor is adjustably mounted for varying the belt tension. The starting switch is within the motor frame. The motor can easily be detached and exchanged for another, in case it is necessary to use a different voltage or an alternating current. The motor is mounted high enough on the column to be out of the way of dirt and chips. The sliding head has a movement of 8 inches on the column, and the machine drills to the center of a 12-inch circle. The greatest distance from the spindle to the table is 11 inches, and the traverse of the spindle is 3 inches. The total height of the machine is 26 inches, and its weight, 90 pounds. The maximum power of the motor is ¼ horsepower.



Twelve-inch Motor-driven Bench Drill

HYDRAULIC BAR STRAIGHTENER

An improved hydraulic bar straightener has been designed by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, for use in machine shops, automobile factories, garages, etc. This machine will quickly bend or straighten bars, shafts or axles and it is adapted to various sizes of stock. The construction is simple and a powerful pressure can easily be exerted on a bar or axle.



Hydraulic Bar-straightener built by the Hydraulic Press Mfg. Co.

The press frame is formed of two steel I-beams having rigid stands at the ends, and the press itself is mounted on a carriage which rolls along the lower, outer flanges of the I-beams. A bracket on the carriage supports the pump and water-box, as the illustration shows. The cylinder strain rods are extra strong and have a large factor of safety. A pressure gage and safety valve are provided to eliminate all danger from overstrain. The upper surface of the I-beams is machined, thus

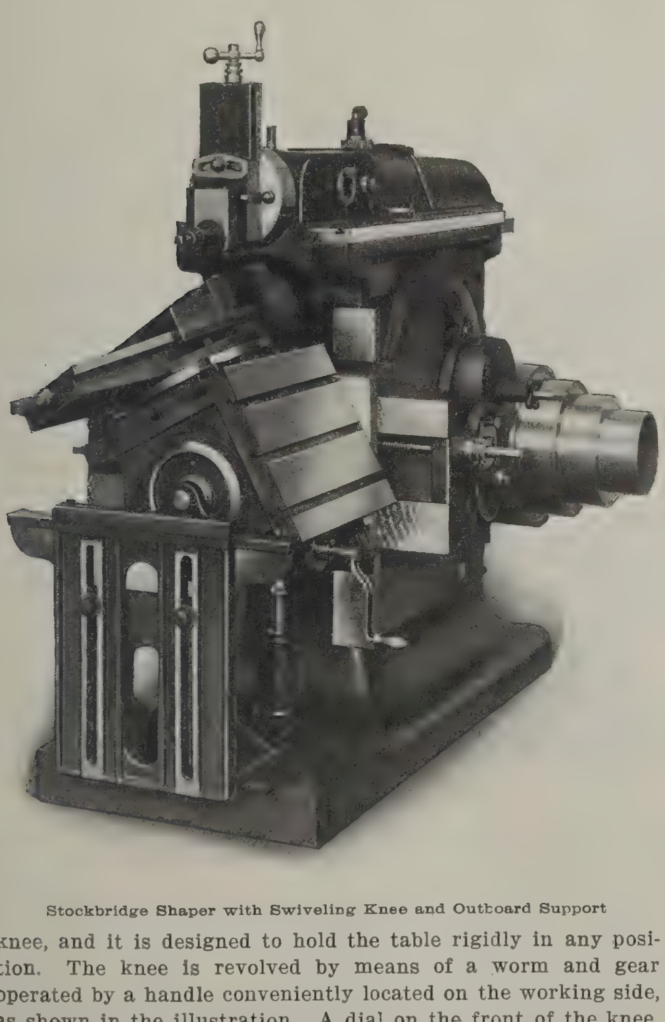
providing a true surface upon which the bending blocks and the tail roller center can slide. By means of the roller centers, axles or shafts can easily be turned to the required position by the hand crank shown. The press can be rolled to either end of the frame with one hand, thus permitting the work to be placed in position without pushing it in endwise.

When the press is in use, the axle or shaft to be bent is placed on the roller centers and turned to the required position. The levers of the bending blocks are then thrown back, thus lifting the axle from the roller centers. The ram is next lowered to the proper position by a hand-lever attached to it, which operates through a rack-and-pinion movement. Everything is now ready for applying the pressure. The pump is operated by hand, and as it is provided with a 30-inch extension handle, pressures up to 125 tons are easily obtained. A pressure of 75 tons is sufficient to bend a solid iron bar 4½ inches in diameter, with the supports 30 inches apart, whereas a pressure of 125 tons will bend a bar 6 inches in diameter with the supports 36 inches apart. It is evident, of course, that larger bars can be bent by increasing the distance between the supports. The ram has a movement of 4 inches, but by using extension blocks which can be attached to it by a set-screw, the advantage of a longer travel can be secured. This makes it possible to straighten large or small bars.

This type of straightener is made in various sizes, having a beam length of from 9 to 25 feet, and with pressure capacities varying from 75 to 125 tons. In addition to the roller centers, the machine may also be equipped with spring centers, both forms being interchangeable.

STOCKBRIDGE SHAPER WITH SUPPORT FOR SWIVELING KNEE

The Stockbridge Machine Co., Worcester, Mass., is now equipping shapers of the swiveling knee type with an outboard support. This support is similar to the type used previously on the shapers built by this company having a standard stationary



Stockbridge Shaper with Swiveling Knee and Outboard Support

knee, and it is designed to hold the table rigidly in any position. The knee is revolved by means of a worm and gear operated by a handle conveniently located on the working side, as shown in the illustration. A dial on the front of the knee, which is graduated in degrees, permits setting the table to any angle when planing bevels. One side of the knee can also be equipped with a tilting top, thus making it possible to plane compound angles.

This swiveling knee support is now applied to the 16-, 20- and 24-inch back-geared shapers, and the 18-inch all-geared type. The machine illustrated is a 24-inch size. The necessity for supporting a knee of the swiveling type is just as great as, if not greater than, for a stationary knee, as shapers having the former design are frequently used for planing parts requiring considerable accuracy.

HAYES CIRCULAR FILE

The circular file shown herewith is intended for filing aluminum, solder, babbitt, and other soft metals. The particular file illustrated is 14 inches in diameter and 1 inch thick. There are teeth on both sides of the file and these are cut by hand. When the file is in use, it is mounted on a stand like an emery-wheel and is rotated at a speed of 200 revolutions per minute.

Circular or Rotary File for Filing Soft Materials

The Ford Motor Car Co. uses a file of this type for filing connecting-rod caps, the babbitt on these caps being "surfaced" by simply holding them against the side of the revolving file. This file is manufactured by the Hayes File Co., Detroit, Mich. It can be obtained in any diameter desired, and either the thickness or grade of cut is varied to meet individual requirements. The file does not clog, and it is especially valuable for finishing soft metals such as those mentioned.

BLISS DOUBLE-DRAW PRESSES

Double-draw presses are the latest development for producing cupped articles or shells by the drawing process. They differ mechanically from the ordinary double-action press in having three, instead of two moving slides, and, therefore, might appropriately be called triple-action presses. The primary object sought in the double-draw press, is to save time and increase production by making two drawing operations on a single article with one stroke of the press, or to draw and re-draw, or re-draw twice in a single operation. It will be seen that this type is, therefore, particularly adapted for articles that require more than one drawing operation to bring them to required dimensions.

The economies effected by this method of drawing, are not due to the simplicity and rapidity of mechanical production alone, but also to reduced handling of shells and the smaller space occupied by the machinery and partially finished product. In addition, the annealing of shells between operations is unnecessary. With the double-draw press, annealing is avoided, as one drawing operation immediately succeeds another, and the heat generated in the first drawing remains in the shell. As annealing involves much expense in the maintenance of furnaces, handling and cleaning annealed shells, etc., the economy, in this respect, is important.

The double-draw presses illustrated herewith are two of a line of six sizes built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. The performance of these machines is said to be very satisfactory. The presses range in drawing capacity

for blanks up to 25 inches in diameter, and the material varies from 1X tin to steel 1/16 inch thick. Shells have been produced having depths up to 10 inches. The smaller sizes are of a somewhat different construction than the larger, being arranged for dies with cutting edges, in order to cut blanks, draw and re-draw in one stroke. The larger sizes (beyond a 12-inch diameter blank capacity) are not adapted for the use of dies with cutting edges.

The slide movements in these presses operate the dies as follows: A double die with the blank on its top, is brought in contact with a blankholder. A tubular punch then descends into the top section of the die, making the first draw. The tubular punch then stops and dwells, thus acting as a blankholder during the second draw. The second draw is performed by a punch that descends through the tubular punch into the lower section of the die, the second draw beginning immediately after the first is completed.

Fig. 1 shows a machine used for cutting blanks up to 12 inches in diameter, from brass sheets or strips up to No. 22

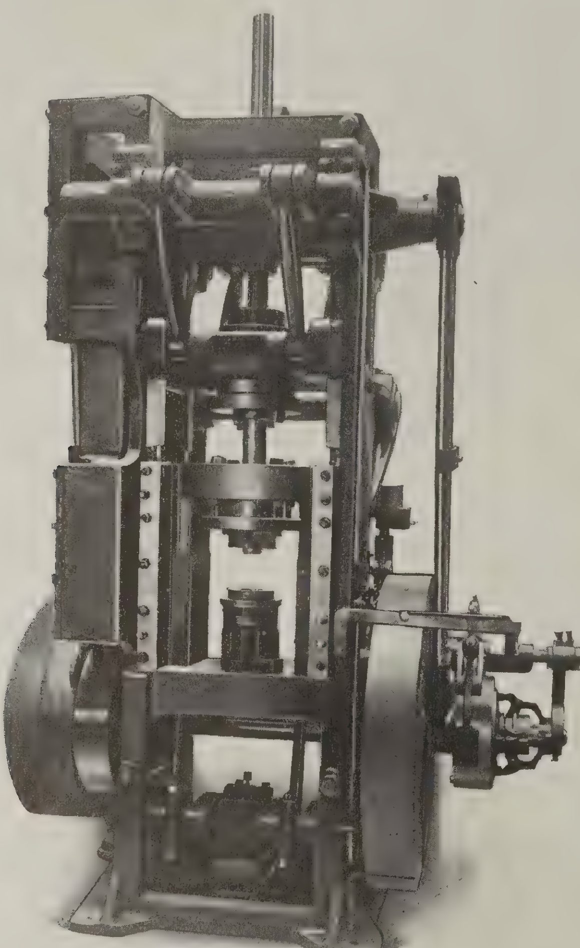


Fig. 1. Double-action Press arranged for Cutting and Drawing

gage thickness, and performing two drawing operations on them. In this machine, the die bed is fixed and rigid and the blankholder carrying the top cutting edges, moves in long adjustable guides. The moving parts are mechanically balanced, as far as possible, and are started and stopped by means of a combined, toggle friction-clutch and brake, either automatically or by hand. The blankholder is actuated by toggles that receive their motion from a cam. These toggles produce a perfect blankholder dwell during the drawing period and receive the blankholder pressure, thus relieving the cam of pressure during that time. The first draw punch slide is actuated by a crank and toggle motion, and the second draw punch by a simple crank motion.

Fig. 2 shows a machine that takes blanks up to 21 inches in diameter and of steel to No. 20 gage thickness. It will receive first draw punches up to 14 inches in diameter and produce shells up to 8 inches final depth. In this machine, the lower dies are fastened to a table that has motion and are brought up against a stationary adjustable blankholder. The table is moved up and down by toggles actuated by a large cam groove in the main gear. The toggles take all the pressure due to the blankholder and the descent of the punches, so that the cam only moves the table up and down. As the table is counterbalanced, its work is very light, which eliminates wear.

The first draw punch slide receives its motion through tog-

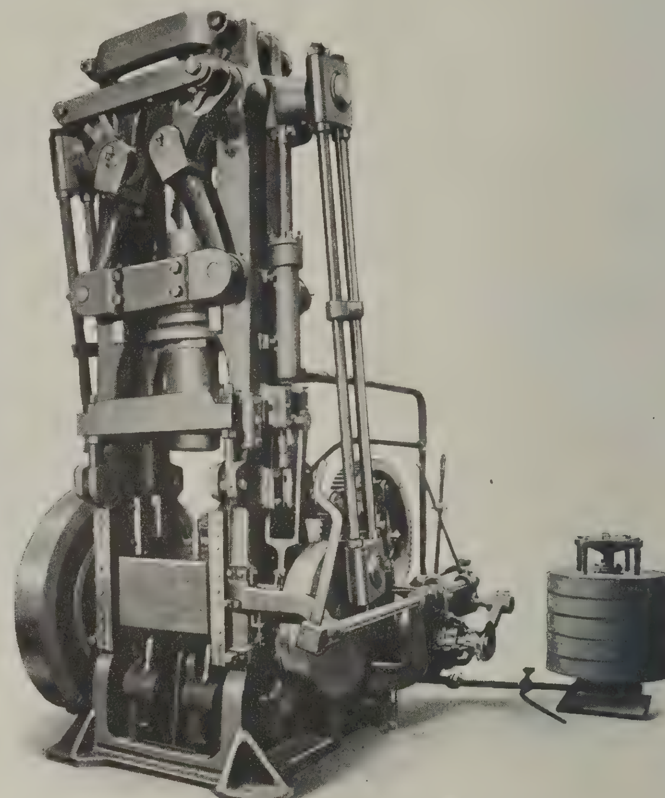


Fig. 2. Double-action Press for Blanks up to 21 Inches in Diameter

gles from the second draw punch slide. These toggles provide a fine dwell for the first draw punch, during the drawing period of the second punch. All the moving parts mentioned, are counterbalanced during their up and down movements by a hydraulic plunger and accumulator system, which makes the starting of the press easy, certain and safe. The hydraulic

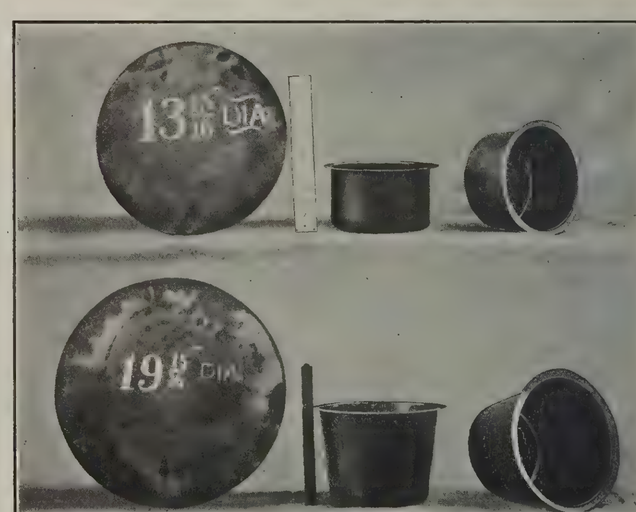


Fig. 3. Blanks and Shells produced from Flat Blank in one Operation on Bliss Double-draw Press

accumulator can be placed in the most convenient position, either below or above the floor line. The machine is driven and controlled by means of a powerful combined, friction clutch and brake fitted with both hand and automatic control. Larger machines have hand control only. Convenient adjustments are provided for the first and second draw punches and stationary blankholder.

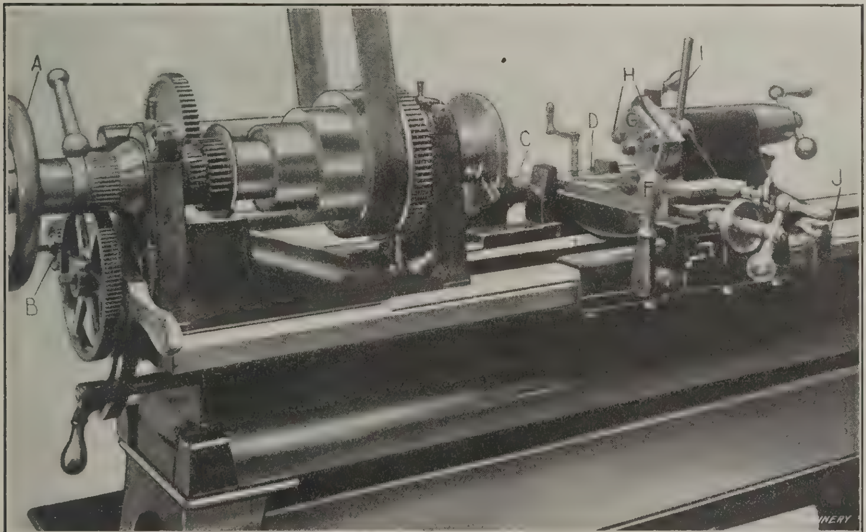
These machines embody many improvements in detail, resulting from a long experience with drawing presses of this type.

BICKFORD SPECIAL THREADING LATHE

The Bickford Machine Co., Greenfield, Mass., is now building a threading lathe designed with special reference to the needs of tap makers. The general construction of this lathe is similar to an ordinary engine lathe, there being a regular back-geared headstock and a divided tailstock having a lateral adjustment for taper work. The bed has short legs and is mounted in an oil tank base. The spindle is hollow and is provided with a draw-in collet attachment operated by hand-wheel *A*. The capacity of the largest collet is 1 inch. The lathe swings 13 inches over the ways, 4 inches over the compound carriage, and takes 28 inches between the centers. This lathe is so designed that threads can be cut in a comparatively short time.

The lead-screw *C* is mounted in a bracket at the rear of the bed and it can be adjusted to any position. Motion is transmitted to this lead-screw through change gears and a telescoping shaft, and it is driven at the ratio of 1 to 1; 1 to 2; 1 to 3 or 1 to 4. With these ratios, a 4-pitch lead-screw can be used to cut a 4, 8, 12 or 16 pitch thread. The change gear on the lead-screw is shown at *B*. The carriage is so divided that the upper part slides across the lathe and carries a half-nut *D* which can be meshed with the lead-screw. This part of the carriage is operated by raising lever *F*, which not only engages the nut with the lead-screw, but is used as a handle for returning the carriage to the starting point. This lever moves to a "dead center" position, so that the cutting tool does not tend to crowd away from the work. The lead-screw thread is of the buttress form, and there is a simple clutch dog at one end, so that the screw can easily be replaced with another of different pitch. The half-nut is also easily detached.

The roughing and finishing thread chasers *H* are of the Landis or milled type. These are held by holder *G* which, in turn, is supported on a compound slide. The chasers are fed in nearly to the required depth by this slide so that the benefit of an angular shear cut is obtained. The chasers are clamped to the holder by lever *I*. The maximum length of thread that can be cut at one setting is 10 inches, but the convenient adjustment afforded by the compound rest for aligning the chasers, makes it feasible to cut a length of 10 inches and then slide the lead-screw along for threading another section. A positive stop *J* is provided for the carriage.

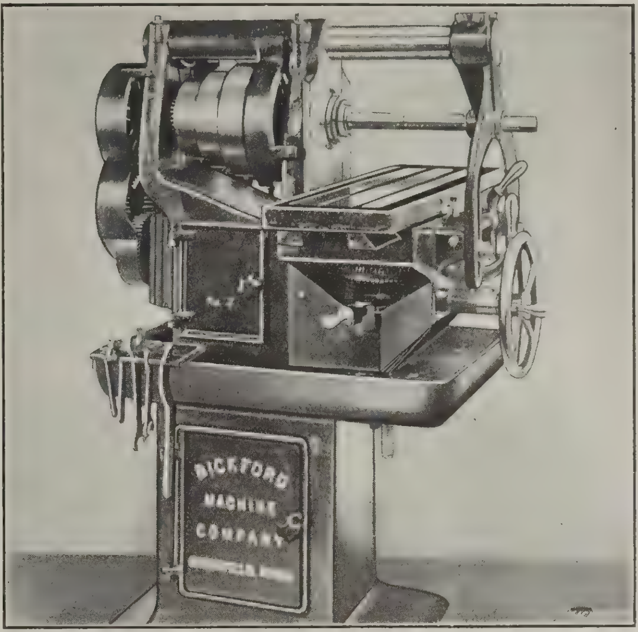


Bickford Threading Lathe of Special Design

BICKFORD PLAIN MILLING MACHINE

The milling machine shown in the accompanying view is built for plain manufacturing operations, in connection with which a rigid design is more desirable than one possessing a wide range. The knee and saddle are formed of one solid casting, which gives the table a rigid support. The table has a bearing 24 inches long and 8 inches wide. The feed is of a rack-and-pinion type. By means of a special clutch and gear device inside the knee, a handwheel at the side of the machine can be connected to operate the knee up or down, or the table in either direction. This change is made by simply moving a lever at the front of the table, to the right or left.

The spindle is of crucible steel and runs in phosphor-bronze bearings. The front bearing has a taper hole in which the spindle is held from end motion by a special clamp collar. This bearing may be adjusted a distance of ¾ inch through the main housing to which it is splined and held by a nut at each end. The front end also has a graduated collar provided with a clamp screw for setting it back to zero from any position. The cone pulley runs free on the spindle and has a small gear which drives the back-shaft, and the latter drives the main gear on the spindle. The ratio of this gearing is 6 to 1. The pulley is held in position by a spring collar located between one end and the main driving gear which travels longitudinally with the spindle.



Bickford Plain Milling Machine

The feed motion is transmitted through a coarse pitch worm in mesh with a large gear on the pinion shaft. The end pressure of this worm is taken by a ball thrust bearing. The feed shaft is all gear driven. The feed changes are effected by opening the door in front of the machine and shifting a lever. The gear box gives ten feed changes for each of the three spindle speeds or a total of thirty changes in all.

The overhanging arm is of steel and 3¼ inches in diameter. The drop arm and braces are cast integral. The levers operating the power feed and stop are conveniently placed. The table has a deep oil channel extending around the platen and loose "splashes" (not shown) are provided for carrying the overflow of oil to a tank in the base. The lubricant is forced to the tool by a gear pump at the rear of the machine. The working surface of the table measures 7¼ by 29½ inches. The weight of the machine is 1750 pounds, and this same type is built in larger or smaller sizes. It is built by the Bickford Machine Co., Greenfield, Mass.

CHAMBERSBURG STEAM-HYDRAULIC PRESSES

The Chambersburg Engineering Co., Chambersburg, Pa., has developed a line of steam-hydraulic forging presses which are built in both the single-frame and four-column types. The single-frame presses range in size up to and including 400 tons pressure, and the four-column types up to and including 5000 tons capacity. These presses have a double-lever control, and multiple tonnages for the larger sizes. With the double-lever control, the entire operation of the press is governed by

the two hand levers seen in Fig. 1 of the accompanying illustrations. As these levers perform the same functions as the two levers on a steam hammer, the operation of the press

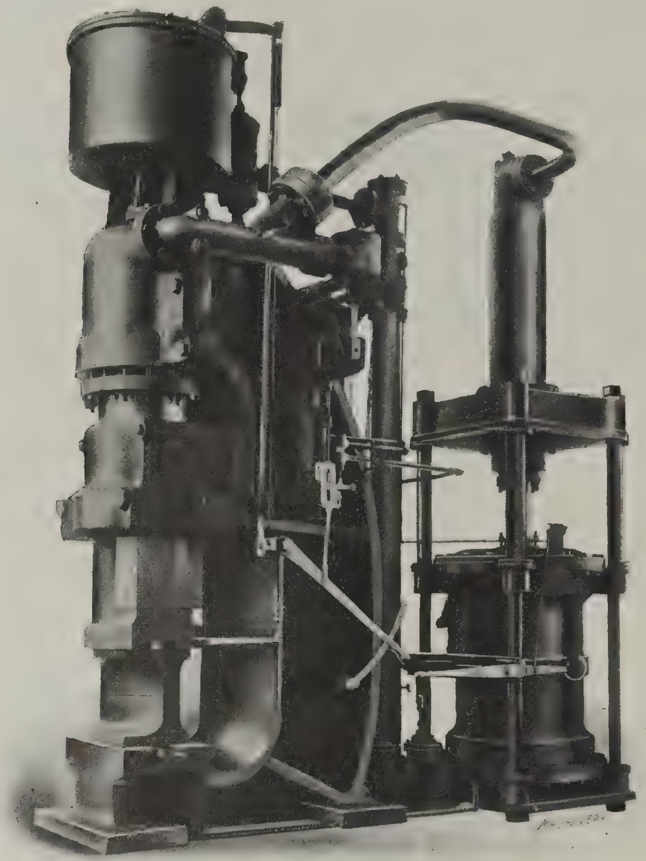


Fig. 1. Chambersburg Steam-hydraulic Press with Triple Intensifier

comes naturally to the workman. With one lever, the position of ram is adjusted for the length of stroke, and with the throttle lever, the power of the stroke is varied. In both cases the ram follows the direction in which the lever is moved.

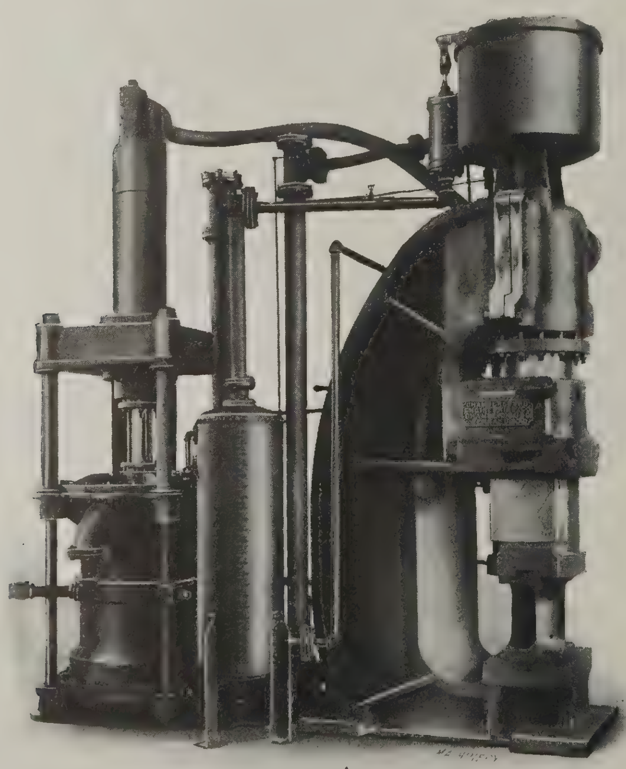


Fig. 2. Opposite Side of Steam-hydraulic Forging Press

For the larger size presses, great economy in steam consumption is said to be effected by means of a triple intensifier which enables the operator to use selective pressures in proportion to the varying necessities of the work; in other words, the amount of steam used is regulated in accordance with the requirements of the work being forged. The usual practice has been to use a single-cylinder intensifier which consumes a constant volume of steam, whether the press is exerting a 500-ton pressure, or 2000 tons in a press having a maximum capacity of 2000 tons. In the Chambersburg design, a press having a maximum capacity of 2000 tons is arranged for three multiple pressures of 600 tons, 1200 tons or 2000 tons, with the steam consumption proportional to the tonnage being used.

The main frame of the 400-ton single-column press illustrated, is an open-hearth steel casting of I-beam section, the web being stiffened by heavy ribs. Projecting flanges at the base form a support for the press. The frame has heavy guides for the ram, fitted with a cap which is held rigidly by bolts to take care of strains in any direction when forging beveled work. The dies are skewed so that the work will clear the frame when either drawing or finishing, and the notches in the ram and die seat can be planed to suit any existing dies.

NIAGARA DOUBLE-ACTION CAM PRESS

The Niagara Machine & Tool Works, Buffalo, N. Y., has added to its line of presses the double-action cam press, shown herewith. This machine is intended for cutting and drawing shells, and possesses several new and interesting features.

Instead of making the adjustment on the blankholder slide (to accommodate dies of various heights) by means of screws

Niagara No. 85 Cam Press

connected to the cam roller yokes, a threaded sleeve is used on the lower end of the blankholder slide, which enables the adjustment to be readily and accurately made. This arrangement also makes it possible to locate the guides for the blankholder slide, directly in line with the center of the crankshaft. Adjustable gibs are provided, not only for the blankholder slide, but also for the inner slide, which is a decided advantage when using combination cutting and drawing dies.

The design of the press, in other respects, conforms with the most improved practice on machines of this type. The outer slide or blankholder is positive in its motion and it is raised and lowered by two cams keyed to the main shaft on each side of the crank. The cam roller yokes are rigidly connected with the blankholder, and provision is made for taking up wear. The lower cam rollers are set in oil boxes to insure good lubrication for both rollers and cams. The inner slide

receives its motion from the crankshaft by means of a pitman, which has vertical adjustment. The press illustrated is equipped with a single roll feed attachment. Presses of this design are made in several sizes.

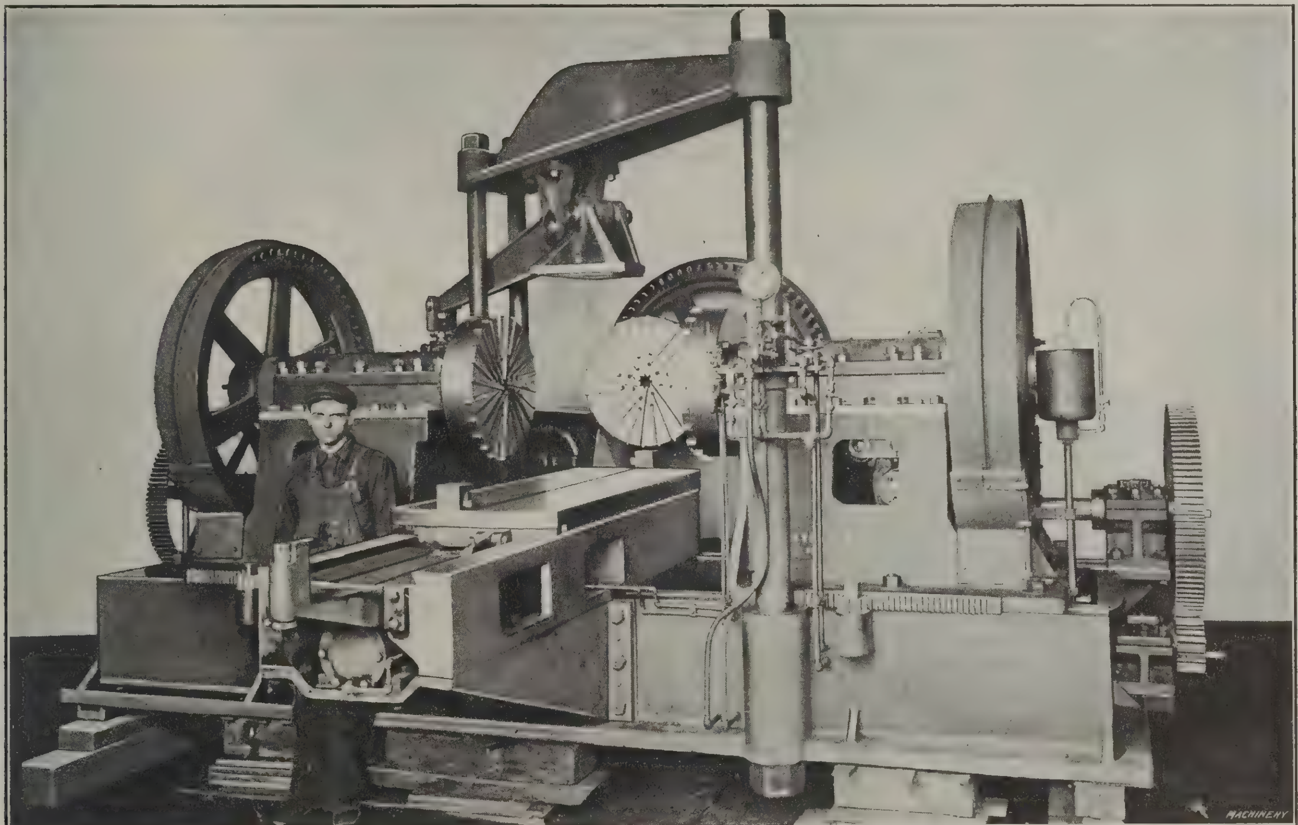
LARGE THREE-WAY FLANGE FACING MACHINE

The Pottstown Machine Co., Pottstown, Pa., has designed a very interesting machine for facing the flanges of large pipe fittings, valve bodies, and similar work. This machine is equipped with three 25-inch facing heads which operate simultaneously. The arrangement of the heads and method of driving them will be seen by referring to the accompanying illustration. The power is derived from a 35 horsepower motor at the rear, which drives through gearing having a ratio of 256 to 1. The spindles are carried by slides which are mounted in heads resting on the main bed. The spindles have a longitudinal movement of 1½ inch, which is sufficient to clear a rough casting and face the flanges to the finished dimensions. Each spindle is fed into the work by an air cylinder, and the feed is controlled by an oil cylinder. These cylinders are located inside the bed and connection is made with the spindle slides by levers which give a powerful feeding movement. The heads carrying the spindles can be adjusted along the bed to accommodate work of different widths. This adjustment is effected by racks and pinions located at the base, as shown in the illustration. Each head is rigidly secured to the bed by six 1½ inch bolts, and the back thrust is further provided for by jack-screws which rest against the ends of the bed and give a positive support.

The work is held in position by a massive steel yoke located above the machine and equipped with a lever and pneumatic cylinder, which is capable of exerting a pressure of fifty tons on the fitting. The movements of the work table, pneumatic clamp, and the facing heads, are controlled by three air valves, which are conveniently located on the yoke column at the right side of the table. An air gage is provided to show what pressure is being applied to the fitting, in order to prevent feeding the cutters against a casting before it is firmly clamped. The work table is long enough to permit using a double set of fitting holders or fixtures, so that the workman can load one fixture while the casting on the other end of the table is being faced.

The method of operating this machine is as follows: The fitting is placed in the fixture and the table is moved in by air to the working position. The three heads are then fed in to the required depth, and while this is taking place, the operator places another casting in the fixture attached to the outer end of the bed. When the inner casting is faced, the cutters are withdrawn and the table is moved outward to clear the heads, after which it is turned halfway around, thus bringing the rough casting in to the facing position. As all of these movements are pneumatically controlled, they are effected quickly by simply working the small air-valves shown. It should be mentioned that the distance which each head feeds inward is predetermined by a stop that arrests the movement of the feed lever and prevents further cutting.

Each facing head has twenty-two high-speed steel cutters which are mounted radially and operate across the entire surface of the flange. The cutter-head spindles are 8 inches in diameter, and the driving gears have a diameter of 51 inches and a face width of 7½ inches. The maximum distance between the front cutter-heads is 45 inches, or 22½ inches from the center of a fitting. The two front heads will face to a minimum width of 9½ inches. The height from the top of the table to the center of the spindle is 16½ inches. The total floor space required by the machine is 17 feet, 4 inches, by 16 feet, 5 inches. The over-all height is 8 feet from the floor line, which is about 8 inches below the top of the main bed. The weight of this machine is 60,000 pounds.



Special Flange Facing Machine built by the Pottstown Machine Co.

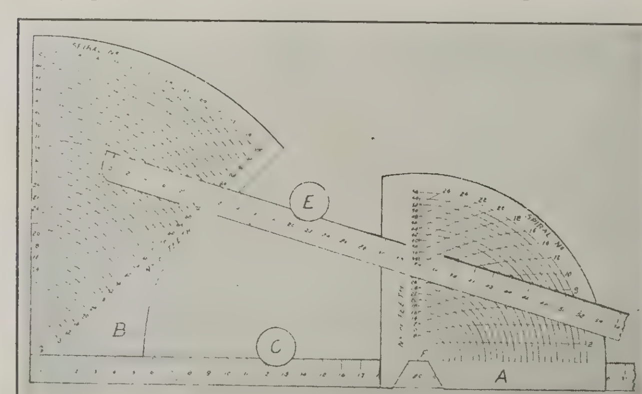
LINEOMETER FOR DETERMINING CHAIN LENGTHS

The Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has developed an instrument by means of which the length of a sprocket or driving chain can be quickly determined without making a calculation. This instrument is known as a chain lineometer, and it enables the length to be ascertained by making three simple adjustments. The instrument in its simplest and cheapest form is made of paper (as shown in the accompanying illustration), and there is also a high-grade steel instrument, which operates on the same principle.

Referring to the illustration, there is a fixed scale *C* laid off in half-inch divisions, each representing a distance equal to the pitch of the chain. On the movable scale *E* each half-inch

division represents a distance equal to two pitches—one for the upper half of the chain and one for the lower half. The circles on the sectors *A* and *B* are the pitch circles or 1-inch pitch sprockets, drawn half size. These circles are crossed by spirals having numbers which represent the number of chain links from the point where each spiral crosses a given circle to the corresponding point on the lower half of the circle.

As an example for illustrating the use of this instrument, suppose it is desired to find the chain length for sprockets having 72 and 36 teeth, respectively, a center-to-center distance of 15 inches and a pitch of ¾ inch. If the center distance is divided by the pitch, the result is 20, which is the center distance *in terms of the pitch*, and the sector *A* is set at this figure on scale *C*. The straightedge *E* is next set approximately tangent to the two pitch circles at *A* and *B*, corresponding to 36 and 72 teeth, respectively. The point where the spirals cross these pitch circles is then noted and the straightedge is shifted so that it covers all but one of these points. The zero point on the scale is set to coincide with the point not covered on the left-hand dial, and the point not covered on the right-hand dial should just touch the straightedge. In other words, place the straightedge in the position that the center line of the chain would occupy in passing from one sprocket to the other. The straightedge reading at the intersection of the spiral and pitch circle lines on the right-hand sector, equals twice the number of links in the span of "free"



Instrument made by Diamond Chain & Mfg. Co. for Determining Chain Lengths

chain. For example under consideration, this is 38, and the number marked on the spiral passing through the zero point is 44, whereas, the number of the spiral passing through the thirty-eighth division is 14. The sum of these three numbers (96) is the chain length *in terms of the pitch* and 96 × ¾ inch = 72 inches, which is the length in inches.

As the length of a roller chain must, in general, be a multiple of twice the pitch, the reading on straightedge *E* must be an even number. If the spiral does not pass exactly through one of the even-numbered scale divisions, the next higher even number is used. If an offset connecting link is employed, this number must be odd, and if the chain is of the "block" type, the reading may be either even or odd, since the chain length can be any multiple of the pitch. With the steel instrument previously referred to, the adjustments are greatly facilitated. The right-hand sector is quickly clamped into position by a thumb-screw, and the zero point of the straightedge is brought to the proper pitch circle by a slide which is graduated on the left for roller chains and on the right for block and twin-roller chains. There is also a linked connection which allows the straightedge to swing about its zero point.

If it is desired to determine a center distance which will eliminate slack in the chain, shift the right-hand sector until one of the regular divisions of the straightedge is on a spiral; then take the center distance reading and multiply by the pitch. To find the length of a belt, a special set of sectors must be used.

CINCINNATI EIGHT-INCH PRECISION BENCH LATHE

The Cincinnati Precision Lathe Co., Cincinnati, Ohio, has brought out a new precision bench lathe which is a decided departure from conventional designs. This lathe is a friction-driven type and has a single constant-speed belt pulley. This arrangement does away with a cone pulley on the spindle, thereby permitting the use of exceptionally long bearings; in fact, the spindle has a bearing that is practically continuous (as will be seen by referring to Fig. 1) which gives a very rigid support and obviates chattering.

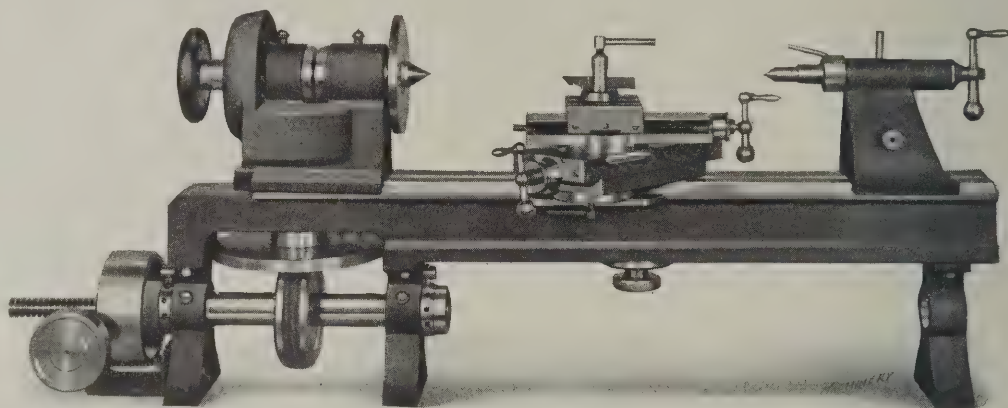


Fig. 1. Precision Bench Lathe built by the Cincinnati Precision Lathe Co.

The method of transmitting power from the main belt pulley to the spindle is shown more clearly in Figs. 2 and 3. The main driving pulley is keyed to a hollow, slotted driving shaft which contains a rack shaft, by means of which the position of the driving friction disk is varied, as will be explained later. A key passes through both of these shafts and engages the driving friction disk which transmits the movement to the horizontal driven disk above it. The latter is keyed to a vertical spindle which drives the lathe spindle through a pair of accurately cut miter gears, as shown in Fig. 2. There is a ball thrust collar bearing between the horizontal friction disk and the lathe bed, and the miter gears run in oil.

The mechanism for varying the speed adjustment is shown in the sectional view, Fig. 3. The rack shaft, previously referred to, meshes with a pinion attached to a handwheel on the outer edge of which is a speed indicator. By means of this handwheel, the friction driving wheel is shifted on the driven disk for obtaining any desired speed in either a forward or reverse direction. When the position of the disk is changed, the driving key slides in a slot cut in the hollow shaft. There is a depression in the center of the driven disk, so that the machine can be stopped independently of the

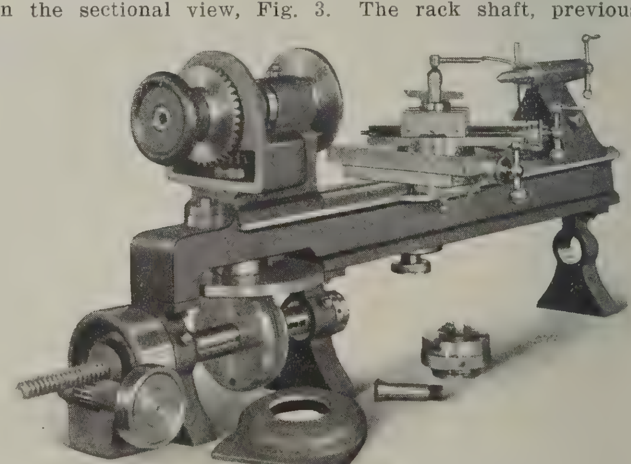


Fig. 2. Another View of the Precision Lathe—Spindle Gear Guard removed

driving belt. If desired, the friction disk can be chamfered at the outer edge to permit stopping the machine by placing the driver either at the central or outer positions. This friction transmission is said to give a strong drive, thus making it possible to take heavy cuts as well as light delicate cuts. The face or periphery of the driving friction disk contains layers of specially treated oak-tanned leather, subjected to a high pressure in order to increase its durability.

Any wear which may occur between the friction disks, can be taken up by means of eccentric bushings so arranged that the friction driving shaft may be raised or lowered parallel to the face of the driven disk. The power required for the heaviest cuts taken on a precision lathe, is so small in proportion to the efficiency of the drive that the friction mechanism cannot be overloaded.

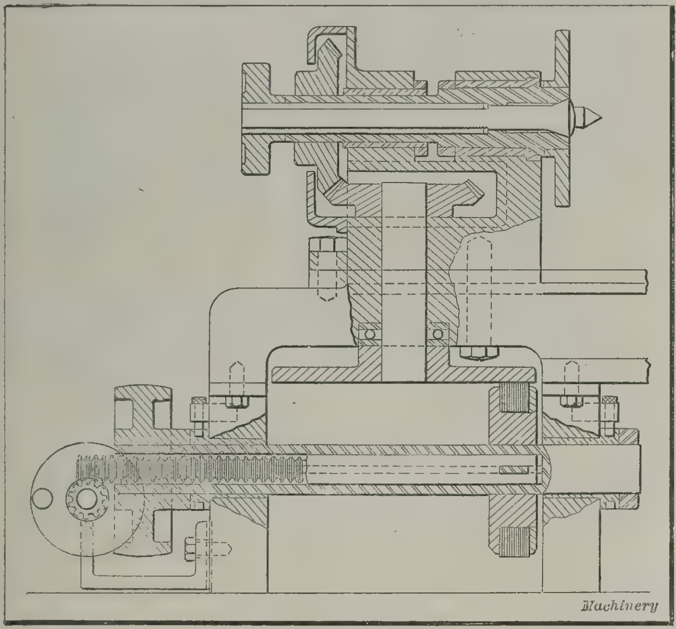
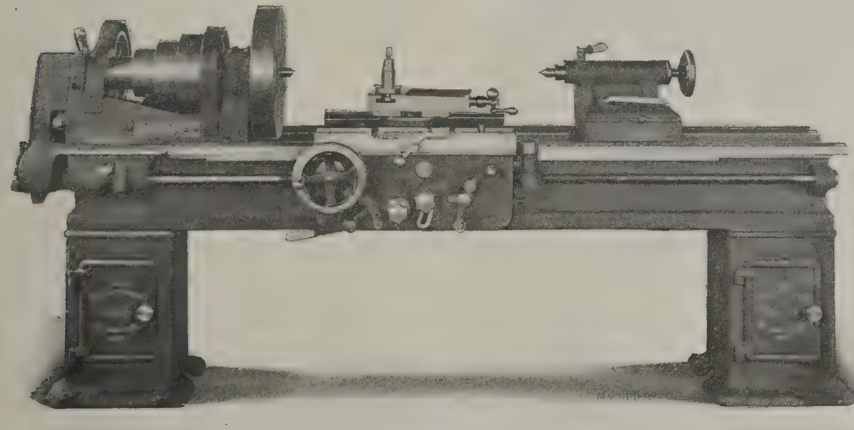


Fig. 3. Sectional View showing Arrangement of Driving and Speed Adjusting Mechanism

The location of the belt pulley eliminates overhead countershafts and permits driving from beneath the bench if desired. When the power is applied from beneath the bench, clutch friction pulleys are used, thus doing away with the tight and loose pulleys. This machine is constructed throughout of high-grade materials. The castings are of "close" iron and they are properly seasoned after being roughed out, before finishing. The spindle is hardened, ground and lapped and its bearings are of high-grade phosphor-bronze. The swivel slide rest is designed along modern lines and is built to withstand heavy service, if necessary. This lathe was designed by Mr. J. M. Tatman of Cincinnati.

ADVANCE NO. 2 ENGINE LATHE

The Advance Machine Tool Co., 591 Twenty-second St., Milwaukee, Wis., has brought out a heavy-duty engine lathe which embodies a number of improvements. The feed mechanism is located in the apron (see accompanying illustration), where it is always within convenient reach of the operator, regardless of the position of the carriage along the bed. This mechanism gives four feed changes varying from 0.015 inch to 0.060 inch. A wide range of feeds can also be obtained through change gears operated by a lever at the headstock end of the lathe.



Lathe built by Advance Machine Tool Co.

This machine has a swing over the V's of 18½ inches, and a swing over the carriage of 12 inches. The tailstock is of the offset type, thus permitting the compound rest to be set parallel to the centers when close to the tailstock. The headstock is extra heavy and has large bearings for the spindle. The spindle is made of chrome-nickel steel and has a 1 9/16-inch hole extending through it. The apron is the double-plate pattern and has no loose brackets of any kind. There is only one friction clutch for both the lateral and cross feeds, thus making it impossible to engage more than one feed at the same time. The lead-screw nut is provided with a stop so that the feeds cannot be operated while chasing threads, and *vice versa*. This lathe is of the heavy pattern, and is tested for alignment within a limit of from 0.001 to 0.0015 inch.

AMES UPRIGHT DIAL GAGE

The upright gage illustrated herewith is an addition to the line of dial gages manufactured by B. C. Ames Co., Waltham, Mass. It is of a low, compact design which is not easily upset and can be placed in the most convenient position for the operator. This gage is desirable for measuring paper, flexible cardboards, fabrics, and rubber, as well as metals of all kinds which have flat surfaces. It can be arranged with a small surface in place of the platen, for measuring sheet metals or any other material which does not have a flat even surface. The spindle of the gage has a travel of 3/10 inch, the same as the regular upright gage made by this company.

Dial Gage made by B. C. Ames Co.

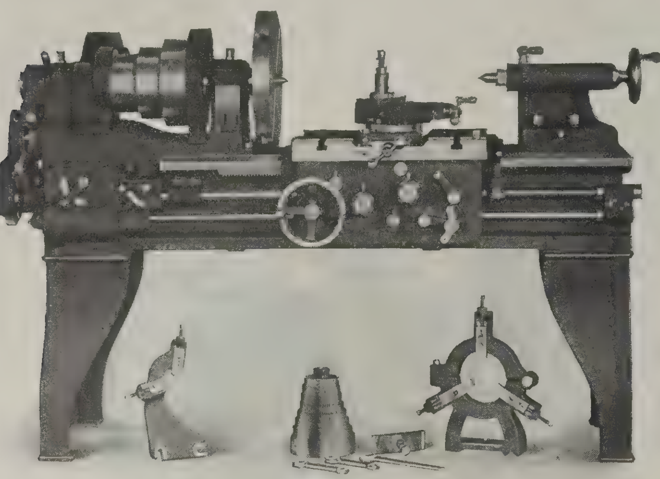
ROCKFORD 16-INCH LATHE

The lathe illustrated herewith is a 16-inch double back-geared design built by the Rockford Lathe & Drill Co., Rockford, Ill. This machine is constructed throughout to meet the conditions of modern shop practice. The bed is of deep section and has wide cross braces. The headstock is massive and is equipped with large bearings lined with the best quality of babbitt metal. The spindle is of high-carbon steel and is accurately ground. It has a 1½-inch hole extending the full length, and draw-in collets up to ⅞ inch capacity may be used. The tailstock is of the offset type and has double clamping bolts to hold it securely to the bed. The carriage has a wide bridge and a bearing of 26¼ inches on the ways, with self-oiling felt wipers.

The thread cutting indicator is so arranged that it can be disengaged when not in use. The apron has a double bearing for all shafts. The gears are of wide face and coarse pitch and are cut from steel. The feeding movements are reversed

in the apron, and an interlocking arrangement makes it impossible to engage the feeds and lead-screw simultaneously. The gear box gives three quick changes of feed for each change of gearing, by means of sliding steel gears and hardened steel clutches. The gear box simplifies the thread cutting and the compounding of gears is avoided.

The regular equipment includes the follow- and steady-rests, large and small faceplates, a full set of change gears, double-friction countershaft and wrenches. Extra attachments are also provided, including a draw-in attachment and collets, taper attachment, turret for the carriage, and a turret on the shears, with or without power feed. The lathe swings over the ways 18½ inches, and over the carriage, 11¾ inches. The maximum distance between the centers (with a 6-foot bed) is



Rockford 16-inch Double Back-geared Lathe

28 inches. The ratios of the back gears are, respectively, 3.5 to 1 and 11.13 to 1. The thread cutting capacity varies from 2 to 96 threads per inch. The net weight of the lathe with a 6-foot bed, is approximately 2150 pounds.

JONES & LAMSON DOUBLE-SPINDLE FLAT TURRET LATHE

The Jones & Lamson Machine Co., Springfield, Vt., is now building a flat turret lathe equipped with two spindles. This double-spindle machine is not intended to displace the well-known single-spindle type built by this company, but it has been developed for producing large quantities of duplicate parts. It is designed primarily for chuck work and can be

Fig. 1. Jones & Lamson Double-spindle Flat Turret Lathe

used as a single-spindle machine if desirable. When two spindles are employed for machining two duplicate parts simultaneously, considerably more time is required for setting up the machine than is necessary for the regular single-spindle type, but the increased rate of production obtained with the two-spindle design, more than offsets this initial handicap. The single-spindle machine is considered the best type for ordinary machine building operations, regardless of whether the work is turned from the bar or is of the chucking variety. On the other hand, the double-spindle type is preferable when work is to be produced in such quantities that the time for setting up the machine becomes a secondary consideration.

When the double-spindle machine is used as a single-spindle type, a chuck 17 inches in diameter is used, and when both

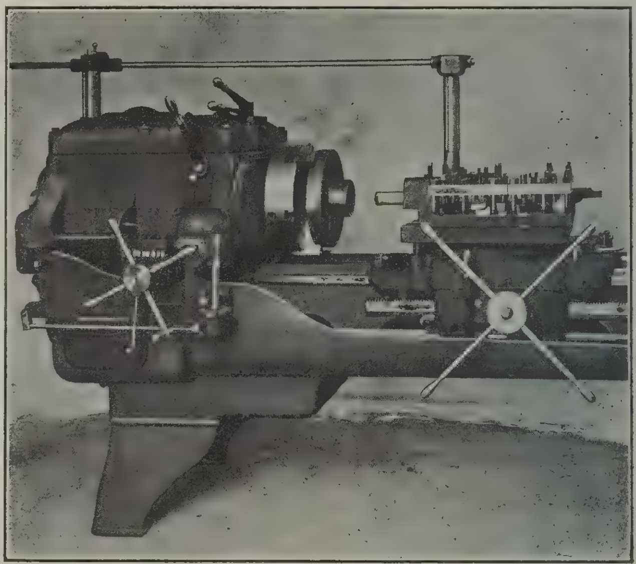


Fig. 2. Double-spindle Machine equipped with 17-inch Chuck for Single-spindle Operation

spindles are in operation, two 9-inch chucks are employed. Fig. 1, of the accompanying illustrations, shows a general view of the machine arranged for using both spindles, whereas, Fig. 2 shows it equipped with the 17-inch chuck for single-spindle operation. Fig. 3 shows the head and a section of the turret at close range. The general construction of the head is illustrated in the line engraving Fig. 4 which indicates the method of adjusting the main spindle for wear and the means provided for receiving the end thrust.

It will be noted that the head is supported by means of rolls *A* bearing upon the hardened steel rail *B*. To provide for vertical "take-up" upon this rail, there are eccentric rolls *C* which bear against the under side, as shown. The cross travel of the head is controlled by rolls *D* which bear against one side of rail *B*, while on the opposite side of the rail, eccentric rolls are similarly placed to provide a means of adjustment.

The two work spindles of the machine have bearings equipped with a form of bushing which enables play to be easily taken up. This arrangement consists of a taper sleeve *F* which bears against the bronze bushing *G*, and when it is necessary to take up wear, the taper sleeve is adjusted by means of the small pinion *H*. Both work spindles are operated by pinion *I* which meshes with the geared faces of the work spindles *J*. Upon this main spindle which supports pinion *I*, a small oil pump provides spray lubrication for the various parts.

The chucks are not attached to the main spindles by hubs of small diameter, in the usual manner, but in a more rigid way as illustrated in Fig. 5. The spindles of the machines, which, by the way, are steel forgings, are provided with heads of the same external diameter as the chucks. The outer end of the spindle *A* is threaded with a right-hand thread, and the inner end of the chuck or faceplace *B* (as the case may be), is threaded with a coarse left-hand thread of the same pitch. After inserting the driving pin *C* in sockets in the spindle and chuck or faceplate, respectively, a right- and left-hand threaded sleeve *D* is screwed on, thus bringing the outer face of the spindle and the inner face of the chuck or faceplate firmly together. To insure the chuck or faceplate being in

the proper position, a seat is bored in the spindle which receives a projection on the inner side of the chuck or faceplate. This construction insures an accurate mounting, and prevents the chuck or faceplate from getting out of alignment.

When the machine is to be used as a single-spindle type, thereby employing a 17-inch chuck and permitting large work to be done, the head of the front spindle is covered with a shield as shown in Fig. 2. In this manner, large chucking work may be easily and efficiently machined. The method of supporting this large chuck on the spindle is exactly the same as has been previously described, although the chuck, of course, extends out beyond the means of support.

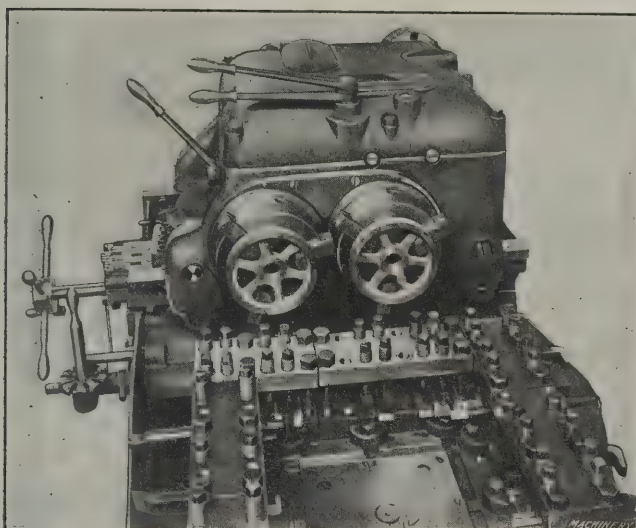


Fig. 3. Turret and Head of Double-spindle Turret Lathe

Fig. 6 shows the construction of the turret and tool-blocks. The general outline of the turret is square, and the tools are rigidly held, with a minimum amount of overhang, by means of the tool blocks and binding screws connected with the clamping plates. All of these parts are plainly shown in this illustration. Two duplicate sets of tools are clamped to each

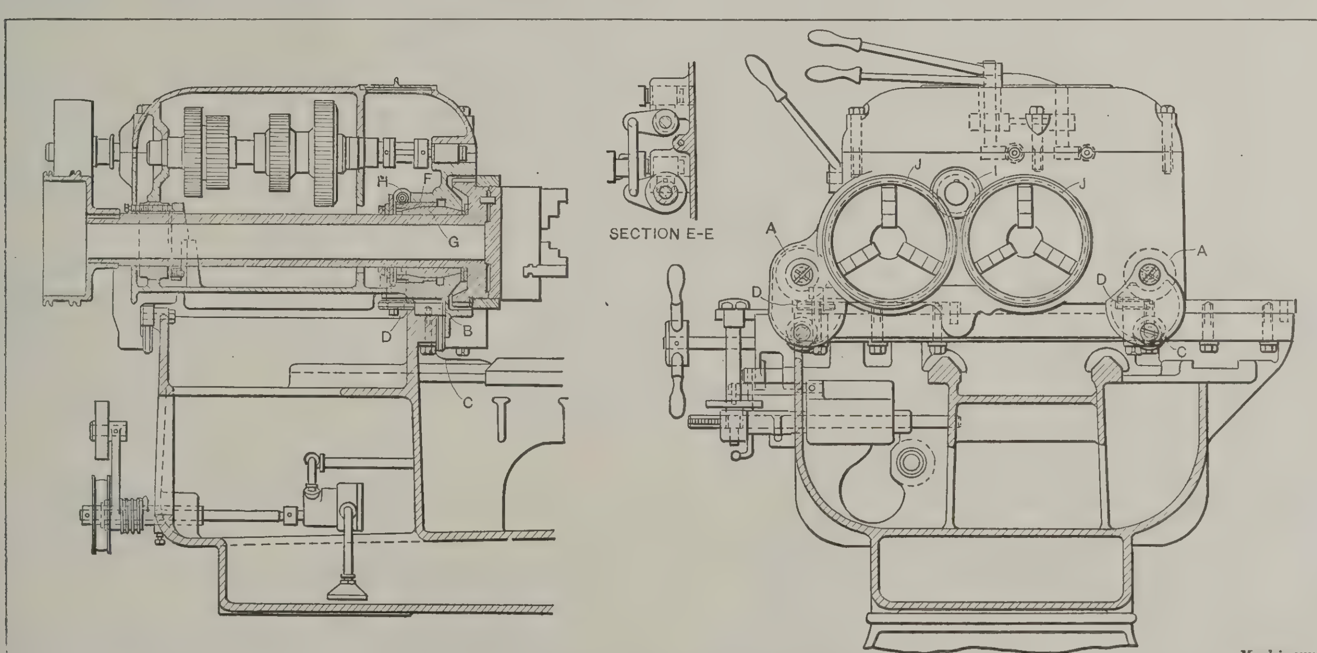


Fig. 4. Views showing the General Construction of the Headstock

side of the turret, and these operate simultaneously on the two pieces held in the chucks or on the faceplates. Primarily the turret is used in but four positions, but when a 17-inch chuck or faceplate is employed, corner blocks may be held by the clamping plates in which tools are supported, giving, if necessary, four additional operations by indexing the turret to eight positions. Provision is made for holding dies at one side of the turret, and each of the corner tool-holding fixtures may be moved to or from its companion tool-holder a slight amount, by means of elongated slots in which the binding screws are placed. As a matter of convenience, the clamping plates are held down by ¾-inch cap-screws, while the set-screws which hold the tools are ⅞ inch diameter. Thus it is possible to clamp through the set-screw holes if this should be necessary on account of a difficult "set-up." Hardened steel supports are provided to support the two inner ends of the turret while in operation. These supports obviate a great

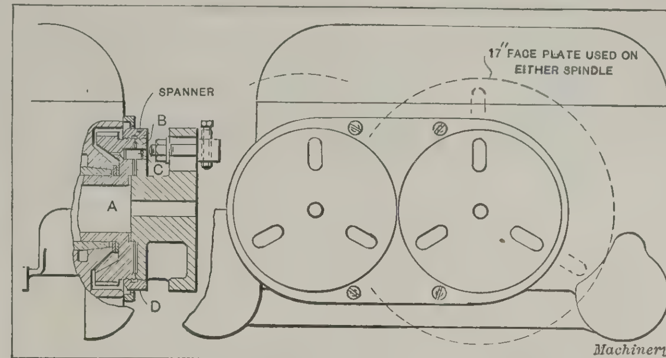


Fig. 5. Method of Supporting Chucks on Double-spindle Machine

deal of chatter and permit the tools to work more satisfactorily. On the under side of the turret, hardened seats are secured which rest upon the carriage supports.

A typical job to demonstrate the application of the double-spindle flat turret lathe is illustrated in Fig. 7. As may be seen, the work consists of sprocket wheels which are held in the two 9-inch chucks. At the first position of the turret, which is the one illustrated, the inside is rough-bored by tools *A*. At the second position of the turret, tools *B* rough-face the inner side of the flange; tools *C* face the outer side of the flange, while tools *D* turn the face of the flange. At the third position of the turret, tools *E* finish-turn the inside of the flange, tools *F* finish-turn the outside of the flange, while tools *G* finish the face of this flange. At the fourth position of the turret, tools *H* finish-bore the work; tools *I* complete the turning on the outside of the flange, while tools *J* accurately size the interior of the flange. It will readily be appreciated that the work done at the first position of the turret, can be accomplished in a much shorter space of time than that done at any of the other three positions.

With the double-spindle flat turret lathe, each operation is a double operation, and, moreover, it is not performed at the same speed; thus, if at one position of the turret, the tools are required to rough out the work, this may be done rapidly, for it has no bearing on the other operations that are subsequently performed. Furthermore, if the following operation has to be performed with great care, this may be done without reducing the speed of the less exacting operations.

A further demonstration of the advantages of a machine of this type involves the time factor. On some machines, of the automatic type, the time for producing any given piece is conceded to be the time of the longest operation performed; thus, if on a four-spindle automatic, the first operation requires 30 seconds, the second operation 30 seconds, the third operation 8 minutes, and the fourth operation 30 seconds, the

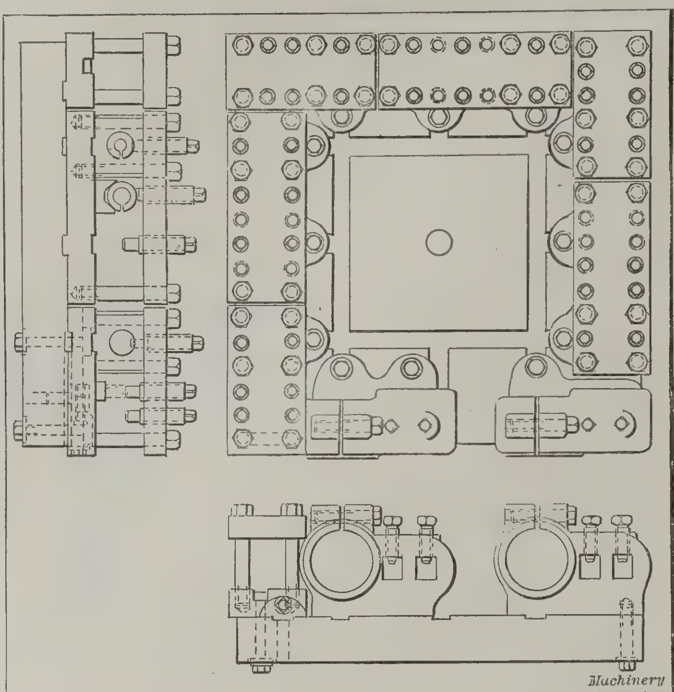


Fig. 6. Elevations and Plan View of Turret and Tool Blocks

time required to produce each piece with this machine will be 8 minutes. With the double-spindle turret lathe on similar work, the time required is the sum of the time of all of the operations divided by two. In this instance, therefore, the time for each piece would be 4¾ minutes, as contrasted with 8 minutes when performed on the multiple-spindle automatic.

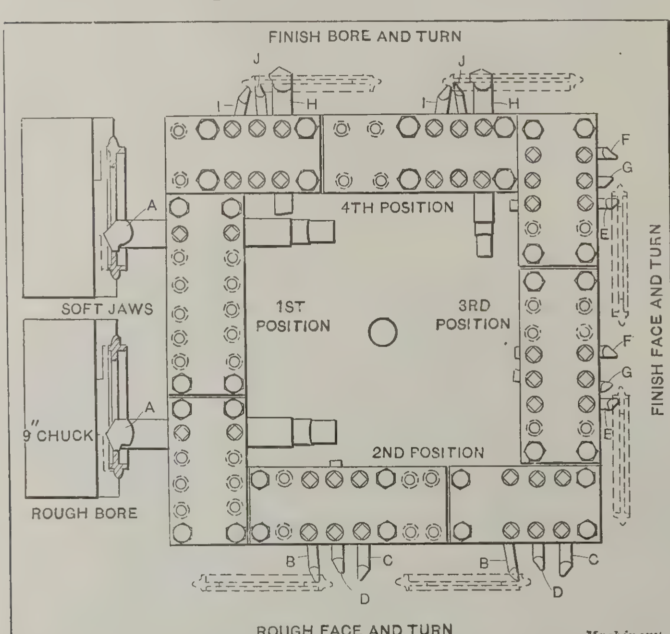


Fig. 7. Diagram showing Tool Equipment and Successive Steps in Machining Sprocket Blanks on Double-spindle Flat Turret Lathe

The double-spindle machine can be used advantageously in connection with the single-spindle flat turret lathe, the single-spindle machine being employed for general work, and the double-spindle machine for the manufacture of duplicate parts in quantity.

* * *

When a boss is made for bolt head or nut, it should be made at least one-quarter inch larger than the largest diameter of the bolt head or nut, so that the head or nut will have a full bearing, even if the hole be cored or drilled out of center.

NEW MACHINERY AND TOOLS NOTES

Filing Machine: Robinson Tool Works, Hartford, Conn. Bench filing machine having a square table which is adjustable for angular work. The stroke of the file may be varied from 0 to 2 inches. All the working parts are protected by a suitable cover.

Turret Head: Milliken Machine Works, West Newton, Mass. Ball turret head for converting ordinary lathe into a turret type, when machining work requiring a number of tools. The turret is held in the tailstock by means of a taper shank, and it is actuated by hand.

Tool Grinder: W. W. Blakely, 100 Leicester Court, Detroit, Mich. Attachment for grinding lathe tools, which is clamped to the ways of the bed and is driven by friction from the cone pulley. This grinder is intended to be used for sharpening tools while cuts are being taken, so that no time will be wasted.

Grinder Countershaft: Rivett Lathe & Mfg. Co., Brighton, Mass. Countershaft built for the grinders manufactured by this company. It is a complete unit and is made to fasten to the wall. The necessary speed changes are obtained by cone-pulleys, and the work-spindle driving-drum is controlled by a clutch so that the work may be stopped independently.

Bolt Cutter: H. B. Brown Co., East Hampton, Conn. Motor-driven bolt cutter built in two sizes, which have maximum capacities for diameters of ¾ inch and 1½ inch, respectively. The small machine is driven direct, and the larger size is equipped with gearing having a ratio of 5 to 1. These machines can be used for nut tapping as well as threading.

Coupling: Valley Iron Works, Williamsport, Pa. Interlocking jaw coupling having compressible sleeves and so designed that the power is transmitted by the jaws and not by the bolts which hold the two parts together. The principal features claimed for this coupling are: greatly increased strength, compensation for any inequalities in the shafts, proper alignment and the elimination of strain on the bolts.

Valve Grinder: McConnell-Browning Engineering Co., Richmond, Va. Hand-operated valve grinder for the grinding of gas or gasoline engine valves. The required reversing motion is obtained by a worm and sleeve, the latter being given a reciprocating movement by turning a crank. Means are provided for shifting the position of the valve on its seat while grinding, without removing the tool from contact.

Gear Hobber: Adams Co., 877 Market St., Dubuque, Iowa. No. 1 gear hobber capable of cutting spur gears, worm-wheels and spiral gears. This machine, in its regular form, will cut spirals of 8 degrees and under, and it can be modified to cut any angle desired, but cannot be adjusted to cut angles differing more than 8 degrees. This is claimed to be a very rigid and efficient machine and comparatively low in price.

Drill Socket: Scully-Jones & Co., 316 Railway Exchange Bldg., Chicago, Ill. Drill socket having a key on the inside and a keyway on the outside, extending almost the entire length of the socket. This gives a positive drive and eliminates the twisting of tangs either on the drill or the socket itself. A reinforcement at the base furnishes means for separating the sockets with a drift, and this type can be "nested" with any other make.

Bench Drill: Monarch Machinery Co., 249 N. 3d St., Philadelphia, Pa. Sensitive bench drilling machine with chuck having capacity for drills up to ¼ inch. The table is 8 inches in diameter and is mounted on a swinging arm. The table has a vertical movement of 7 inches, and the spindle a feeding movement of 4 inches. A two-step cone pulley provides two speeds, and an adjustable idler is used to vary the belt tension. The machine will drill to the center of a 10½-inch circle.

* * *

A WONDERFUL MACHINE

It is possible by the use of a few technical terms to make the description of a simple mechanism rather complicated. The following description of a new machine was supplied by a machinist in order to show how "big" words may complicate matters:

"Well," said James, "I went over and saw that new machine to-day, and it is astonishing the fine work it does. By means of a pedal attachment, a fulcrumed lever converts a vertical reciprocating motion into a circular movement. The principal part of the machine is a huge disk which revolves in a vertical plane. Power is applied through the axis of the disk, and while the speed of the driving arbor is moderate, the periphery of the apparatus is traveling at high velocity. Work is done on this periphery. Pieces of the hardest steel are by mere impact reduced to any shape the skillful operator desires."

"What in thunder is that machine, anyway?" demanded Tom Briggs.

"Oh, it's a new grindstone," replied James, and a silence fell upon the group.

LETTERING TITLES

By E. J. G. PHILLIPS*

To produce a well executed title for tracings, having letters sufficiently large and bold to quickly attract attention, requires considerable time if done in the ordinary way. The method described in the following offers a way of producing very satisfactory titles in a relatively short time. The accompanying illustration is about a half-size representation of a master card, which if carefully prepared will serve as a convenient guide for laying out letters of various sizes, without the use of preliminary construction lines. It may be considered a tedious job to lay out this master card, but as this one layout will last for years, the time required is well spent. If the original is made on tracing cloth, a permanent vandyke negative may be made from it, and then black on white vandyke prints may be produced and mounted on cardboard in sufficient numbers to supply the entire drafting force.

Master Card for Laying out and Lettering Titles on Drawings

The upper half of the card is used for several styles of letters and figures from ⅛ to ½ inch in height; complete alphabets of two styles are shown, the first having vertical and the second slant letters. While the styles shown are very plain, more elaborate ones may be made from the same master card. For these letters the guide lines are laid out in the following proportions: the horizontal spaces are made equal to or one-third of the height and all letters are made two spaces wide, except M which requires three spaces, W, four spaces and I, one space. These proportions may not be exactly correct, but the writer believes that the alphabets given at the top of the illustration show reasonably good proportion.

The lower half of the card is used for block letters and figures from 3/16 to 1/2 inch high, as indicated at the left of each line. The usual proportions are used, *viz.* five spaces high and four spaces wide except M which requires five spaces, W, six spaces and I, one space. These guides may also be used for the Gothic letters as described in the March, 1910, number of MACHINERY. Every fifth vertical graduation is extended above the top line and every tenth graduation is numbered, convenient for locating a title in a certain space.

When the tracing is ready for the title, the master card is placed beneath the cloth, bringing the guides for the desired size of letters in their proper location, and then they are inked in. When slant letters are to be used, the triangle should be set so that when it matches one of the graduations in the top line, it will coincide with the next graduation to the left, in the bottom line.

When it is desired to locate a title in the center of a given space, the spaces required should be counted making the allowances previously given for each letter, and leaving one space between letters and four spaces between words. In this way the number of spaces required for the title can be quickly found, and by referring to the figures above each set of guide lines, the lettering can be begun at the proper place. On the other hand, if the space for the title is limited and it is desired to use the largest letters possible, first determine the number of spaces required; then by referring to the figures and measuring the length of the required number of spaces, the proper size of letters may be found.

* Address: 233 Park Ave., Aurora, Ill.

* * *

THAT RED-HAIRED BOY

By A. P. PRESS

We needed another boy in the office, and the boss put it up to me one day. "Say, Jim," said he, "get me a good boy—one that is *good* for something. Get a red-headed boy if necessary—only get him!"

I transmitted the request to the office, just as he told me: "Wanted—One good office boy. *Must be red-headed.*"

The hiring clerk called me up and tried to call me down for it, but I told him that if he didn't like it, he could have it out with the boss, for it was none of my funeral anyhow. I waited a week, but the boy did not show up. I knew I had to get him somewhere, so I commenced watching the trolley cars as I came down mornings; and one day, clinging to the rear end of the running board, I saw what I thought we wanted. So I dropped off the car at the same time he did.

"Where are you working, son?"

"Down at the shear shop, sir."

"What do you make a week?"

"Four fifty, sir."

"Would you like a job at six dollars if you could get it?"

"I certainly would, sir." (Always with the "sir.")

"Well, go down to the hiring office and ask the boss there if he wants a boy. If he says 'No,' take your hat off and say, 'Kindly look at my head, sir,' and he will will hire you."

The kid went, and from what the hiring clerk told me afterwards, I think he did just as he was told. He came to work and made good with the "old man" right off, and stayed with us nearly a year. Every noon after lunch he used to slide off into the die-sinking department and work away on the end of a piece of steel—die-sinking. One day I asked him what he was doing. He answered, "I am going to be a die-sinker bye and bye, and I am working it up now."

A few weeks after that (this I learned long afterwards) he wrote a letter to a silver shop, asking them if they wanted a boy to learn die-sinking, and if so, he would like to hear from them. The boy waited a couple of weeks, then went down to the shop and asked if the boss die-sinker was there. When the boss came out, the boy asked:

"Is there any chance for an apprentice, sir?"

"Not a bit," said the foreman, as he turned to go back.

"But look, sir," he persisted. "I have done a little in that line," and he pulled a piece of aluminum about four inches long from his pocket. It was all covered over with impressions from the lines and stamps he had cut. Now, I never saw a die-sinker who would not leave a funeral procession to look at a scrap of metal. This one was no exception to the rest of them, so back he came, looked over the sample, and it ended with his promising the boy a job later on.

The next night the boy gave notice, having landed the job. It is not difficult to look a little way into the future and see where that boy will be five or ten years from now. Following the mark he has set for himself, he is going to get there—and he will not always be sinking dies either.

MACHINING A FAN MOTOR CASE IN A BARDONS & OLIVER TURRET LATHE

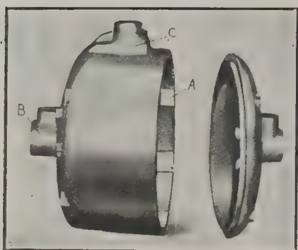


Fig. 1. Fan Motor Case to be machined

An excellent example of accurate turret lathe work is represented in Fig. 2, which shows the set-up used in machining the fan motor case shown in Fig. 1. This motor case is made from an iron casting with eight ribs cast on the inside circumference of the large hole, the remaining portions of the shell between the ribs not being more than ⅛ inch thick. The ribs *A* are to be machined, and a hole is to be drilled, bored and reamed in the shank *B*, which must be concentric with the large hole in the case to within a limit of 0.002 inch. When the shape and character of this casting are considered, 0.002 inch is a very close limit to attain, and can only be accomplished with a first-class tool equipment and considerable ingenuity on the part of the designer.

When being machined, the casting is gripped by the shank *B* in a spring collet, and is additionally driven by boss *C*, which fits in a slot in hood *A*, Fig. 2. Screwed into hood *A* are sixteen knurled thumb-screws *B* and *C*. These are used to support the casting during the roughing operations. The screws *B* in the circumference of the hood are opposite the projections or ribs on the casting, which are to be machined. The screws *C* in the rear of the cap are binder or tension screws for shank *B*, Fig. 1. The order in which the machining operations are carried on is very interesting, and it is due to this layout that such accuracy can be obtained.

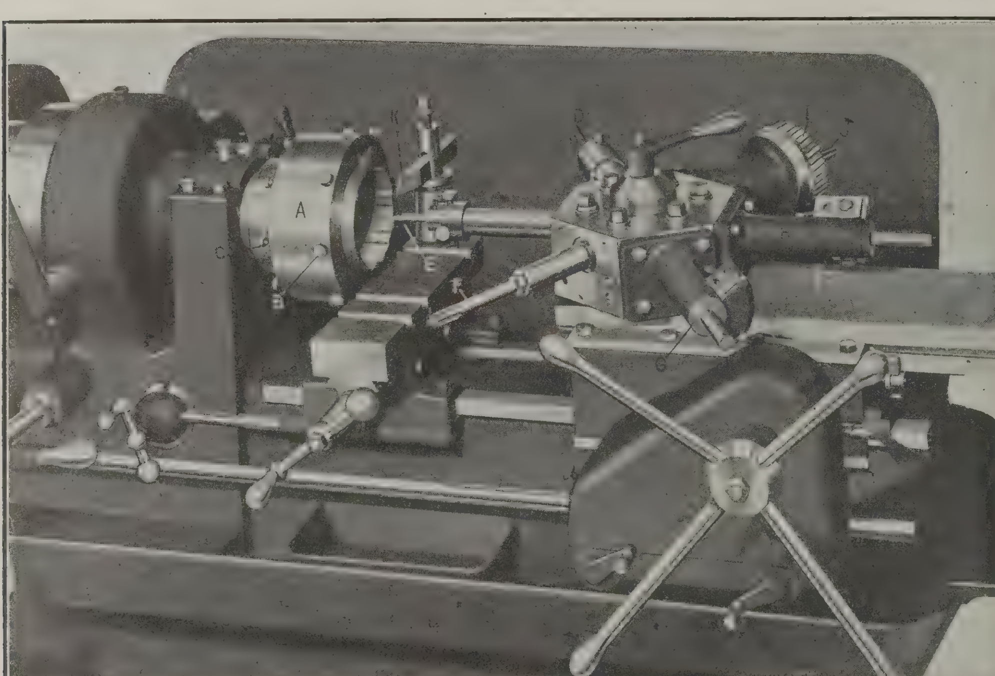


Fig. 2. "Set-up" of Tools for Machining a Fan Motor Case in a Turret Lathe built by Bardons & Oliver, Cleveland

After the casting is placed in the chuck, the knurled screws *B* are tightened, centering the casting so that it will run practically true, and also holding it rigidly in the hood. The order of operations after the casting is placed in the chuck and the screws are tightened, is as follows. (Refer now to Fig. 2).

1. Drill small hole in shank *B*, Fig. 1, with drill held in holder *D* at a speed of 192 R. P. M. (open belt) and a feed of 0.0135 inch per revolution.
2. Bore small hole with boring tool *E* at a speed of 192 R. P. M. (open belt), feed 0.0135 inch per revolution.
3. Ream small hole with reamer *F* held in floating holder; speed 44 R. P. M. (with back-gears thrown in), feed by hand.
4. Rough-bore large hole with boring-tool *G* provided with two cutting tools; speed 44 R. P. M. (with back-gears thrown in), feed 0.020 inch per revolution.
5. Adjust knurled thumb-screws *B*, partly releasing their pressure on the casting.
6. Finish-bore large hole with boring-tool *H* provided with two cutting edges; speed 44 R. P. M. (with back-gears thrown in), feed by hand.
7. Again adjust knurled screws, leaving casting practically loose, and relieving all strains set up by the cutting tools.
8. Finish-ream large and small holes with reamers *I* and *J* (reamer *J* floating); speed 24 R. P. M. (with back-gears thrown in), feed by hand.

It is due largely to the manner in which this last operation is handled that the required accuracy is obtained. Here, it can be seen by referring to the order of operations, that the casting practically floats on the large reamer *I*, the small reamer *J* being guided by the hole which has been previously reamed and not removing any material, but simply acting as a "steady pin" for the large reamer. The cutting tools in the boring-tool holders *G* and *H* are spaced the same distance apart as the projections to be machined in the large hole, thus insuring rigidity and obviating chattering. The large hole is 5.505 inches in diameter and the small hole ¾ inch in diameter. The casting is faced off with the turning tool *K* held on the cross-slide, this operation being accomplished while the boring-tool *G* is at work. The time to complete one case is thirteen minutes, including clamping the work and machining.

* * *

ANNUAL MEETING OF THE N. M. T. A.

The fourteenth annual meeting of the National Metal Trades Association was held in New York City, April 11, at the Hotel Astor. The meeting was remarkable for the despatch with which the business was transacted, the public program, including the reading of several papers of length, being carried through in one day. The banquet given to the members and guests in the evening, at which speakers of international fame spoke on the tariff, universal peace and education, was a notable affair, giving a member of the president's cabinet an opportunity to voice sentiments regarding protection and free trade of extraordinary public interest. F. C. Caldwell of H. W. Caldwell & Son Co., Chicago, the president of the association, presided, assisted by Robert Wuest of Cleveland, the commissioner, who has well demonstrated his ability to conduct the affairs of this association of over seven hundred manufacturers of metal products.

The program included the valuable reports: "Systematic Compensation for Industrial Accidents," presented by Henry D. Sharpe, president of Brown & Sharpe Mfg. Co., and "Industrial Education," presented by F. A. Geier, president of the Cincinnati Milling Machine Co.; the papers "Prevention of Industrial Accidents," by William H. Doolittle, the association's safety inspector; "Employer's Liability and Workmen's Compensation—What has been done to Date and is now doing in It," by Miles H. Dawson, attorney and consulting actuary, New York City; "How far must Business Yield to the Demands of Industrial Organizations?" by Hon. J. J. Feeley, of Boston; the reports of Commissioner Robert Wuest, and Assistant Commissioner H. E. Herrod, and other reports on the various activities of the association.

The report on industrial education comprised the Hartford, Cleveland, New Haven, St. Louis, Chicago, Springfield, New York and New Jersey and Cincinnati branches, all of which are doing effective work in educating boys. The cooperative course in engineering in Cincinnati has been in operation six years and three hundred are taking it. This year thirty-five will graduate and take positions as assistant engineers and foremen, and other executive positions. A new building has been added which will increase the capacity of the school to four hundred. The Cincinnati continuation school work has

been extended to include the apprentices employed in the allied printing trades. Notwithstanding the depression in business, the attendance has been two hundred.

Mr. C. A. Prosser, the recently appointed secretary of the National Society for the Promotion of Industrial Education, spoke on the Page education bill, which carries an appropriation of $14,000,000. This bill to extend Federal aid to industrial education was primarily intended to help agriculture, and Mr. Prosser pleaded that the bill might be given a scope that would comprehend industrial education generally. He argued that the moral effect of Federal aid would be to make young men generally look upon the industries in a more favorable light and thus reduce the crowding in the so-called "genteel" occupations.

The report on industrial accidents by Mr. Doolittle is a painstaking paper describing a large variety of conditions in shops, mills and factories likely to cause accidents to workmen. Stereopticon views showed practical protective devices for machine tools, presses, saws, elevators, etc., which have been provided in the plants of members of the association.

The paper by Mr. Dawson, of which a full abstract appears in another part of this number, is a summary of the changes made in the relation of employers and employes in the United States and abroad by legislative enactment of employers' liability and workmen's compensation laws. The progress of this movement during the past two years is remarkable, and it foreshadows the time, comparatively close at hand, when every industry will be required to directly bear the burden of workmen's disabilities resulting from their occupations.

Judge Feeley's paper on the relations of capital and labor, defines a strike and what constitutes an unjustifiable strike under the laws of Massachusetts; also a lawful strike, methods of enforcing a strike, the sympathetic strike and the boycott.

The speakers at the banquet were Hon. Franklin MacVeagh, secretary of the treasury who spoke on the tariff; Hon. W. Morgan Shuster, formerly treasurer of Persia, whose theme was international peace; and Dr. Arthur A. Hammerschlag, of Pittsburg, a noted exponent of industrial education.

The officers elected for the ensuing year are:

President, Henry D. Sharpe, of Brown & Sharpe Mfg. Co., Providence, R. I.

First vice-president, W. A. Layman of Wagner Electric Mfg. Co., St. Louis, Mo.

Second Vice-President, L. H. Kittredge of the Peerless Motor Car Co., Cleveland, Ohio.

Treasurer, Howard P. Eelles of the Bucyrus Co., Cleveland, Ohio.

* * *

SINKING OF THE TITANIC

The sinking of the White Star Steamship *Titanic* on her first voyage is the most appalling of the long roll of disasters on the sea. Though built with all the safeguards that human ingenuity could devise, collision with an iceberg off Cape Race, Newfoundland, just before midnight, April 14, so crushed the hull that in less than three hours she had sunk in one of the profound depths of the Atlantic, carrying down 1600 of the passengers and crew and millions in treasure. The boasted security of the modern steamship seems a hollow mockery in the face of this catastrophe—so great that it stuns the intelligence and sickens the imagination. A great vessel of 46,000 tons registered, the largest ever built, was lost by an accident that everyone familiar with the perils of the sea knew to be possible, but which few supposed could be so disastrous as this.

Out of this appalling disaster the wireless telegraph emerges triumphant. Without this wonderful means of communication few, if any, would have survived to tell the awful tale. Although but a few hours in the boats before they were picked up by the *Carpathia* of the Cunard line, several of the 700 died of shock and the intense cold. Had life boats been available for all and had there been time to embark in an orderly way, the loss of life even then would have been severe. Many more lifeboats are needed but will be futile unless both crew and passengers are drilled to act systematically in emergencies, each going to his appointed place on signal. But important as are lifeboats and lifeboat drill they are secondary. The business of steamship companies is transporting passengers from one port to another—not dumping them into small boats to perish in the open sea. Let us devote more thought to making vessels stronger and safer, to the construction of bulkheads that will stand the greatest water pressure that can be imposed on them, to the design of bulkhead doors that will promptly close in emergencies, to the personnel of the crews and finally to navigation laws that will stop this reckless trifling with death in taking the risks of the shorter route and running at full speed when icebergs are moving down from the North.

* * *

AN ACCESSION TO MACHINERY'S STAFF

We are glad to announce that Mr. William Ledyard Cathcart has become a member of MACHINERY's editorial staff in the capacity of consulting engineer. Mr. Cathcart will devote particular attention to problems in mechanics and machine design, and to the preparation of a series of reference books on machine shop practice and machine details, which he is especially qualified to edit.

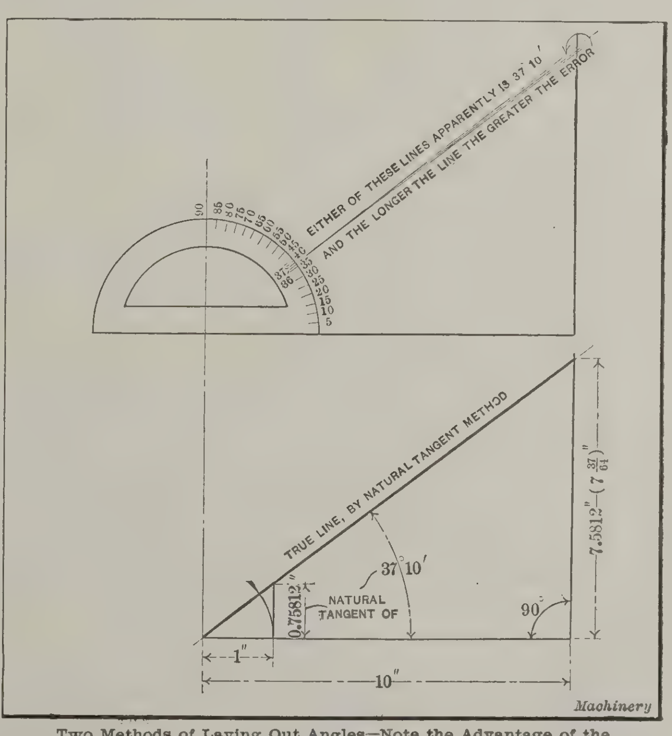
Mr. Cathcart is a graduate of the University of Pennsylvania and the United States Naval Academy, and following his graduation served sixteen years as an officer of the engineering corps of the United States Navy. During the Spanish-American War he volunteered for service, was appointed chief engineer in the Navy and ordered to special duty at Washington on the staff of the late Admiral Melville, then engineer-in-chief. Mr. Cathcart spent two years as professor of marine engineering; four years as adjunct professor of mechanical engineering, Columbia University; seven years as treasurer of a textile manufacturing company; five years with the Babcock & Wilcox Co., New York, translating, collating and analyzing scientific data from French and German sources. Prof. Cathcart is the author of "Machine Design," "Fastenings" and co-author with Prof. J. Irvin Chaffee of "The Elements of Graphic Statics."

* * *

LAYING OUT ANGLES ACCURATELY

By HARRY B. WRIGLEY*

In laying out an angle by an ordinary circular protractor, it is evident that a slight error at the circumference of the protractor will be multiplied many times in plotting a long line. The angle can be laid out accurately by the "natural



Two Methods of Laying Out Angles—Note the Advantage of the "Natural Tangent" Method

tangent" method. To illustrate, assume that it is necessary to lay out an angle of 37 degrees, 10 minutes. The natural tangent is 0.75812, and as this represents the altitude in inches of a right angle triangle having a base 1 inch long, the alti-

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tude having a base 10 inches long will be ten times the natural tangent or 7.5812 inches (7 37/64 inches). It is evident that it is only necessary to find the natural tangent of the angle and multiply it by 10 which is equivalent to moving the decimal point one place to the right, in order to obtain the altitude when the base is 10 inches. A 10-inch base is taken as a matter of convenience, as it simply means moving the decimal point as described. The two methods of laying out angles—by means of the protractor and natural tangent—are shown in the accompanying illustration, where it can be seen that the angle can be laid out much more accurately by the latter method.

[A similar method for laying out angles accurately, but which employed the use of the sine, was illustrated and described in MACHINERY, June, 1911. It is evident that any of the functions of a right angle triangle—sine, cosine, tangent, or cotangent—can be used for laying out angles. Some prefer the sine, as the sine of half the angle is equal to half the chord.—EDITOR.]

* * *

PERSONALS

J. C. Ward, director and general manager of Edgar Allen & Co., Ltd., Chicago, departed April 21 for a business trip in Japan. Mr. Ward expects to be gone for several months.

F. B. Jacobs, who for the past year has been traveling for the Carborundum Co., Niagara Falls, N. Y., gathering data on shop practice, has entered the company's store at Philadelphia as a salesman.

E. Hawkinson, foreman in the toolmaking department of the Canadian General Electric Co's. plant at Peterboro, Ont., for the last three years, has resigned his position to take the position of tool designer for the Russell Motor Car Co., of Toronto.

William W. Bishop, for six years manager of the machinery department of the Cincinnati Iron & Steel Co., Cincinnati, Ohio, has resigned his position to become associated with the sales department of the Shaw Electric Crane Co., with headquarters in Chicago.

George Langen, works manager of the Cincinnati Planer Co., who intended to start in March for an extended European trip, was stricken with appendicitis two days before his sailing date. Mr. Langen is recovering, but his trip has been indefinitely postponed.

Ralph E. Flanders, of the Fellows Gear Shaper Co., Springfield, Vt., formerly associate editor of MACHINERY, addressed the American Society of Swedish Engineers, Brooklyn, N. Y., April 20, on the subject: "Scientific Management from a Social and Economic Standpoint."

Selbert M. Connor, heretofore an engineering draftsman with one of the large railroads terminating in Chicago, has started in business for himself, having opened an office at 414 Sherman St. Mr. Connor will undertake drawing, mapping and the execution of commissions for patterns, model work or any work of a mechanical nature.

A. N. Goddard (W. P. I. '99), for thirteen years with the Morgan Construction Co., Worcester, Mass., as assistant superintendent, recently resigned his position to become superintendent with the Union Twist Drill Co., Athol, Mass. When leaving the Morgan Construction Co., the employes presented him with a solid gold watch and guard suitably engraved.

E. F. Lake, formerly steel editor of the *American Machinist*, who for the past year has been conducting a consulting metallurgical business in Bayonne, N. J., has been placed in charge of the laboratory of the Perfection Spring Co., Cleveland, Ohio. Mr. Lake has contributed a number of valuable articles on alloy steels, extrusion of metals and die-casting machines to MACHINERY.

R. S. Bryant has been appointed consulting engineer of the Standard Welding Co., Cleveland, Ohio. Mr. Bryant was formerly with the Bryant Rim Co., of Columbus, Ohio, and his long experience in the design and manufacture of automobile rims peculiarly fits him to carry out the company's policy of constantly improving its products and service, as well as keeping its automobile rim designs in every way up to the latest requirements of the trade.

George Sherwood Hodgins, a well-known writer on railway topics, at one time editor of the *Railway Digest* and later of *Railway and Locomotive Engineering*, has been engaged by the commissioners of the Trans-Continental Railway of Canada to make a special report concerning the shop equipment of the various roundhouses, terminal shops, etc., now built or being constructed on that line. Mr. Hodgins will be engaged for several months on this work.

Frederick A. Hall, engineer, 5-9 Beekman St., New York, announces that Mr. Mancius S. Hutton is associated with him in the management of the office and conduct of the business. Mr. Hutton, who is the son of Prof. F. R. Hutton, honorary secretary and past president of the American Society of Mechanical Engineers, will have general charge of correspondence regarding the business, and will give special attention to the departments of boilers, engines and power equipment in which Mr. Hall acts as the direct representative of manufacturers.

Dr. Rudolf Diesel of Munich, Germany, director of the Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo., came to New York April 6 on the steamer *Amerika*. He will make a tour of the United States, lecturing before engineering societies and other bodies on the possibilities of the internal combustion engine. He is the inventor of the Diesel engine which is displacing steam engines in Europe for industrial purposes, and is being applied as the motive power of marine vessels with success. Dr. Diesel predicts that the internal combustion locomotive will eventually displace the steam locomotive because of its superior economy and simplicity. He was made an honorary member of the American Society of Mechanical Engineers, April 30, at the meeting of the gas power section. The conferring of honorary membership was followed by an illustrated lecture by Dr. Diesel on the development of the Diesel engine.

OBITUARIES

Frank B. Manville, an inventor of automatic machinery for making wire goods, and one of the organizers of the E. J. Manville Machine Co., Waterbury, Conn., died at his home in Waterville, Conn., March 29, aged sixty-two years. Mr. Manville invented machinery for making hooks and eyes, threading bicycle spokes by the rolling process, and forming rims for bicycle wheels. He also invented a brass shoe lace hook. He had worked in the Winchester, Colt, Whitney and Ames armories, and at the Elgin watch factory. Although one of the organizers of the E. J. Manville Machine Co., he was no longer connected with that concern. A widow and three brothers survive him.

Stanley K. Fox, machine demonstrator for the Gleason Works, Rochester, N. Y., was lost in the wreck of the *Titanic*, April 15. He helped the women and children into the life boats until the last one was filled and then calmly awaited his fate. Mr. Fox was thirty-eight years old, and was twenty-eight when he made his start with the Gleason Works without mechanical training. He soon became an expert machine operator, excelling all others in setting up work rapidly. Soon he was sent out to demonstrate machines and made many friends by his enthusiasm and kindly nature. He made his first European trip four years ago and was abroad last year from June to October and went again on the last trip in January. A memorial service was held in St. Andrew's Episcopal Church, Rochester, April 20, in which Rev. Dr. Thomas paid a high tribute to Mr. Fox's sterling qualities.

* * *

COMING EVENTS

May 9-18.—First Annual Aeronautical Exhibition held in the Grand Central Palace, New York City, under the auspices of the Aero Club of America.

May 13-15.—Triple joint convention at Norfolk, Va., of the American Supply and Machinery Manufacturers' Association, National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association. The program includes papers on "Workmen's Compensation"; "Motion Study"; "The National Banking and Currency Problem"; and "The American Merchant Marine." F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 13-25.—Newark industrial exposition under the auspices of the Board of Trade of Newark, N. J., in the First Regiment Armory. It is claimed that one hundred thousand different articles are manufactured in the three thousand shops of the Newark industrial district, the diversity being proportionately greater than that of any other manufacturing district in the country. William G. Rose, manager, Newark, N. J.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Building, Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

May 16-17.—Semi-annual convention of the National Machine Tool Builders' Association at Atlantic City, N. J., Hotel Chalfonte headquarters. E. P. Bullard, Jr., president, Bridgeport, Conn.; James H. Herron, secretary, Cleveland, Ohio.

May 20-22.—Railway Storekeepers Association's convention in Buffalo, N. Y. Hotel Statler, headquarters. Wm. E. Kelley, secretary-treasurer, 825 Wabash Ave., Chicago, Ill.

May 27-31.—International Safety Congress to be held at Milan, Italy. Dr. W. H. Tolman, director of the American Museum of Safety, 29 W. 39th St., New York City, is a delegate to the congress from the United States.

May 28-31.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Hotel Hollenden, headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

June 17-22.—First annual gas engine show under the auspices of the National Gas Engine Association in the Auditorium, Cleveland, Ohio. Albert Stritmatter, secretary, Cincinnati, Ohio.

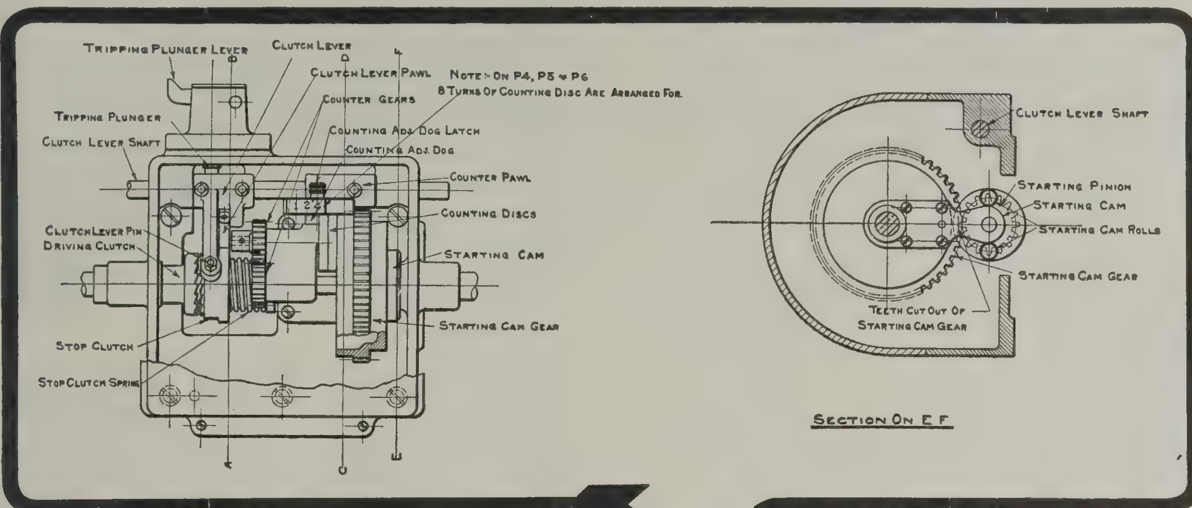
July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

Study these Diagrams of the Mechanism that Indexes Gears so Accurately and Quickly

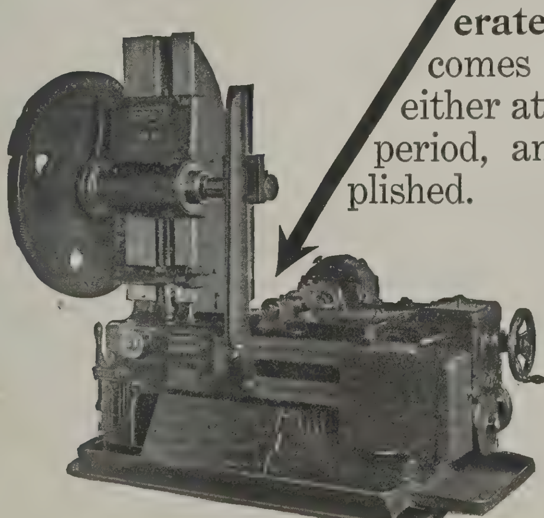


The indexing mechanism on a gear cutting machine is a feature of great importance.

It should not operate with a shock, for that will cause the spacing of the gear teeth to be inaccurate. Neither should it operate too slowly, for that will impair the production of the machine.

The indexing mechanism on B. & S. Automatic Gear Cutting Machines overcomes both of these difficulties because of certain exclusive features in its design.

At each indexing, the mechanism **starts slowly, is accelerated and then retarded** just before it comes to a stop. Hence there is no shock either at the beginning or end of the indexing period, and the operation is quickly accomplished.



Rapid, accurate indexing, together with other excellent features in design, enable a high rate of production to be obtained with B. & S. machines.

Write for special circulars of these machines.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

COLUMBIA UNIVERSITY, New York, has issued an announcement for the Summer session for 1912, beginning July 8 and continuing until April 16.

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN, 116 Nassau St., New York City. Year book containing the constitution and by-laws governing the society; also list of members.

BELOIT COLLEGE, Beloit, Wis. Sixty-fifth annual catalogue of the college, containing information relating to the faculty and students, the courses, admission requirements, scholarships, etc.

VIRGINIA POLYTECHNIC INSTITUTE, Blacksburg, Va. Bulletin, April, 1912, covering 172, 6 by 9-inch pages, giving courses of instruction, and general information useful to prospective students, as well as a list of students for the year 1911-1912.

LOUISIANA STATE UNIVERSITY, Baton Rouge, La. Bulletin giving information relative to the summer school of the university. The term of this summer school begins June 3 and ends August 2. The courses of instruction, admission requirements, fees, etc., are dealt with in this bulletin.

MODERN SYSTEMS CORRESPONDENCE SCHOOL, 6 Beacon St., Boston, Mass. Booklet entitled, "As Others See Us," being an extract from an article in *Castings* on specialized correspondence schools. This school, of which Mr. Oscar E. Perrigo is director, specializes its courses to meet the needs of individuals.

SOCIETY OF AUTOMOBILE ENGINEERS removed its New York office from No. 1451 Broadway to the U. S. Rubber Bldg., Broadway and 58th St., May 1. The growth in membership and activities of the society made necessary the removal to larger quarters. The new location will be appreciated by out-of-town members, being close to the Columbus Circle subway station and on the route of the Broadway surface car lines.

NORTHWESTERN UNIVERSITY, Evanston and Chicago, Ill. Annual catalogue 1911-1912, covering 515, 6 by 9-inch pages, containing complete information of the various departments of the University, including the College of Liberal Arts, the College of Engineering, and the School of Commerce, and information relating to fraternities, university societies, alumni association, register of students, and general information relating to expenses, fees, etc.

AMERICAN ASSOCIATION FOR LABOR LEGISLATION, Metropolitan Tower, New York City, is entitled to much credit for the enactment of the phosphorus match bill signed by President Taft, April 9. Investigation of "phossy jaw," the occupational disease of match factory workers, led to the introduction of the bill in June, 1910, immediately after the publication of the report on phosphorus poisoning by John B. Andrews, secretary of the association. Public sentiment demanded the prohibition of the death-dealing match. Through this legislation one of the most terrible of occupational diseases will be abolished.

NEW BOOKS AND PAMPHLETS

ELECTRIC POWER ON THE FARM. By Adolph Shane. 62 pages, 6 by 9 inches. 31 illustrations. Bulletin No. 25 of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.

SECOND ANNUAL REPORT ON THE STATISTICS OF EXPRESS COMPANIES IN THE UNITED STATES, for the year ending June 30, 1910. 38 pages, 8 by 10 inches. Published by the Interstate Commerce Commission, Washington, D. C.

KERRAWALLA'S TEXTILE AND ENGINEERING DIRECTORY AND YEAR BOOK. 10 by 13 inches, 111 pages. Published by C. D. Kerrawalla, Kalachowki Road, Parel, Bombay, India.

The Textile and Engineering Directory and Year Book for 1912 is the seventh issue. Among the useful information contained are complete lists of cotton ginning and pressing factories, jute presses, cotton jute, woolen and silk mills, iron works, gold, copper, iron, lead, manganese, ruby, salt and coal mines, flour, sugar, oil, rice, saw, bone and paper mills, quarries, coil works, roperies, mica works in India, cotton mills in China and Japan together with a number of useful tables for mill and factory owners, managers, engineers, carding, spinning and weaving masters, hardware and mill store merchants, etc. The directory is freely circulated among the users of textile and engineering machinery in India and is, therefore, of special interest to manufacturing concerns who wish to reach this trade.

TRANSPORTATION RATES. By A. M. Fisher. 16 pages, 5 by 7½ inches. Published by the author, New York. Price 50 cents.

This comment upon transportation rates, it is stated, has been written with particular reference to the section of the Interstate Commerce Act which is properly known as the "long and short haul" clause. The booklet is written from an extremely one-sided point of view, in which the opinions of the old-time "stand-pat" railway managers' ideas only are considered. As an example of the spirit of the booklet the following statement may be quoted: "It need not be anticipated that there will be a general revival of business with the present Interstate Commerce Act in effect and enforced." Digressing somewhat from the avowed purpose of the book, the author mentions that "it is hardly to be expected that profitable methods can be devised for the operation of the subways and other urban transportation service." It is difficult to understand on what basis this statement is made, in view of the fact that financiers seem to be extremely anxious to obtain monopolies in transportation services in cities, subways included. Another example of the peculiar mental processes by means of which the conclusions in this booklet are arrived at is the statement that the result of a parcels post would be "a very decided influence toward increasing the cost of living." The author finally advocates the introduction of scientific transportation rates. Just what he means by "scientific" is not entirely clear, but may perhaps be surmised from the few quotations given above.

NEW CATALOGUES AND CIRCULARS

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 147 on Crocker-Wheeler electric fans.

DETROIT FUSE & MFG. CO., Detroit, Mich. Revised bulletin No. 23 on the "Detroit" three-phase motor starter.

STUDEBAKER AUTOMOBILE CO., South Bend, Ind. Bulletin No. 1023 on electric commercial motor vehicles for all purposes.

DAMASCUS BRONZE CO., Pittsburg, Pa. Pamphlet on "Damascus" bronze products with special reference to bearings.

DETROIT FUSE & MFG. CO., Detroit, Mich. Catalogue of the "Detroit" ironclad fused switches and the "Arkless" indicating fuses.

HANNIFIN MFG. CO., Chicago, Ill. Catalogue of air-operated chucks, countershafts, gate valve seating chucks, special tools and machinery.

ROCKFORD IRON WORKS, Rockford, Ill. Circular and specifications of the Rockford inclinable open-back foot press, size A; also No. 4 flywheel press.

GENERAL FIRE EXTINGUISHER CO., Providence, R. I. Bulletin on the "Grinnell" automatic sprinklers for the protection of shops, mills and factories from fire.

J. H. WILLIAMS & CO., 61 Richards St., Brooklyn, N. Y. Catalogue of lathe dogs, C-clamps, machinists' clamps, planer strap clamps, drop-forged wrenches, drop forgings, etc.

F. O. WEYDELL, 224 S. Jefferson St., Chicago, Ill. Circular of the "Hi-Low" drawing table which can be quickly changed in height from 36 to 44 inches to suit the convenience of the draftsman.

AMERICAN TAP & DIE CO., Greenfield, Mass. Catalogue No. 4 of "Adamantine" screw plates; "Eagle" brand taps, dies, stocks and tap wrenches; and pipe tools, comprising stocks, dies, taps and reamers.

AUTOCALL CO., 100-110 Franklin Ave., Shelby, Ohio. Card illustrating the "Autocall" and its application in the manufacturing establishments for locating foremen, superintendents and others without loss of time.

FRANCIS REED CO., Worcester, Mass. Circular of the No. 20 Stanley sensitive drill having six spindle speeds, detachable countershaft, ball thrust bearing for spindle, ample power for one-half-inch drill and which sells for $50.

BROWN HOISTING MACHINERY CO., Cleveland, Ohio. Pamphlet illustrating and describing "Brownhoist" suspended bins for coal, ore, ashes, etc., and catalogue of the "Brownhoist" tramrail systems, trolleys and electric hoists.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Bulletins, Nos. 1009 on push buttons; 1016 on automatic motor starters for non-reversing direct-current motors; 1025 on lifting magnets; and 1027 on current limit panels for direct-current motors.

UNIVERSAL STAMPING CO., Buffalo, N. Y. Bulletin illustrating safety devices made to prevent the flying of chips from shaper tools, lathe tools and other cutting tools, emery wheel guards, safety belt hanger, snap-on reflectors, lamp shades, lamp stands, etc.

CHICAGO PNEUMATIC TOOL CO., Chicago, Ill. Bulletins, E-19, E-20, E-21 and E-22 on universal electric drills, operating on direct or alternating current; electric drills for heavy work; Duntley track drill; and air-cooled direct current drills, respectively.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis. Booklet entitled, "Cutting the Cost of Lumber Production," illustrating handling and transporting apparatus built by the company, comprising monorail systems, traveling electric cranes and hoists and electric transfer cars for handling lumber in bulk.

WATSON-STILLMAN CO., 192 Fulton St., New York, has just issued catalogue No. 85 "Hydro-Pneumatic Wheel Presses," which describes and lists the company's line of full hydro-pneumatic wheel presses. Seventy-six types and sizes of hydraulic tools exclusively of Watson-Stillman designs are also listed.

SCULLY JONES & CO., 316 Railway Exchange, Chicago, Ill. Circular of the "Wear-ever" sockets for drills. The sockets are made of special steel, heat-treated, and reinforced at the bottom by a solid ring of metal of increased diameter having a drift groove which saves time in separating nested sockets.

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y. Circular of the "Balopticon" for the projection of large opaque objects on a screen. This instrument is designed for educational purposes and enables a lecturer to project drawings, photographs, working models, mechanisms, etc., directly on the screen without previous preparation.

EUREKA CO., North East, Pa. Price-list of copper hammers for machine shop use, furnished in sizes from ¼ pound to 16 pounds, with or without handles. Copper hammers are more durable than babbitt hammers and have the characteristic of not seriously marring steel or cast iron when employed for driving or hammering work.

INDUSTRIAL INSTRUMENT CO., Foxboro, Mass. Bulletin No. 60 on indicating gages for all purposes comprising pressure and vacuum gages, compound, ammonia, pyrometer, test, hydraulic, electric alarm, altitude, sulphite, illuminated dial, standard duplex and triplex, and recording gages, thermographs, marine and locomotive clocks, etc.

WATSON-STILLMAN CO., 192 Fulton St., New York. Bulletin J describing a filling liquid, called "Jackohol," developed for hydraulic tools such as jacks, presses, punches, benders, etc. This liquid does not freeze, thicken, gum or change chemical composition. It is invariably protective to the metal surfaces and packings with which it comes in contact.

W. P. DAVIS MACHINE CO., Rochester, N. Y. Treatise on keyseating and keyways compiled for American machine shop practice. This interesting and valuable little booklet contains a fund of useful information on a very practical subject affecting everyone having to do with the design and construction of machinery. The booklet also illustrates the Davis keyseater made in two sizes.

PRATT & WHITNEY CO., Hartford, Conn. Wall hanger of machinists' handy tables comprising U. S. standard screw threads, standard dimensions of wrought iron, welded tubes, table of cutting speeds and feed per minute, metric standard screw threads, pitch or angle diameters of hand taps, U. S. and Whitworth standard and A. S. M. E. standard screw threads for machine screws.

FURNACE GAS CONSUMER CO., Matteawan, N. Y. Pamphlet entitled "Smokeless Chimneys," describing a furnace gas consumer for the prevention of smoke, consisting of a bank of fire clay tubes installed back of the bridge-wall underneath the boiler which becomes incandescent and thus promotes complete combustion of the gases before they are cooled by contact with the water-backed surfaces.

KEUFFEL & ESSER CO., Adams and Third Sts., Hoboken, N. J. Descriptive circular of an improved farm transit with and without compass for the use of builders, architects, instructors, farmers, etc. This instrument, which without compass sells for $30, has a 10-inch telescope, one-inch aperture. The same instrument with compass sells for $38. The circular also illustrates farm levels selling for $16 and $25.

GENERAL ELECTRIC CO., Schenectady, N. Y. Booklet No. 4926 on the application of electricity to marine service. The publication is printed in colors and describes the various pieces manufactured and supplied by the company for marine use. The data given are of general interest to motor boat owners and among these data will be found reproductions of the flags of the principal yacht clubs throughout the country.

J. M. CARPENTER TAP & DIE CO., Pawtucket, R. I. Catalogue No. 19 on tools for cutting screw threads comprising taps, dies, screw plates, die-stocks, tap wrenches, etc. The catalogue also contains useful tables on U. S. Standard threads, V threads, International, and French standard threads, Whitworth standard threads, British Association standard, Acme standard and A. S. M. E. standard for machine screws, etc.

RAHN-LARMON CO., Cincinnati, Ohio. Catalogue of Rahn-Larmon engine, turret and gap lathes built in the following series and sizes: Series A, 16-, 18- and 20-inch engine lathes; series A, 16-, 18- and 20-inch gap lathes; series B, 18-, 20- and 22-inch engine lathes; series D, 22-, 24- and 26-inch engine lathes; series G, 24- and 48-inch extension bed gap lathes; and series F, 26-, 28-, 30- and 32-inch engine lathes.

HALE-MCADAMS WHEEL CO., 224 High Avenue, Cleveland, Ohio. Circular of the Cleveland friction clutch which is made in nine sizes,

Inspection and Routing Department.

Department for Assembling and Testing Feed and Drive Boxes.

Department for Testing the Completed Machines.

EVERY DETAIL OF CINCINNATI MILLERS

is inspected after every operation. Some of them pass through this department as many as twenty times before they are finished. Hardened gears, clutches, and similar parts are also tested with the scleroscope and must meet definite standards of hardness set for each piece.

The drive box, feed box, etc., each form a complete unit of mechanism. They are assembled by skilled men who are expert on this work because they do nothing else.

Every unit when assembled, is given a running test under working conditions before passing into stock.

The completed machine must pass an exacting inspection for alignment; must run continuously for a given period; and must also do a variety of milling successfully.

These running and working tests are a final check on each unit of mechanism, and are a guarantee that every detail is fully up to our high standard of excellence.

These are some of our Manufacturing Methods. Visit us and see them for yourself.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

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CONTENTS FOR MAY

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ranging from 8 inches diameter to 24 inches diameter and having capacities of 8 to 63 horsepower per hundred revolutions per minute. The clutch is self-oiling, has few parts, is easily adjusted, and has other advantages of interest to all those concerned with the installation of clutches.

INDUSTRIAL INSTRUMENT CO., Foxboro, Mass. Bulletin No. 61 on portable or hand tachometers, single-spindle multi-speed spring type made by Dr. Th. Horn of Leipzig, Germany. These instruments show at a glance the rate of rotation or peripheral speed and by means of the selective speed-changing mechanism a single instrument may have several scales. One of the forms of this instrument is a cut meter for showing the cutting speed of lathe and planer work.

NEW PROCESS TWIST DRILL CO., Taunton, Mass. Catalogue of carbon high-speed and "Reliance" high-speed twist drills. The regular carbon steel and high-speed drills are hot-forged and twisted instead of being milled from the solid as is the common practice. The "Reliance" high-speed twist drills are made from profile stock inserted in a carbon steel shank by a special process. The claim is made that the hot forging process gives the drill greater strength because the grain follows the spiral fluting.

HESS-BRIGHT MFG. CO., 2111 Fairmount Ave., Philadelphia, Pa. Data Sheets, Nos. 5-A, 52-I, 65-A, 68-A, 70-A, 75, 76 and 78 on mounting collar type ball thrust bearing to take thrust in one direction only; DWF adapter bearings; centrifugal basket mountings; application of floating bushes to grinding spindles; DWF adapter and method of assembling with bearings on a straight shaft; standard form of mounting for two-bearing four-cylinder crankshaft; built-up crankshaft and two-cylinder V type motor; and mountings for rolls.

ADAMS CO., 877 Market St., Dubuque, Iowa. Circular No. 812 illustrating and describing the No. 4 Farwell universal gear hobber which was illustrated and described in the March number of MACHINERY. This gear hobber cuts spur gears, worm-wheels, spiral and worm gears, herringbone gears, ratchet wheels, sprocket wheels, etc. It has a capacity for gear diameters up to 24 inches, and with arbor support removed, up to 28 inches. The vertical feed of the head is 12 inches and the coarsest diametral pitch cut in steel is 3½ pitch, and in cast iron or bronze, 3 pitch.

CRESCENT MACHINE CO., 56 Main St., Leetonia, Ohio. Catalogue for 1912 of "Crescent" wood-working machinery comprising band saws, "Crescent" angle band saws which may be tilted for bevel sawing, guards for band saws, setting and filing clamps, saw tables, saw guards, shaper fence, single and double spindle shapers, jointers, variety woodworker, planers and matchers, surfacers, swing cut-off saws, disk grinders, universal borers, post borers, etc. A valuable feature of the catalogue is the data on the horsepower required for machines, which enables a customer to estimate the probable power requirements of machines to be installed.

W. S. ROCKWELL CO., 50 Church St., New York. Specimen views from catalogue No. 14 showing installations of Rockwell oil and gas furnaces, among which are installations of single chamber and double chamber annealing furnaces, double-end underfired annealing furnaces for brass, copper, German silver, sterling silver, etc.; single-end underfired annealing furnaces for the same fuel and purposes are shown, also annealing and hardening furnaces, carbonizing furnaces, rotary annealing and hardening furnaces, rod heating furnaces, forge furnaces, brass melting furnaces, plate heating furnaces, and soft metal furnaces, all using oil or gas fuel.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletins Nos. 4915 on direct current motors; 4921 on electric heating and cooking; 4922 on electricity in metal mines; 4923 on modern electrical equipment for economical production of iron and steel; 4928 on searchlight projections for commercial use; 4929 on electrically operated brick plants; 4933 on small polyphase motors; 4934 on battery charging rheostats; 4935 on GE-201-A railway motor; 4940 on commutating pole motors; 4941 on water flow meters; 4942 on Thompson direct current test meter; 4943 on direct current motor starting panels for heavy service; and 4944 on isolated and small plant alternating current switchboard panels.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Leaflets, Nos. 2362 on type CA alternating-current motors; 2409 on self-starting synchronous motors, ranging in capacity from 90 to 1500 horsepower and from 220 to 6600 volts; 2441 on the application of small motors; 2443 on motors for crane and hoist service; 2446 on type QK electrically-operated brakes for direct-current cranes and hoist motors; 2447 on type SP electrically-operated brakes designed especially for mill and crane service; 2449 on hand-operated controllers for light crane and hoist service; 2383 on alternating-current steel mill motors, type MA; and circulars Nos. 1088 on three-wire direct-current generators; 1522 on multiple unit trains and HL control; and 4049 on type F carbon circuit-breakers.

TRADE NOTES

DOEHLER DIE-CASTING CO., Court and Ninth Sts., Brooklyn, N. Y., has established a Detroit office in the Ford Bldg., Room 1313, in charge of the company's vice-president, Mr. H. B. Griffin.

E. L. ESSLEY MACHINERY CO., Chicago, Ill., has made Mr. James L. Gough sales manager and Mr. James J. Shanahan representative for Indiana and Michigan, replacing Mr. J. A. Richardson, resigned.

CANTON MACHINERY EXCHANGE, 624 N. Market St., Canton, Ohio, was recently organized to deal in machine tool specialties, and the catalogues and literature of manufacturers of machine tools and accessories are requested.

EDGAR ALLEN & CO., LTD., Chicago, Ill., formerly of 434 W. Randolph St., has moved to larger and more commodious quarters at 718-722 W. Lake St., where a full stock of all grades of Allen's tool steels will be carried.

ALLIS-CHALMERS CO., Milwaukee, Wis., which recently went into the hands of receivers, has been reorganized with a capital stock of $42,500,000. The stock consists of $26,000,000 common and $16,500,000 seven per cent accumulative preferred stock.

LUCAS MACHINE TOOL CO., Cleveland, Ohio, was awarded a gold medal and diploma at the Brussels Exposition in 1910 for the Lucas precision horizontal boring, drilling and milling machine which was exhibited by the company's representative, Mr. Alfred H. Schütte.

PAGE-STORMS DROP FORGE CO., Chicopee, Mass., has installed a thoroughly equipped chemical laboratory, modern in every respect. It is under the direction of an experienced chemist who was connected with the Halcomb Steel Co., Syracuse, N. Y., for about four years.

ANDREW C. CAMPBELL, Waterbury, Conn., will erect a factory on State St. for the manufacture of a patented self-spreading cotter-pin. The cotter-pin is so fashioned that when inserted in a hole and driven with a hammer, one part slips past the other, thus spreading their ends, and preventing the pin from falling out.

SUFFERN & SON certified public accountants, have established a branch at 1121 Newhouse Bldg., Salt Lake City, Utah, under the direction of Mr. Charles A. Secor, as resident partner. This office will have a staff of competent accountants and will also command the services and abilities of the entire organization.

JOSEPH T. RYERSON & SON, Chicago, Ill., have been appointed as sole agents for Chicago territory to represent the full line of multi-spindle drill presses manufactured by the Fox Machine Co., Grand Rapids, Mich., and a machine has been installed on the floor of the Chicago machine tool warehouse for demonstrating purposes.

HOSKINS MFG. CO., 459 Lawton Ave., Detroit, Mich., maker of Hoskins electric furnaces, pyrometers and heating appliances, and "International" electric heaters, has opened an office in the Oliver Bldg., Pittsburg. This office will enable the company to more adequately care for its rapidly growing business in the Pittsburg district.

RICKARD & SLOAN, 20 Vesey St., New York, is a newly organized advertising firm, composed of William L. Rickard and Clifford A. Sloan. The firm will give particular attention to the planning and management of advertising campaigns for firms engaged in the manufacture of mechanical and electrical apparatus and accessories.

BUFFALO FOUNDRY & MACHINE CO., 63 Winchester Ave., Buffalo, N. Y., was damaged by fire early in the morning of April 11 to the extent of about $10,000. Because of its steel and glass construction the building is practically fireproof, excepting the roof, where the greatest damage was done. The damage stopped business in the plant for only a few days.

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

June, 1912

MILLING MAIN-RODS AT THE JUNIATA SHOPS

By FRANKLIN D. JONES*

THE machining of locomotive main-rods at the Juniata Shops of the Pennsylvania R. R. was described in MACHINERY (railway edition) February, 1910. Since that time, however, the method of milling these rods has been improved considerably, which is saying a great deal, as the former practice was doubtless in advance of that found in the average shop. In connection with the milling operations, a large amount of stock is removed and, at first thought, it would seem more economical to forge closer to the finish size, but this superfluous metal is milled off so rapidly that any fancy forge work would cost more than the extra time required for milling. As the article previously referred to contained a complete description of the rod work, we shall deal more particularly with the milling operations, in order to show how quickly a large amount of stock can be removed by milling. when the machine itself is adapted to the work and the cutter is properly constructed.

The successive stages through which the main-rod passes while being transformed from a rough forging to the finished product, are illustrated in Fig. 1. The rough forging is shown at *A* just as it comes from the blacksmith shop. It is made of 50 point carbon steel, and the particular rod referred to in this article weighs approximately 1831 pounds before any milling operations have been performed. After it is milled, the weight is reduced to 1535 pounds. The first operation is that of planing the sides and edges of the enlarged ends. The sides are finished to the required width, but the top and bottom edges are simply rough-planed, as they have an irregular outline which cannot be machined to advantage by planing. A special double-head rod planer is used for this work. Each head of this planer has two tool-heads on the cross-rail and a similar number of side-heads, so that two forgings can be planed simultaneously. The object in planing the ends first is to provide finished surfaces for setting up the work while milling the sides and edges. The rod is next taken to the laying-out benches where the finished outline is transferred to it from a steel templet. Centers for the holes which have to be drilled in the ends are also located at this time.

The third operation is that of milling the edges. A group of six rods is placed on a horizontal milling machine and the edges of first one side and then the other are milled to the required outline, as will be described more in detail later on. The sides are then finished to the required width by milling, two rods being placed on the machine at a time. The shape of the work after the milling operation is shown at *B*. The rods are next placed on another milling machine of the horizontal type which cuts deep grooves or channels in the sides as shown at *C*. This channeling operation is performed on two rods simultaneously. The channel, which is $4\frac{1}{2}$ inches wide and $1\frac{3}{4}$ inch deep, is completed by taking two cuts, each of which is $\frac{7}{8}$ inch deep.

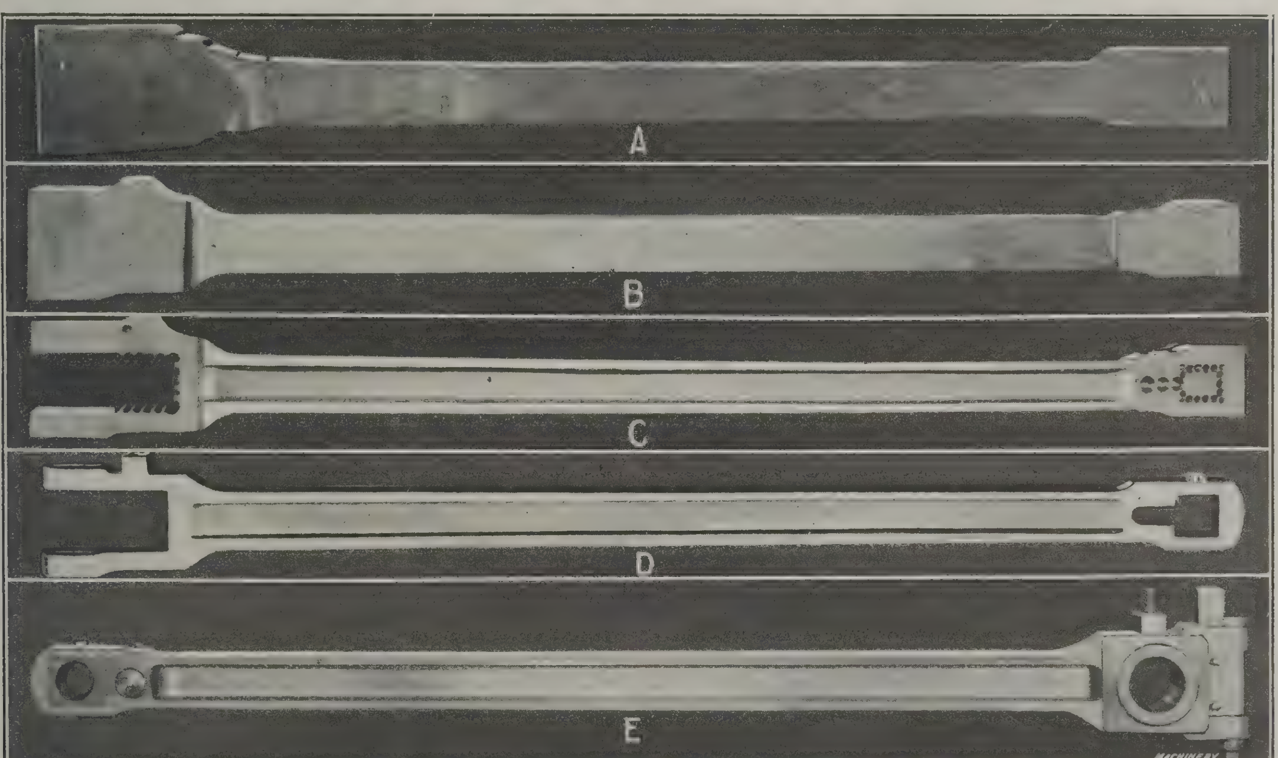


Fig. 1. The Evolution of a Locomotive Main-rod

After both sides have been channeled, thus forming an I-beam section, the drilling indicated at *C* is done, preparatory to forming openings at the ends for the bearing brasses. The small end is blocked out entirely by drilling, as the illustration shows, and the large end, after being drilled part way, is taken to a double-blade sawing machine which removes a solid block of metal from the center. These rough interior surfaces are next finished to the proper width in a slotter, the previously scribed lines serving as a guide for the workman. A view of the rod after the slotting operation is shown at *D*. The holes for the key-slot at the large end are next drilled and slotted and the oil holes are also drilled and counterbored, which completes the machining operations. The rod is now taken to the bench, where the sides and ends are finished and polished,

* Associate Editor of MACHINERY.

and finally, the brasses, keys and bolts are fitted in place, thus completing the rod as shown at *E*.

The milling of the sides and edges of these rods is done by the powerful horizontal milling machine shown in Figs. 2 and 3. The table of this machine is driven by a rack and spiral pinion, and power to the cutter arbor is transmitted through large worm-gears on each side, as indicated in the illustration. The milling cutter used is 33 inches wide and is composed of three units 11 inches long and 8¾ inches in diameter. It is equipped with inserted blades which are held in helical grooves. When the edges of the rods are being milled, this cutter covers a surface 30 inches wide and takes cuts ranging in depth from 1/4 inch to 1 3/16 inch. As previously stated, the edges of six rods are milled simultaneously. Fig. 2 illustrates how the work is set up for the first milling operation, and Fig. 4 is a view showing a group of rods after the edges have been machined. When the sides are being milled, two rods are clamped to the table as indicated in Fig. 3, and Fig. 5 shows the work after the sides have been milled.

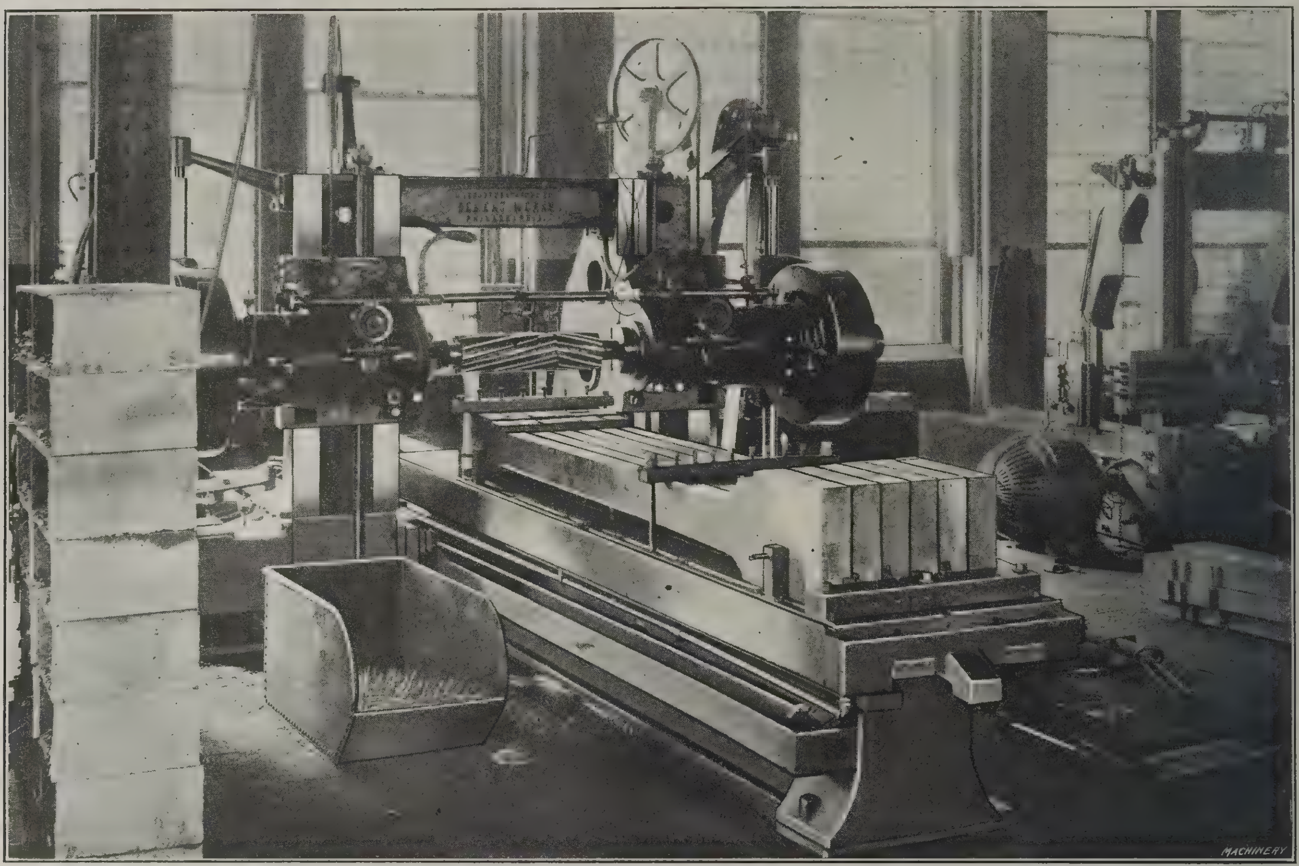


Fig. 2. Horizontal Milling Machine in which the Edges of Six Main-rods are milled simultaneously

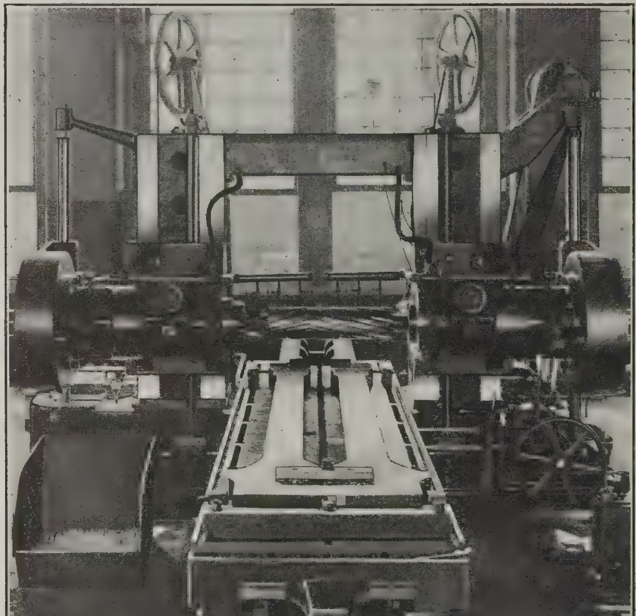


Fig. 3. Method of Holding the Rods while the Sides are being milled

The diagram, Fig. 6, shows the lengths of the different sections or surfaces on the sides and edges, which are milled. The time required for milling each of these sections, together with the average depth of cut, will be given in order to show exactly what is accomplished. Section *A*, the original outline of which is indicated in a general way by the dotted lines, is finished to the form shown in 55 minutes, two cuts, each having a depth of 1 3/16 inch, being required. Part *B*, the original form of which is also indicated by dotted lines, is milled in 1 hour, 40 minutes. Section *C* requires only 35 minutes, and the depth of cut varies from ⅜ to ⅝ inch. Section *D* takes 20 minutes, the cut being 1 inch deep part way and ¾ inch the remainder of the way. Section *E* is milled in 40 minutes, the time being increased for the length milled, because of the hand manipulation required for the irregular outline. The long cut

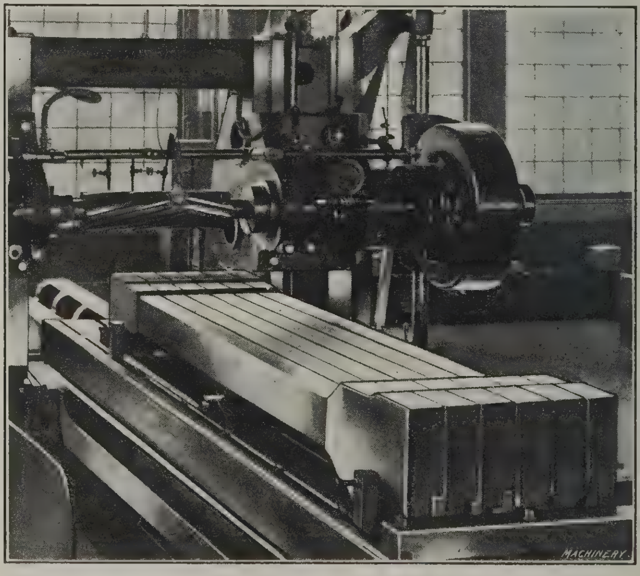


Fig. 4. View showing Group of Rods after Edges have been milled

F requires 45 minutes and varies in depth from ½ to ¾ inch. Section *G* is milled in 15 minutes and the depth of cut is ¾ inch. It should be remembered that the time given in each case is for six rods, whereas the following figures which refer to side milling operations are for two rods. Side *H* is milled in 22 minutes, the cut varying in depth from ¼ to ½ inch, and the opposite side *I* requires the same time, and approximately the same amount of metal is removed.

These figures were not taken from special tests, but represent everyday practice. After the edges and sides are milled the weight of a rod is reduced from 1831 pounds to 1535 pounds, as previously stated, 296 pounds of metal having been removed. The total time for milling the edges of six rods is 5 hours and 10 minutes, and both sides of six rods are finished in 2 hours and 12 minutes, making a total cutting time of 7 hours and 22 minutes. The average amount of stock removed per hour is 241 pounds, and the average time required for milling each rod is about 1 hour and 13 minutes. It will be seen that the figures given in the preceding sentence justify the great difference in weight between the rough forging and the milled rod; in other words, the milling is done so rapidly that it is not necessary to forge close to the finish size. By removing plenty of stock from the outside, a solid homogeneous rod, free from surface flaws or other imperfections, is obtained.

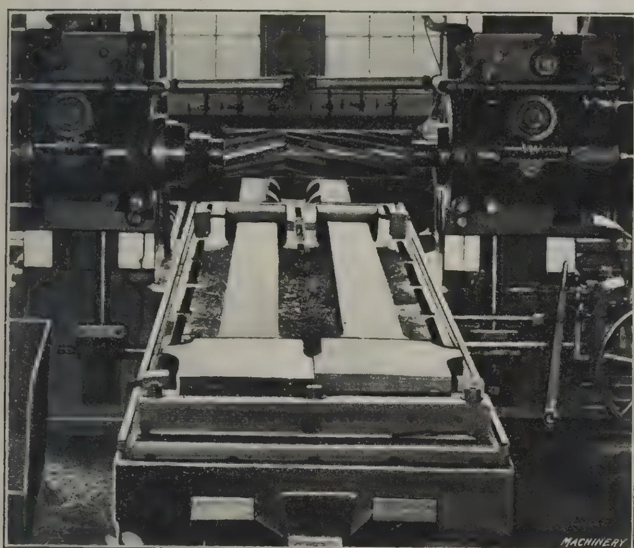


Fig. 5. Two Rods after the Sides have been milled

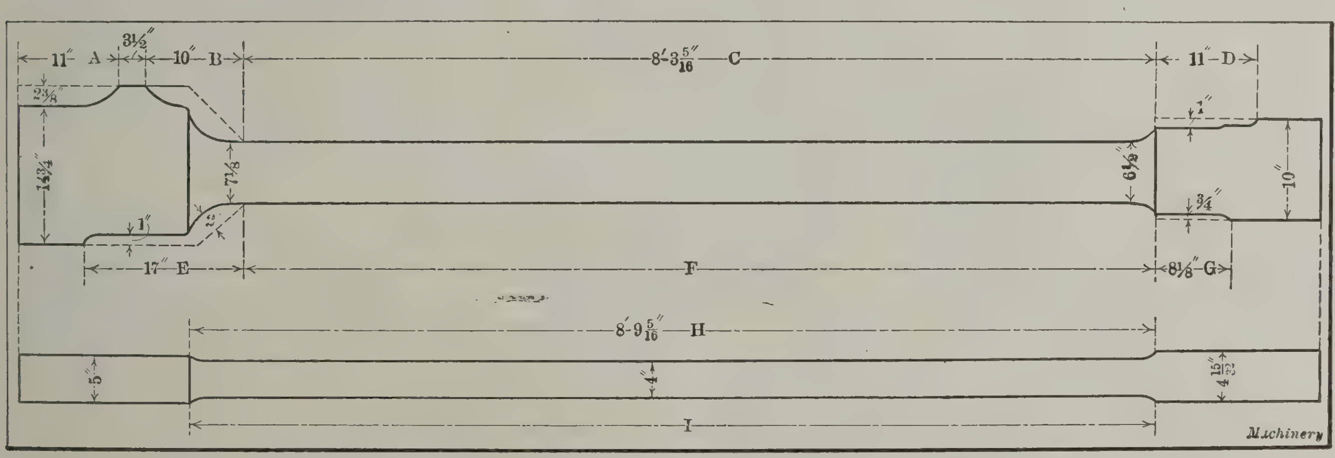


Fig. 6. Diagram showing Sections of Main-rod which are milled—Time and Average Depth of Cut given in Text

* * *

AUTOGENOUS WELDING IN GERMANY

According to a report by Consul General A. M. Thackara of Berlin, Germany, autogenous welding methods are used very extensively in Germany, and practically all of the larger manufacturers of metal products have their own welding plants. There are comparatively few independent welding plants, but there has been a notable increase in the number of small welding apparatus sold during the last year. It is estimated that about 12,000 plants in Germany are using autogenous welding apparatus at the present time. In both Berlin and Cologne courses in the manipulation of welding apparatus have been given. The "Handbuch für Carbid und Acetylene," by Prof. Vogel, published by Friedr. Vieweg & Sohn, Braunschweig, has been recommended to the American consul in Berlin as being the best work describing the different German welding apparatus. The price of this book is 15 marks (approximately $3.60). By far the greater number of German plants use acetylene instead of hydrogen gas, because, although the prices of acetylene and hydrogen are practically the same, the claim is made that a greater amount of hydrogen is required to do a given piece of work, and, furthermore, hydrogen is not suitable for welding comparatively thick pieces.

* * *

OLD DAYS IN AN EASTERN MACHINE SHOP

By R. H. G.

About thirty-five years ago the Pratt & Whitney Co. of Hartford, Conn., made all kinds of special machines to order, and it was only necessary for the customer to send a sample of the article that he wished made in large quantities to the firm; an automatic machine would then be designed and built for the work. At that time there were working in the drafting-room of the plant some of the best mechanics and inventors in this country. The machines designed always had novel features, and in this way the company obtained its prominent position. Mr. Frank Pratt, the president, was himself one of the best draftsmen and designers in his day, and had on his staff such men as J. Reynolds, John J. Grant, Charles Church, and others.

One day Mr. Pratt came into the drafting-room and asked if a certain special machine had been laid out; when nobody replied, he said: "Give me a drawing-table and I'll show you young fellows how to draw a machine in quick time." He was soon at work, and it did not take him long to outline the machine. He had, however, not done any work of this kind for several years, and the calculations of the various movements proved tedious to him. He was also anxious to finish the work, and started to ink in the drawing before it was quite completed. Then he was called away on business for a few days, and when he started drawing again, upon his return, he noticed several mistakes, so that it became necessary for him to do a good deal of erasing. When the erasing commenced, Mr. Reynolds spoke up and said: "Mr. Pratt, there's a new way out for making drawings quick and easy." Mr. Pratt, who always was interested in everything new, said: "What is it?" Mr. Reynolds replied, "You take a large sheet of drawing paper, and after carefully fastening it to your table, you cover the entire paper with lines and circles, and then you erase those which you do not wish to use."

Mr. Reynolds did not stay to see the effect of his explanation.

* * *

SAFETY GATES FOR SHOP DOORS OPENING ON RAILROAD TRACKS

The very frequent practice of running railroad tracks close to factory walls and having doors from the factory open directly upon the railroad track, has been the cause of many fatal accidents. A simple method of guarding against accidents of this kind has been adopted by a large western concern. Small gates are provided which ordinarily extend across the railroad track, but which are so arranged that when cars

are to pass along the track, they can be swung aside so as to close the entrance to the shop. The gates are cared for by the switching crew, who close them across the doors of the shop when a train approaches. This means of safety is very effective, because it cannot easily be neglected. Should the switchman not attend to his duties, however, the neglect would be apparent, as the gates extending across the tracks in front of the approaching train would be broken by it, and, hence, an indisputable evidence of the neglect to close the gates in front of the doors opening upon the tracks would be at hand.

* * *

FORCE-MAKING FOR EMBOSSING DIES

By CHESTER L. LUCAS*

THE term "force" is used in connection with die-sinking, but the words "force" and "hub" are often confused by those who are not familiar with this work. A hub is a hardened steel punch used to form an impression in a die. Usually the die is heated to facilitate this operation. Only a small percentage of dies require the use of a hub, but there are some designs that are more easily cut "on the hub." A die having flat panels with projecting lines, as illustrated in Fig. 9, would be very difficult to make without a hub, and so would one in which a number of letters or parts of the design had flat faces cut to the same depth, as shown in Fig. 10. After the dies are made, the work of the hub is done, unless duplicate dies are to be made at some future time.

A "force," or "forcer," is, as its name implies, a block of metal which *forces* sheet stock into every crevice in the impression of a die. A force is probably used with nine out of every ten embossing dies. The exceptions are dies in which the design is extremely shallow and the metal relatively thick, and dies for emblems, buttons or similar work in which the design is so intricate that a force would be of no advantage. "Strikings" to illustrate these cases are shown at *A*, *F*, *G*, *M*, *N*, *O*, and *R*, Fig. 1. In such cases the metal is simply driven into the impression by a flat steel block held in the hammer of the press. This block is often called a flat force, and is usually made by heating a piece of round bar steel, about two inches long, laying it on a plain hard die block in the press, and striking several blows upon it with the hammer of the press, in which has been mounted a "pick-up." One of these pick-ups is shown in Fig. 8. The flat force is hardened and tempered to a light straw color.

Fig. 2 illustrates four embossing dies for which forces would be required, and Fig. 3 shows a group of forces, those at *A* and *D* being made of copper and the rest of steel. Those at *B* and *C* show the reverse sides with the ridges formed by the pick-up. In Fig. 4 are shown, in place, the die *A*, the force *B*, and the pick-up *C*, keyed in the hammer of the press, which is illustrated at *D*.

Forces are made from different materials, depending upon the character of the work, the design of the die, and the thickness of the metal being stamped. In determining the material from which a force shall be made it is quite important that the number of impressions be taken into consideration. Thus, if only fifty or one hundred impressions are to be made, it would be inexpedient to make a steel force.

Tin or Lead Forces

Tin or lead forces are used for embossing dies where the designs are large and no small detail is required, and the material to be stamped is soft, like brittania metal or silver. Tin is, by far, the better of these two metals, but often lead is employed in its place. The stampings shown at *C* and *P*, Fig. 1, are easily made by means of tin forces. The metal is soft and thin and the detail is not too complicated. The method of making a tin or lead force is to surround the design on the die with a wall of putty. The molten tin or lead is then poured into this enclosure and allowed to set. This operation can often be performed without removing the die from the press. As soon as the metal has cooled, the putty is removed from the die and the hammer brought down upon the tin or lead casting. The blow thus struck imbeds the top side of the force into the pick-up of the hammer and sharpens the face of the force, leaving it ready for use.

A typical job upon which this class of force is employed is shown set up in the press in Fig. 5. The work being stamped is a silver hand-mirror mounting. The lead force for this job may be seen imbedded in the pick-up of the press, which has

Fig. 1. Stampings from Embossing Dies involving Use of Forces of Various Kinds

* Associate Editor of MACHINERY.

a series of parallel slots extending both ways across its face, enabling it to hold the large lead force firmly. In the stampings shown in front of the die, holes have been punched at the center of the impression. This is done to allow the metal to "pull" evenly in forming the design, thereby lessening the danger of cracking or causing thin spots in the work. Beside these stampings is shown a lead force that has just been removed from one of the other presses. Lead or tin forces are very short-lived, but as they are extremely easy to make, they are profitable to employ if the character of the work permits it.

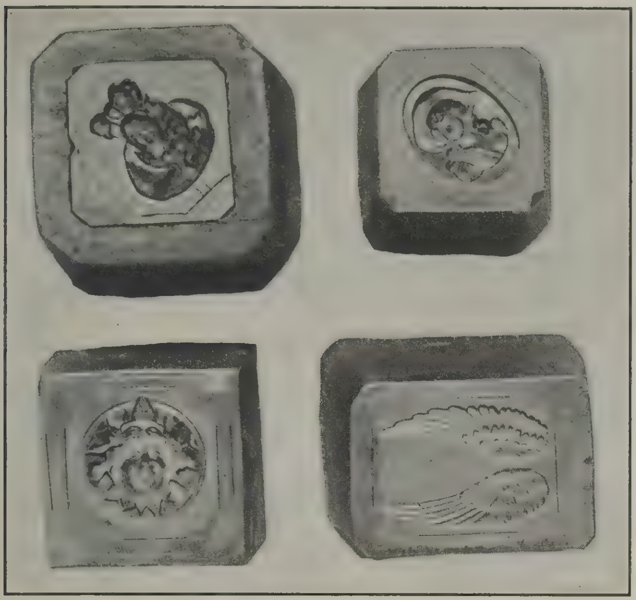


Fig. 2. Embossing Dies requiring Forces

Cast Brass Forces

On long runs of soft metal stamping, when it would be too slow to stop and renew the lead force many times, cast brass forces are made. A plaster of Paris pattern is first made, and after being cut away in certain places and built up at the ends to anticipate the loss from shrinkage of the brass, a casting is made. After filing up this casting, it is fitted to the pick-up and struck into the die to bring up the design. It is relieved where necessary, and is then ready for use. Fig. 6 shows a pattern for a brass force.

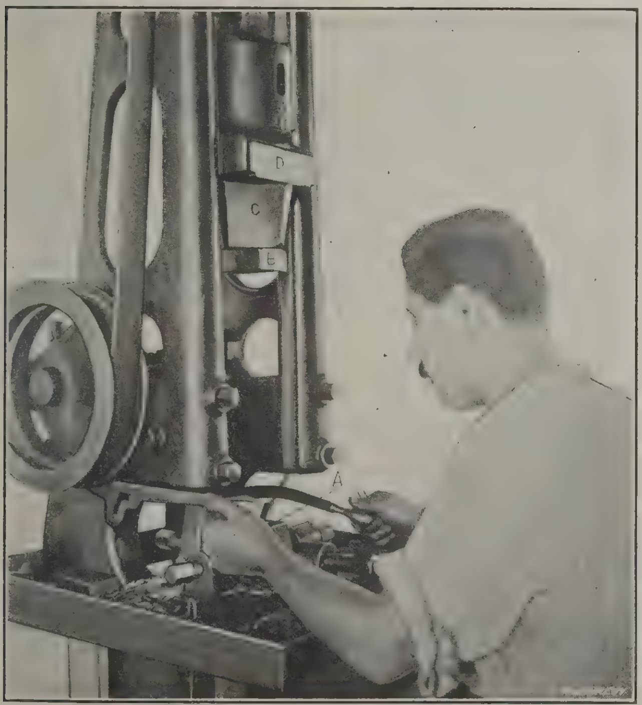


Fig. 4. Showing the Use of Embossing Die, Force and Pick-up

Copper Forces

For work in which the requirements are somewhat more severe than in the work just described, copper forces are generally used. They are especially useful in striking up small gold emblems which are too deep to be successfully made with a flat block for the top die. One of these designs is shown at *S*, Fig. 1. Copper forces are seldom used for work over one and one-half or two inches in diameter. They are made by taking a blank piece of sheet copper from 1/16 to 1/8 inch thick, placing it on the die, and striking it into the impression. This operation is performed without heating the metal. In order to get the force "full," it is often necessary to anneal it and restrike it several times. It is then finally placed in the die with a small piece of beeswax on top of it, and is "picked up" on the flat top die. The metal blanks are then struck up in the usual manner.

Fig. 3. Copper and Steel Forces

Difficult cases require that the blanks be run through a first operation consisting of striking them into the impression of the die; this being done, they are struck a second blow, which is often so severe that the copper force is loosened from the hammer at each blow. It is, however, an easy matter to lay the partly formed blanks in the die, place the copper force on top, seated in the impression in the partly formed blank, and proceed with the striking. Thus it is immaterial whether the force sticks to the top die or not.

Fig. 5. Lead Force in Use

Copper forces are also used for striking up deep articles in which the requirements are too severe for tin or lead forces, because of the metal being excessively hard or thick. The

samples shown at H and L, Fig. 1, should be made by using copper forces. A force for this class of work is made by heating a piece of bar copper to a red heat, placing it on the die which has been previously set up in position in the press with a pick-up in the hammer, and striking it repeatedly into the die impression until every detail of the design is plainly visible on the force. During this striking operation it is

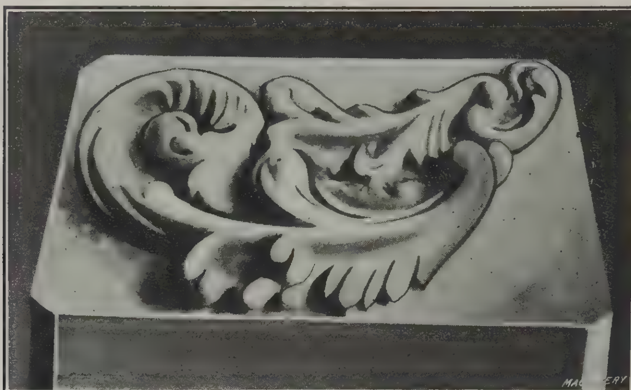


Fig. 6. Plaster of Paris Pattern for a Brass Force

necessary to clean out the die after each blow, either by an air blast or with a wire brush. The whole operation must be carried through as rapidly as possible in order to get the force "up" at the first heat, because a second heat produces an inferior force, on account of the softening of the metal on reheating. The copper force is left in the pick-up, and while cooling, is struck into the die at intervals to make up for the shrinkage. If the design is fairly symmetrical in all directions, the result of the shrinkage will be negligible, but if the design is long and narrow, trouble generally arises, a point which will be touched upon more fully in the following.

Soft Steel Forces

Soft steel forces are employed in many shops in preference to hardened tool-steel forces because there is less danger of

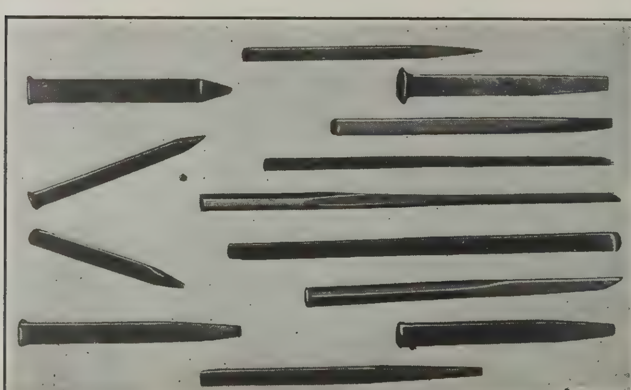


Fig. 7. Chisels and Punches used in Fitting and Relieving Forces

the die being injured by careless operators. If a hardened force, for instance, is struck into the die without any work being placed in it, the die will be injured. In general, soft steel forces are employed in cases where a lead, tin or copper force would not stand up to the requirements, and yet a tool-steel force is not required. A typical piece of work of this character is shown at K, Fig. 1.

Another case in which it is advantageous to use soft steel forces is where the trouble caused by shrinkage would be great, and it is, therefore, considered best to work up the force cold. This is especially true of forces for name-plate dies where the letters are weak and narrow. A force cannot be made cold, however, without a great deal of trouble, unless the design is fairly shallow and of even depth.

When working up a machine-steel force cold, the outline of the blank should first be machined to approximately match the impression of the die. The face of the force should then be covered with a thin coating of solder. This is best accomplished by flowing solder over the face of the force, afterwards wiping off the surplus with a piece of clean waste. In this condition the force is laid upon the die in the press, care being taken to have its face match that of the impression in the die, after which a fairly hard blow is struck upon the top side of the force. This will leave an impression upon the force-face; the steel may be chipped off from the parts of the force where it is not needed, as shown in Fig. 17, and the force refitted in the die and struck again. This process is repeated until every detail of the force comes up sharp. Sometimes it is advantageous to use punches to drive the metal down and out of the way rather than to try and chip it away with chisels. Some of these punches are shown in Fig. 7, and the method of doing the work is illustrated in Fig. 18.

The advantage of working up a force cold, as mentioned, is that the problem of shrinkage does not enter into the work. The shrinkage of a force is illustrated by Figs. 11, 12 and 13. Fig. 11 shows the face of a die with the impression of a long narrow scroll cut in it. In working up a force for this design, it should be done cold, if possible, and the force will then

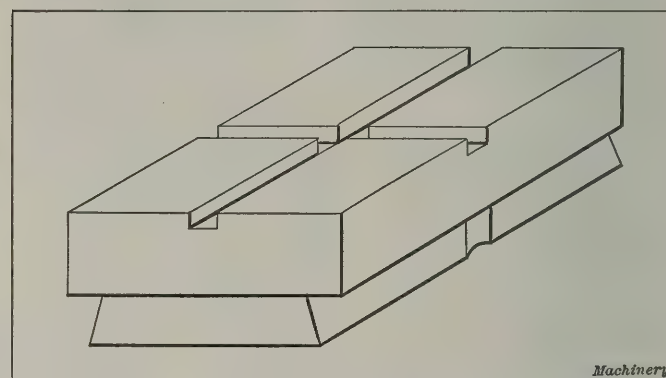


Fig. 8. One Form of Pick-up

fit as shown in Fig. 12. If, however, it is thought best to try to make the force hot, the result will generally be as shown in Fig. 13, in which the force, while a good fit for the die when hot, shrank in cooling. The shrinkage of the force may be evened up by distributing the poor fit in both directions and by favoring the worst places during the relieving. By doing a little driving over of the metal and with the aid of a few impressions struck cold, the force may be made passable. It takes, of course, a great deal more skill to make a

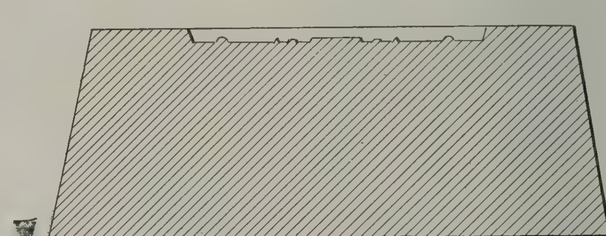


Fig. 9

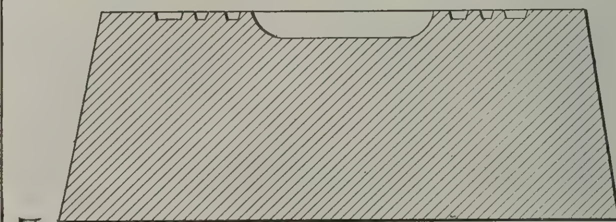


Fig. 10

Figs. 9 and 10. Types of Dies that can best be made by Use of Hubs

force cold than it does to fit it hot, but for designs resembling that in Fig. 11, the force should be made cold if possible.

Hardened Steel Forces

Without doubt, the majority of forces used for the ordinary run of brass and copper work are made of tool steel and hardened. This is necessary either on account of the toughness of the metal being worked, the thickness of the stock, or the large number of impressions to be produced.

For making a force of this character, Jessop's steel is considered the best. Other brands of steel on the market are,

however, used to good advantage, and no doubt the use of Jessop's steel may be traced to the fact that it has been a good, well-known steel for so many years back. In selecting the stock for a force of this kind, the shape of the blank piece of steel should depend upon the design of the die. While a good many force-makers simply cut off a piece of square or round steel from the bar, heat it, and strike it into the die,

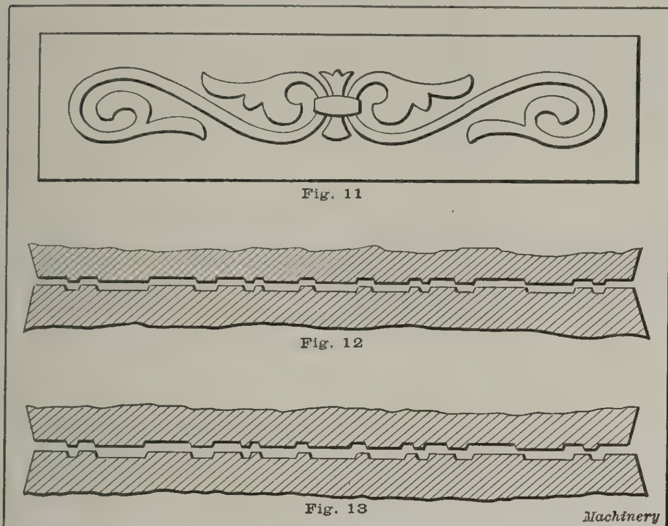


Fig. 11. Design of a Die whose Force can best be made Cold. Fig. 12. Illustrating the Way a Force must fit the Die. Fig. 13. Showing the Effect of Shrinkage

there are many cases when the force could be more quickly made by using a blank that had been carefully prepared by machining. Such an instance is illustrated in Figs. 14 and 15. In these two illustrations the impressions in the dies are alike. In Fig. 14, a flat block of steel is shown being struck into the die. The idea of this illustration is to bring out the fact that it is very difficult to get the center of the force "full" when using a blank of this shape, because the steel at the sides retards the central part of the blank from flowing into

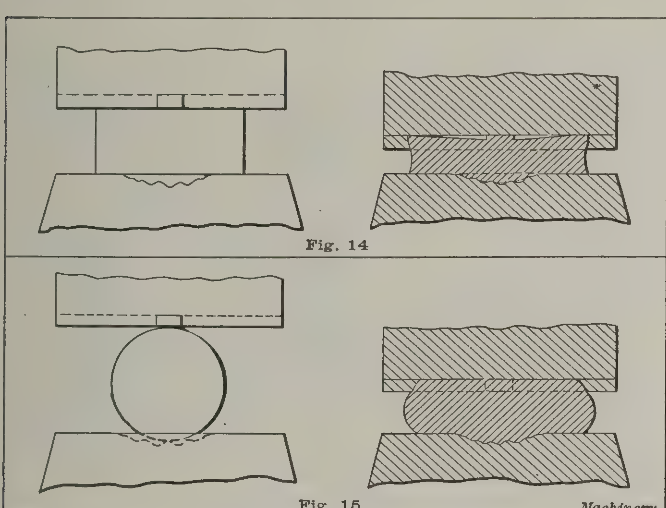


Fig. 14. Making a Force from a Flat Piece of Steel. Fig. 15. Making a Force from a Round Piece of Steel

the impression in the die. To overcome this tendency, the force-blank should be turned in a lathe so as to round the ends about as shown in Fig. 15. When a force-blank of this shape is struck into the die, the first part of the impression to be filled is the center. The last part of the impression to be filled, and the easiest, is the outside edge of the design.

In striking up a force, there are several essential points to be borne in mind. Among these the most important is to have the ways of the drop press adjusted so that there will be a minimum amount of shake to the hammer; the die should be solidly held in place by the poppet screws, care being taken to see that it rests on an even base on the bed of the press. The edges of the grooves in the pick-up should also be in good condition. After heating the blank to a bright red heat, it should at once be carried to the die and laid in the proper position and struck immediately. In striking, the heaviest blows should be struck at the beginning, picking the force up at the first blow if possible, as the hot steel should not be kept in contact with the face of the die any longer than possible. During the operation of striking up the force, the scale formed should be brushed off the die as rapidly as possible after each blow with a wire brush, or, better still, with an air blast. It is often necessary to use a second or even a third heat. If the design is fairly regular in outline and the impression does not have too much detail, the force may be struck into the die at short intervals while cooling in its position on

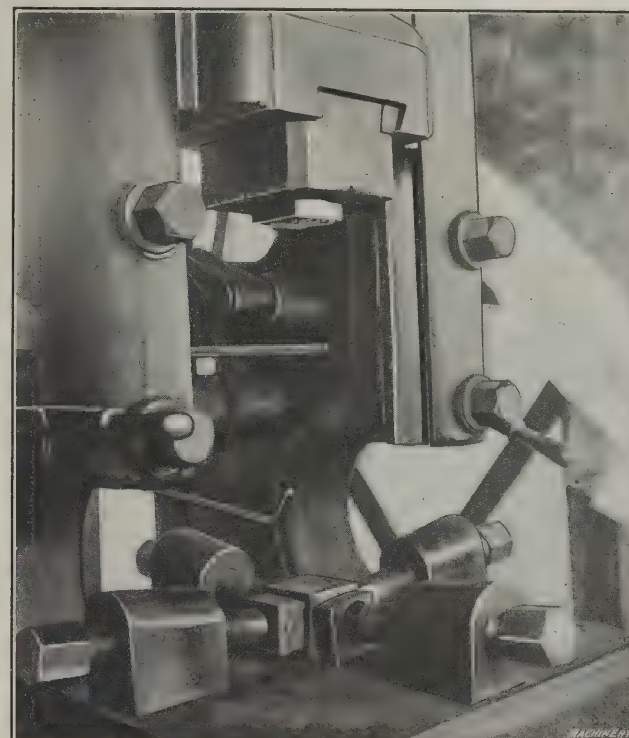


Fig. 16. Striking the Force in Cold

the pick-up, which will, in a measure, reduce the evils of shrinkage.

In order to make it possible to grip the force while working on the face, the first operation after striking consists in squaring up the edges in the shaper. It is usually necessary to anneal the force before it can be machined. At this time the machine work necessary for the relieving (which will be referred to later) can also be done. In addition, the ribs on the back of the force should be peened out to fit the slots in the pick-up, for, in cooling, these ribs have shrunk until they are a loose fit in the slots. In some shops forces are held in the

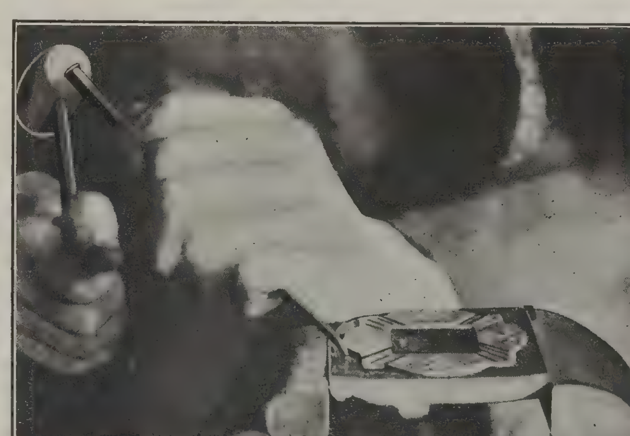


Fig. 17. Fitting and Relieving the Force—Chipping

pick-up from the back by means of screws engaging tapped holes in the force, but this is not good practice.

Fitting and Relieving the Force

The fitting of a force consists in overcoming the "misfit" caused by shrinkage. This is accomplished by "driving" over all necessary parts, "stretching" the design toward the ends, and chipping off at the inside of the design. When nearly

fitted, the force may be struck into the die cold a few times to properly shape the affected parts. Between these blows, it will usually be found that additional cutting or punching is necessary to facilitate the remainder of the work of fitting.

In order to produce good stampings from the force, certain parts of its face must be relieved. The amount of this relief depends upon the design, and especially upon the thickness of the metal being stamped. The first step in the relieving of the force consists in cutting away the metal from the background of the face of the force around the design to a depth slightly in excess of the thickness of the metal. This operation may be, and usually is, partly accomplished by machining in the shaper or lathe, going as close to the edge of the design as possible without running into it. In removing this metal, it is, of course, necessary to take the same depth from the interior of the design of a piece like that shown at *Q*, Fig. 1, as from the outside, so that the force will not strike hard at

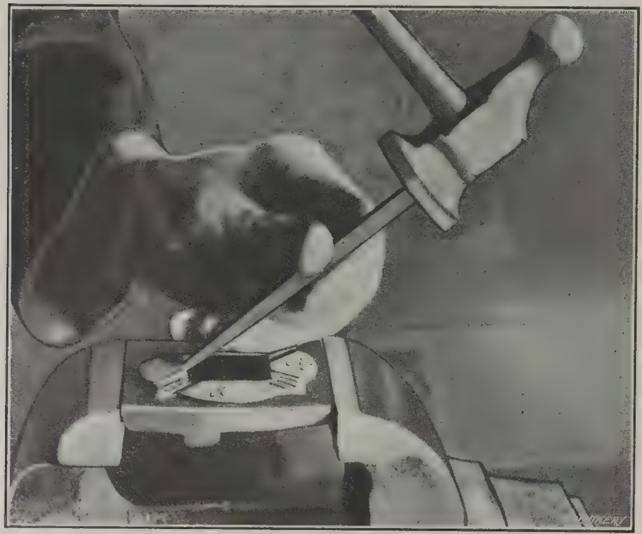


Fig. 18. Fitting and Relieving the Force—Driving up

the center. On large rings, etc., the interior of the design can best be relieved in the lathe.

The next step consists in chipping away the remainder of the metal up to the edge of the design as illustrated in Fig. 17. This being done, the metal must be removed from any straight portions of the design of the force. This will be more clearly understood by referring to Fig. 19—especially the section shown at *B*. If, on a design of this character, the force is not relieved on the sides, which in this case are very nearly straight, the effect of the blow upon the metal will thin the stock at the points *F*, *G*, *H*, and *I*, in the manner shown. To overcome such troubles, the force must be relieved at these and similar portions so as to produce a stamping of even thickness

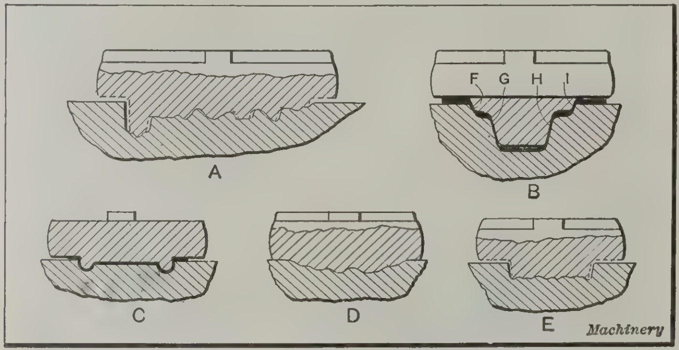


Fig. 19. Illustrating Points about Relieving Forces

as shown at *C*. In this view it will be seen that the two ribs on the force are very much thinner than the corresponding impressions in the die, due to the fact that they have been relieved. At *A* is shown a force set into the impression of the die after having been properly relieved. It may be thought strange that the face of the force is not also relieved, but it must be remembered that it is the face of the design that receives the full effect of the blow, and all stock possible should be left on this part of the force. In order to leave the face of the force as high as possible, the stock is often punched or driven up from the sides, thereby forcing the face of the force higher than it formerly was. Occasionally there is a force which requires no relieving. Such an instance is shown at *D*, in which the design could be struck up without relieving the force at all, unless it be very slightly around the background outside of the design. At *E* is shown another instance where the sides must be relieved to permit the force to push the metal into the bottom of the design and act with the full blow upon the impression at this part of the die.

The most difficult parts of a force to bring up are "matted" backgrounds, like those shown on parts *I* and *J*, Fig. 1. The detail is here too fine to be brought up by punches. The best way to take care of such places is to clean all scale from the surface and strike the force into the die, cold, several times. In stamping thin metal, the matted portions will not "come up" unless the force is perfectly fitted at these points. Moreover, it is seldom advisable to lower a matted background in relieving, for all possible pressure is needed to bring up the matting to the best advantage.

Hardening the Force

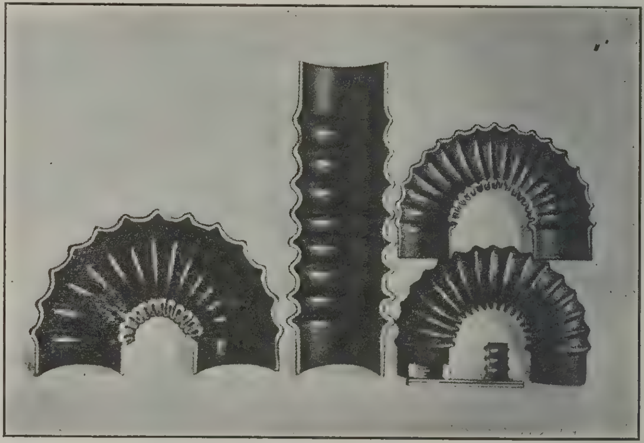
After the force had been fitted and relieved and a few stampings struck up to make sure that the work has been done right, the force may be hardened. The temper of the force should be drawn to a dark straw color. If there is little detail to the design it will be best to draw the temper to a purple color, especially if the metal being worked is hard, thereby lessening the risk of breaking the force while in use.

All of the presses shown were made by the Standard Machinery Co., Providence, R. I., and were photographed through the courtesy of Philip Vester & Brother, and George Parks Co., both of Providence, R. I.

* * *

ELASTIC CORRUGATED TUBES

The accompanying illustration from *Engineering* shows a form of corrugated tube which has been designed for expansion joints, heating- and smoke-tubes, superheaters, condensers, etc., where the tubes are subjected to wide ranges of temperature. These tubes, instead of having a spiral corrugation, frequently seen in tubes made in the past, have corrugations parallel to one another. This method of construction is adapted to tubes



Some Examples of Elastic Corrugated Tubes

made in a great range of sizes. Owing to the construction the tubes can be bent to a very small radius. They are manufactured with an inside diameter of from 1⅜ to 18 inches. The process of manufacture is claimed to be such that after pressing out the corrugations, the pipe retains its exact original internal diameter, and there is an absolute uniform thickness of the metal in all the parts.

The chief advantages claimed for these pipes are: That they are of great utility in all cases where the expansion or vibration of pipes has to be taken into consideration; that they are valuable as boiler tubes because of the increased heating surface and because they relieve the strain due to expansion and contraction; that they are well adapted for superheaters owing to the whirling motion given to the steam; that they are exceedingly well fitted for expansion joints; that they take up much less space than bends of ordinary piping, because the bends can be made much shorter; and that the stress on the flanges and connections is greatly reduced.

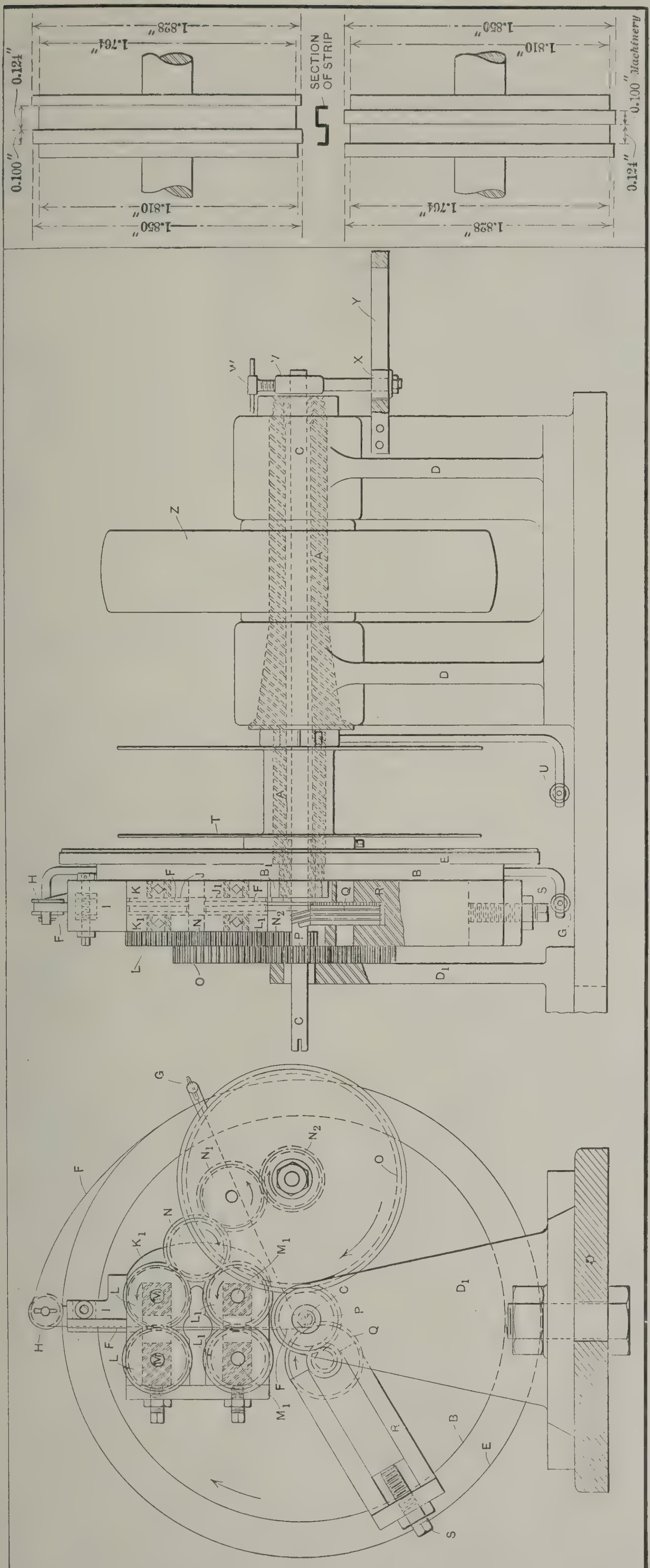


Fig. 2. Forming Rolls

Fig. 1. Details of the Tube Forming Machine

MACHINE FOR FORMING FLEXIBLE TUBING

By RICHARD TOEPLITZ*

Flexible tubing is extensively used in the automobile industry in connection with horns and speedometers, etc. The usual method of making this tubing is to form a length of ribbon stock and turn it over a revolving mandrel, at the same time making it airproof by running an asbestos cord between the single turns. This method has several disadvantages, the most prominent of which are the difficulty of freeing the finished tubing from the mandrel and the starting of a new piece of stock.

Briefly stated, the machine to be described in the following consists of a stationary mandrel supported by the frame of the machine, and a faceplate, which carries the forming rolls and the ribbon stock for the tubing, and which revolves on the mandrel. The formed tubing is pushed from the end of the mandrel as soon as formed, and is received by a special pair of rolls whose purpose it is to prevent the tubing from twisting. Referring to the illustrations, Fig. 1 shows the details of the tube forming machine; Fig. 2 shows the forming rolls together with a section of the formed stock; Fig. 3 shows a length of flexible tubing; and Fig. 4, the rolls which receive the tubing as it leaves the forming machine.

The construction of the forming machine, Fig. 1, is as follows: On the main-shaft *A* of the machine is mounted the faceplate *B*. The main-shaft is hollow throughout its entire length to receive the mandrel *C*, which is supported by bushings at both ends. Shaft *A* runs in suitable bearings located in the main casting or frame *D* of the machine. On the reverse side of faceplate *B* is located a case *E*, which contains the ribbon stock from which the tubing is formed. This ribbon stock comes in the form of rolls and provision is made for readily replacing these rolls as they are used up. The ribbon stock *F* leaves case *E*, and running over roller *H* passes through bracket *I* to the forming rolls *J* and J_1. These forming rolls are an important factor in the operation of tube making, and are shown in detail in Fig. 2. Referring to this latter illustration, in which the rolls are shown approximately full size, it will be seen that the rolls are in reality dies, running together so that the projections on the one roll push the stock into depressions on the corresponding roll. The brass for which this set of rolls was made was 0.012 inch thick and 19/64 inch wide. The rolls are made of tool steel and hardened.

Returning to Fig. 1, the shafts *M* and M_1, upon which the forming rolls run, are mounted in suitable boxes which, in turn, are fitted in slides in the side plates *K* and K_1. By means of adjusting screws and check nuts, the rolls are kept in proper relation to each other, varying, of course, with the thickness of metal being formed. Keyed to the outer ends of shafts *M* and M_1 are gears *L* and L_1. These gears are cut with 29 teeth of 16 pitch, and both pairs are driven by means of gears *N*, N_1 and N_2, which also have 29 teeth. Gear N_2 is permanently attached to gear *O*, which

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has 105 teeth of 16 pitch. Gear O is mounted, together with the other mechanism previously described, upon faceplate B, and is driven by contact with the stationary gear P held upon the frame of the machine.

The face of the grooved roller Q, which corresponds exactly with the shape of the strip, is mounted in fixture R which is located on faceplate B, and is adjusted with relation to the center mandrel C by means of set-screw S. The function of this roller is to roll the stock into its circular form after it has left the forming rolls. Reel T is mounted on shaft A behind case E which carries the ribbon stock. A supply of asbestos cord is contained on this reel, the free end of which passes over guide roller U to guide roller G, from which it runs to the mandrel as may be seen in the front elevation view of Fig. 1. This cord is wound between the single turns of the metal and its function is to make the joints of the tubing air- and liquid-tight.

As before stated, mandrel C runs completely through the main shaft A. At the rear end of the machine a holder V is clamped to it by clamping screw W. At the lower end of this holder is mounted roll X which is free to turn. This roll engages a slot in bracket Y that is bolted to the machine at this point. The object of this holder is to prevent the mandrel from turning while the tubing is being formed, but it does not interfere with the longitudinal travel of the arbor within the limits of the slot in bracket Y.

Operation of the Machine

The machine is operated by starting a coil of brass ribbon over pulley H down through the forming rolls J and J_1. At the same time, the end of the asbestos cord is run over rolls U and G down to the mandrel C. Mandrel C is moved to its extreme "in" position, and the end of the formed ribbon is passed through the slot in the end of the mandrel. The end of the asbestos cord is also caught in this slot. The machine is turned about two revolutions by hand and care taken that the brass ribbon and asbestos cord are properly coiled; then the grooved roller Q, the right-hand side of which feeds into the formed strip of stock, is pressed against the tube and locked by the tension screw. The extreme right-hand ridge on this roll is very finely corrugated to assist in driving the brass strip, and, moreover, this roll is keyed to the same shaft as a gear which meshes with the stationary gear P. The action of this

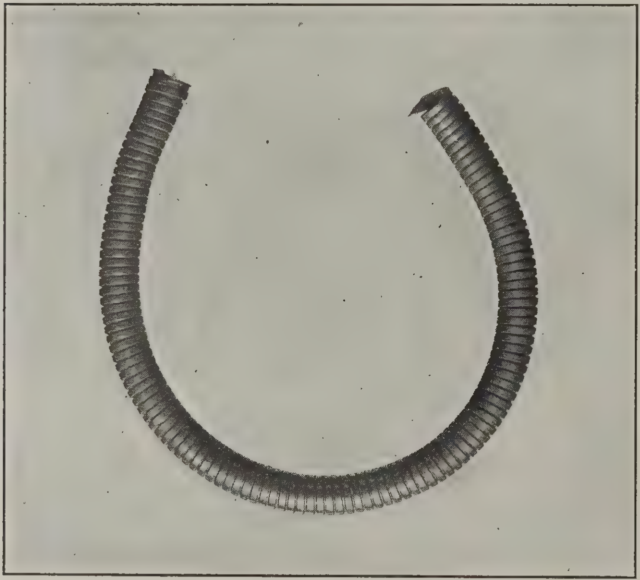


Fig. 3. Flexible Tubing

roller moves the tubing and mandrel forward until the holder V on the rear end of the mandrel touches the end of the slot in Y; then the machine is stopped and the end of the strip is removed from the slot in the mandrel; the mandrel is then pulled back, it being held from turning by means of holder V. The machine can now be run continuously, as long as the coil of stock in case E lasts. As the faceplate and shaft turn about the mandrel C, it is obvious that the entire chain of gearing, forming rolls and grooved roll Q revolve with the shaft about the stationary gear P.

It is very important that the stock should be drawn through the forming rolls just fast enough to be taken up completely as it turns about the mandrel C; thus it will be very apparent that if stock which is thicker or thinner than 0.012 inch be used, or if the diameter of the tubing being formed is larger or smaller than in this instance, the gearing must be changed by substituting larger or smaller gears.

It has been found advantageous to guide the tube around the pulley A, Fig. 4, and to hold the tubing in place by roller B so that it cannot twist as it leaves the machine. This pulley A, being mounted on a shaft C upon the outer end of which is a

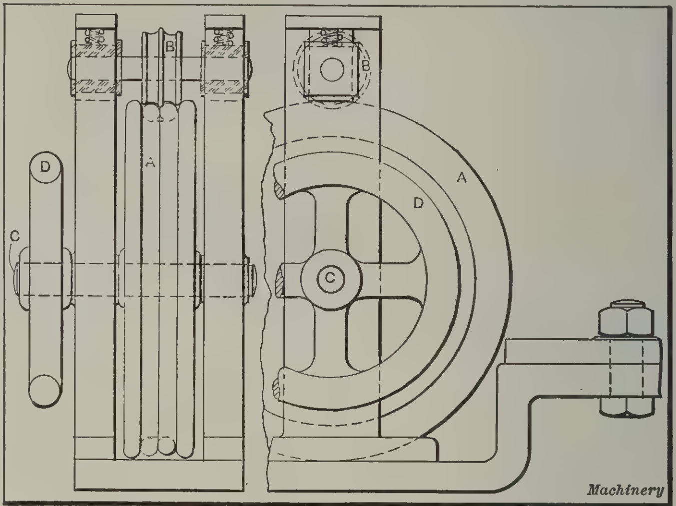


Fig. 4. Roller for receiving the Tubing after it leaves the Machine

handwheel D, enables the operator to coil up the tube as it is being formed.

After the supply of ribbon in case E has been exhausted, it may be replenished by moving back stand D_1, Fig. 1, and withdrawing the grooved roller Q. But B_1, on the end of main-shaft A, is then removed and plate B lifted off, thus making it possible to slip in a new coil of brass ribbon. The asbestos will last for several coils of brass. Should tubing of smaller or greater diameter be required, it is only necessary to remove the tube bushings at the ends of mandrel C, put the proper size mandrel and corresponding bushings in place, and change the gearing so that the speed at which the brass strip travels is equal to one turn around the mandrel for each revolution of the machine.

This machine, which is in successful operation, has required no repairs and is turning out an average of 225 pounds of tubing per day. A roll of ribbon weighing in the vicinity of 12 pounds will produce a continuous length of tubing about 70 feet long. The machine is run at a rate of 225 R. P. M. and at this speed will produce 30 inches of tubing per minute.

* * *

HEAT TREATMENT FOR VANADIUM TOOL STEEL

The George Hamilton Co., Providence, R. I., maker of figured rolls for rings, galleries, hubs, dies and tools, recommends the following treatment for vanadium tool steel in *American Vanadium Facts.* The brand "Hawk H" hardens very well in oil, water, brine, or sulphuric acid, but oil is preferred for the best results. In oil hardening, heat to between 1450 and 1550 degrees F. (dull cherry red) and then quench in oil. In hardening for toughness, draw to about 425 degrees F. (very faint yellow). In water hardening, heat to about 1400 degrees F. to get the best results.

* * *

TIME LOST WAITING FOR TRAINS

The traveler in the West who would go from town to town on local railway trains should count on wasting about one hour waiting for each train—but not always. If he could be sure that the trains would always be late he could allow for it and conserve his time, but, of course, if he does so the train he wants to take is likely to be on time. The annual loss of time of the traveling public through defective train service is enormous, and it is a serious indictment of railway management that such conditions generally prevail.

LOCATING JIG BUTTONS

By H. P. FAIRFIELD*

The use of jig buttons for accurately locating centers in the body or frame of drill jigs is not a new method, but perhaps some of the readers of MACHINERY have never seen it applied. It is for these that the accompanying halftones are presented. The reasons for using jig buttons and the general subject of jig and fixture making are excellently treated in MACHINERY'S Reference Books Nos. 3, 41, 42, and 43, and these are freely used by the classes in jig and fixture construction at the Worcester Polytechnic Institute. It is probable that by no other method used in the average shop, can centers for jig

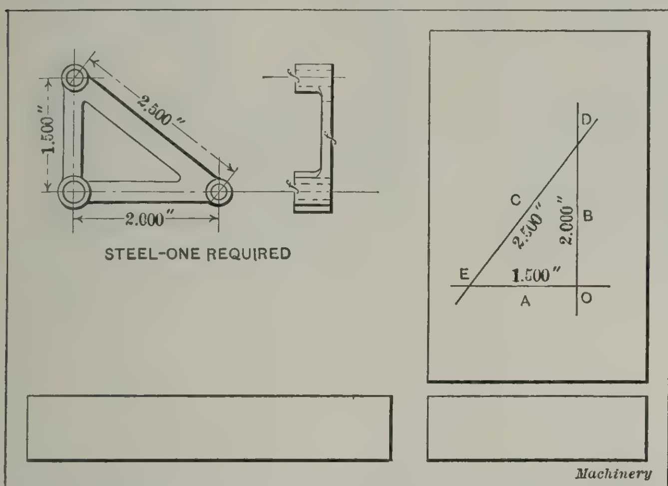


Fig. 1. Piece to be drilled, and Jig Plate to be laid out

bushings be so accurately located as by means of these jig buttons.† The buttons can be placed so accurately to the true location that the ordinary shop measuring and testing instruments can detect no errors; and expert jig-makers can bore the holes and can place the drill bushings so nicely that the inspection department can find no errors. In the shops of one firm with which the writer is familiar certain jigs are invariably rejected by the inspector if any error can be found. In most jig construction, however, certain tolerances are allowed.

The method of setting jig buttons described in the following, is typical of the common practice of toolmakers. To

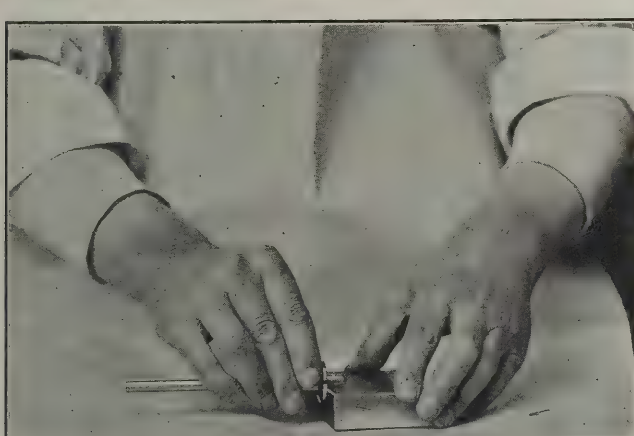


Fig. 2. First Step in Laying-out the Jig Plate

illustrate the operation it was thought best to choose as simple an example as possible, and, therefore, the buttons are located upon the cover plate of a simple drill jig used to drill the holes in the piece shown in the line-engraving Fig. 1. The lay-out of the length of the sides to insure a right angle at *O* is very simple, as the sides *A*, *B*, and *C* must be to each other as 3, 4, and 5; or, in other words, if the relations of the sides to each other are as 3, 4, and 5, angle *O* will be a right angle; because the square of the base plus the square of the perpendicular in a right-angled triangle is equal to the square of the hypotenuse. The halftones show, step by step, how to locate the buttons at the exact points desired. In the problem selected not only must the buttons be at the points shown, but those at *O* and *D* must be in a line exactly parallel to the side of the plate on which they are to be set.

* Address: Worcester Polytechnic Institute, Worcester, Mass.
† See MACHINERY, April, 1912: "A New System for Locating Holes to be Bored on the Milling Machine."

While different toolmakers may proceed in different ways, the order of progression here followed represents good average practice. Assume that the cover plate is planed to shape.

Fig. 3. Second Step in Laying-out Jig Plate

The portion upon which the buttons are to be located can be prepared for a lay-out by wetting with a solution of copper sulphate (blue vitriol). As this evaporates, a thin deposit of copper is left upon the surface of the plate; the finest line scratched through this upon the surface of the plate is very distinct, and the points of intersection of the lines can also

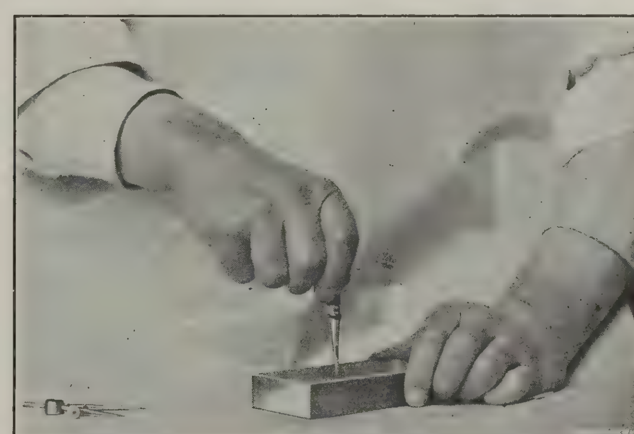


Fig. 4. Prick-punching the Intersections of the Lines

be easily noted. Now, set the scratch-gage to the distance that the line *OD*, Fig. 1, is to be from the edge of the plate, and gage or scribe a fine line parallel to the working edge of the plate with the tool held as shown in Fig. 2. This line is the line *OD* of the triangle. Next, place the beam of a square firmly against the base side of the plate and slide the blade

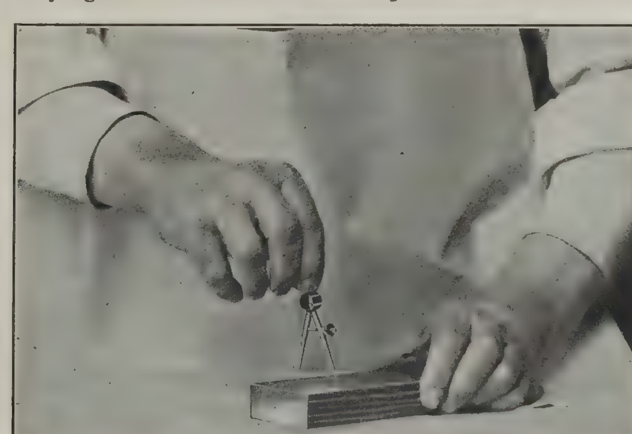


Fig. 5. Laying-out Location of Center by the Aid of Dividers

along the plate until it coincides with the center *O*. Using a fine pointed scriber, scribe a line at right angles to *OD*, as shown in Fig. 3. This is the line *OE* of our right-angled triangle. At the intersection of *OD* and *OE*, at point *O*, locate a light center-punch mark as shown in Fig. 4. If a magnifier

such as jewelers employ is used, this light prick-punch mark can be located very accurately, but as the buttons are subsequently located by independent means any high degree of accuracy in the preliminary location is not necessary. The writer uses the automatic center-punch shown in Fig. 4 for all lay-outs.

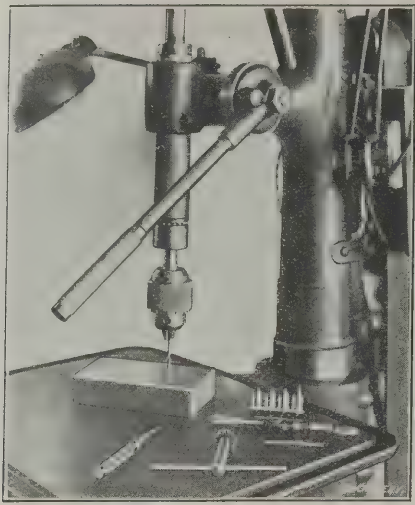


Fig. 6. Drilling for the Button Screw

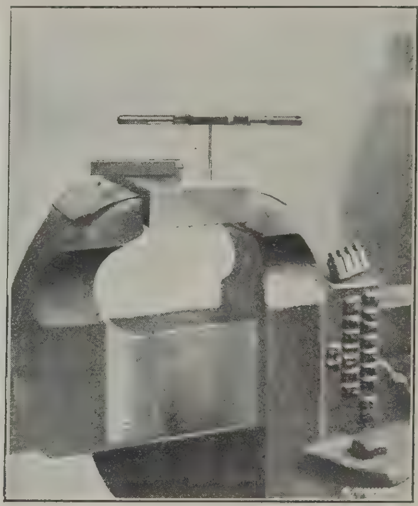


Fig. 7. Tapping for the Button Screw

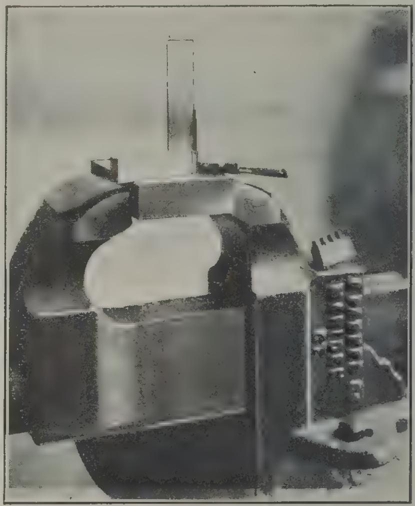


Fig. 8. "Squaring-up" the Tap

Next, set a pair of toolmakers' dividers to the length of line *OE*, and with *O* as a center scribe a short arc across *OE*, as shown in Fig. 5. If the points of the dividers are kept sharp, this line, like the preceding ones, will show sharply against the copper coating. With the center-punch lightly prick a center at the point of intersection of line *OE* and the short arc just scribed, as shown in Fig. 4. If an adjustable automatic center-punch is used, the center points can be as lightly pricked as the toolmaker wishes. The location of point *D* on the line *OD* is prick-punched in a manner similar to that of the location of *E*. Deepen and enlarge the prick-punched centers sufficiently to enter the point of the tap drill, and drill for the button screws as shown in Fig. 6. Tap the drilled hole for the button screws (see Fig. 7), carefully testing to insure perfect "squareness" with the surface upon which the buttons are to be clamped, as shown in Fig. 8. If this is not carefully done, the buttons cannot be so easily and accurately adjusted.

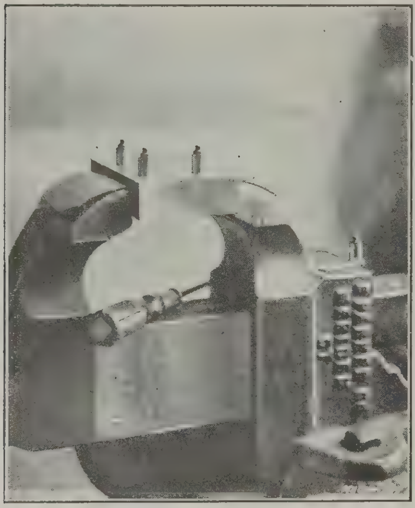


Fig. 9. The Buttons in Place


Fig. 10. Accurately Adjusting the Buttons with relation to the Side of the Plate

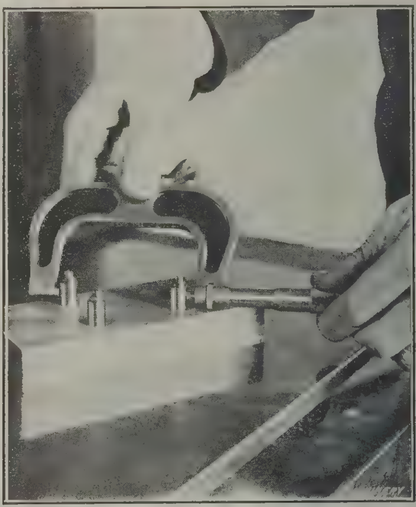


Fig. 11. Using a Micrometer for the Adjustment of the Buttons

Clamp the buttons in their approximate positions by means of the button screws, as in Fig. 9. In doing this, remember that at this stage these positions are only approximate, and that the tension placed upon the screws must admit of further adjustment. Adjust the buttons by micrometer to the desired distance from the edge or side of the plate, as shown in Fig. 10. Note that the micrometer reading from the edge of the plate, when made as shown in this halftone, is as much greater than

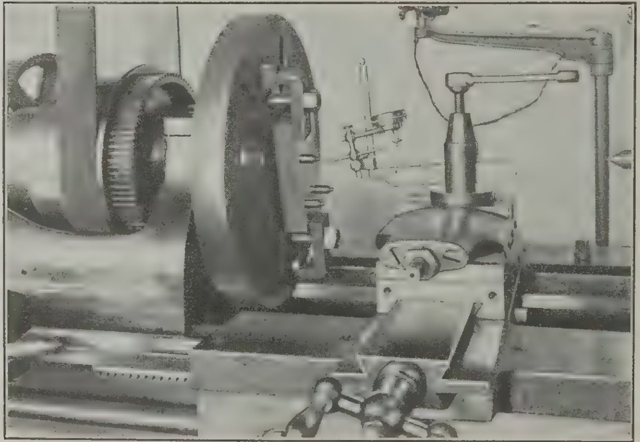


Fig. 12. Indicating the Buttons on the Lathe

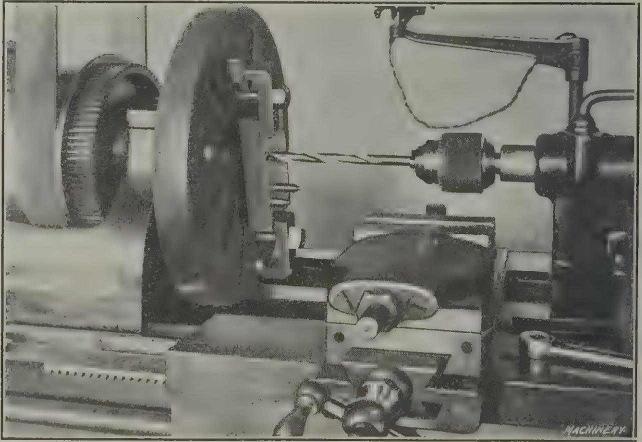


Fig. 13. Drilling the Bushing Holes

the distance from the center of the hole to be bored to the edge of the plate, as the sum of the thickness of the straightedge and the radius of the button. Adjust the buttons correctly with regard to the distance *OD* by micrometer and shift the button at *E* until the center to center distances *OE* and *DE* are those designated. It is possible, in this manner, to locate the buttons where desired within an error too small for the micrometer to indicate. If the holes to be bushed can be bored concentric with the buttons as located, the greatest accuracy can be obtained by this method. While the writer uses micrometers for all possible measurements, the proper use of a high-grade height-gage will assist the toolmaker in many cases. The surface plate used must then have an especially smooth surface, and it is a delicate job to determine just when contact between the surface of the button and the feeler is made.

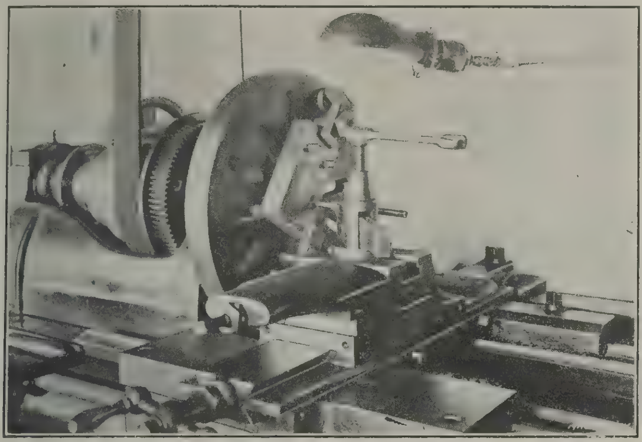


Fig. 14. Boring the Bushing Holes

Instead of depending upon "feel," the toolmaker often uses some thin pigment on either surface, and indicates contact by sight rather than by "feel."

Next, clamp the cover plate, which carries the buttons previously located, upon a lathe faceplate. The clamping should be sufficiently firm to retain the position and yet allow adjustment. Using a copper or lead hammer, adjust the cover plate upon the faceplate until one of the buttons indicates "dead true." Fig. 12 shows one of several indicators designed for this purpose. After the faceplate is screwed firmly upon the nose of the spindle, and before mounting the work upon it, its face surface should be indicated, and if appreciably out of true, a light finish cut with a lathe tool should be made, starting at the center and feeding to the outer edge. This is commonly known as "truing up the faceplate."

Fig. 15. Tools used by the Jig-maker

After the button is indicated dead true, it is removed and the bushing hole drilled to approximately the desired size, as in Fig. 13. Where a suitable milling machine is accessible, the plate can be drilled and bored in that machine. In fact, this job can be done upon any machine in which it is possible to indicate the button concentric with the center line of the spindle. Then, for boring the hole (see Fig. 14), use an inside boring tool with a keen cutting edge to avoid error due to its springing. An inside boring tool ground to correct clearance and cutting angles, properly set and run at the correct speed, will turn out a hole that will indicate dead true. If the work when clamped to the faceplate throws it out of balance, a weight should be clamped to the "light" side, sufficient to restore the balance. Fig. 15 shows some of the tools needed by the toolmaker. In closing, the writer offers no defense for the button method of locating holes for drill bushings, as none is needed, but submits it to young toolmakers as probably the most accurate method for the purpose.

* * *

STRENGTH OF STEEL TUBES UNDER INTERNAL FLUID PRESSURE*

In order to arrive at some definite conclusion as to the formulas which ought to be used for calculating the strength of tubes, pipes, and cylinders subjected to internal fluid pressure, a number of different formulas were investigated and compared. These formulas were the so-called "common" formulas generally found in books on mechanics and based directly on the tensile strength of the material, and the formulas given by Barlow, Lamé, Clavarino and Birnie. It was found that of the five formulas considered, that of Barlow is the best suited for all ordinary calculations pertaining to the bursting strength of commercial tubes, pipes, and cylinders. The theoretical error on the side of safety resulting from its use will generally not exceed the actual combined error on the side of danger resulting from the use of either Birnie's or Clavarino's formulas. This is true, at least up to the yield point of the material, for any ratio of thickness of wall to outside diameter less than 0.3. In this respect, Barlow's formula is superior to the common approximate formula which gives errors that are entirely too large on the side of danger for very thick walls.

Barlow's formula assumes that because of the elasticity of the material, the different circumferential fibers will have their diameters increased in such a manner as to keep the area of cross-section constant, and that the length of the tube is unaltered by the internal fluid pressure. As neither of these assumptions is theoretically correct, the formula, of course, gives only approximate results; but, as already mentioned, the errors are on the side of safety.

Assume that

D = outside diameter in inches,

t = average thickness of wall in inches,

p = internal fluid pressure in pounds per square inch,

f = working or safe fiber stress in pounds per square inch.

The Barlow formula is then as follows:

$$\frac{p}{f} = \frac{2t}{D}, \text{ from which}$$

$$p = \frac{2ft}{D};\ t = \frac{Dp}{2f};\ f = \frac{Dp}{2t}$$

It should be observed that while the Barlow formula is similar in form to the common formula, it gives results quite different when applied to tubes and pipes having walls of considerable thickness. This is due to the fact that the Barlow formula is expressed in terms of the outside diameter, whereas the common formula is expressed in terms of the inside diameter.

The average ultimate tensile strength of seamless steel tubes may be assumed at 60,000 pounds per square inch; that for butt-welded steel pipe at 40,000; that for lap-welded steel pipe at 50,000; and that for wrought-iron pipe at 28,000 pounds per square inch.

The investigations undertaken also indicated that if seamless steel tubes are assumed to have a strength of 100 per cent, butt-welded steel pipe has a comparative strength of 73 per cent, and lap-welded steel pipe of 92 per cent. From this it will be seen that the strength of a butt-weld is only about 80 per cent of that of a lap-weld. The relative strengths of wrought-iron and steel pipe are as follows: Butt-welded wrought-iron pipe has 70 per cent of the strength of similar butt-welded steel pipe, and lap-welded wrought-iron pipe has 57 per cent of the strength of similar lap-welded steel pipe.

* Abstract of a paper by Mr. Reid T. Stewart, of Pittsburg, Pa., read before the American Society of Mechanical Engineers.

TURNING CHILLED IRON ROLLS*

By F. B. JACOBS†

Ordinary soft steel which contains 0.25 per cent carbon and up is rolled from a steel billet in a mill generally called a finishing mill. Different rolling mills have different methods of "setting-up" finishing mills; the following method is often used for small mills, say twelve-inch mills, or those where the rolls are twelve inches in diameter. First there are three roughing rolls. These are set one above another and are made from steel castings with 0.70 to 1.20 per cent carbon. Next there are three pony rolls set the same as the roughing rolls and made from the same quality of steel. The next set consists of the so-called "strand rolls," which are set "three high" in the same manner as the roughing and pony rolls. Strand rolls are made of ordinary cast iron for rolling flat stock, and of chilled iron for rolling rounds and squares. After the strand rolls come two edging rolls, set one above the other, these being made of chilled iron, and finally come the two finishing rolls which are relied upon to finish the bar stock to the correct dimensions. These rolls are also made of chilled iron.

All the rolls have grooves turned in them termed "passes," the passes in the roughing rolls being a little smaller than the billet to be rolled. Down through the mill the passes decrease in size to the finishing rolls, where the passes are just a trifle larger than the size of the finished bar. The frames or housings that carry the rolls are set side by side, the wobblers or ends of the rolls being connected in the same manner as the two rolls shown in the roll lathe in Fig. 1. The mill is generally driven by a direct-connected steam engine, steam being considered the most economical means of driving the mill, as it is generated by the waste heat from the furnaces.

The process of rolling steel is quite simple and can be briefly described as follows: One roller starts the billet of white-hot steel through the roughing rolls; a roller on the opposite side of the mill grabs it with a pair of heavy tongs and starts it back. In this manner it is sent through all the sets of rolls, and after coming from the finishing rolls it is laid out flat to cool. As may be imagined, rolling is a dangerous occupation; it calls for a sure hand, a rapid eye, and great strength. In spite of reasonable precautions, serious accidents sometimes happen. Rolling is, without a doubt, the best paying of all the mechanical pursuits, good rollers earning from eight to fifteen dollars* a day, depending on the locality, and the quality of the material worked on. It takes at least six years of hard work and close attention to become an expert roller.

The constant rolling of hot metal soon wears the passes of the rolls, which makes it necessary to re-finish them. The turning of new rolls and the re-dressing of worn ones is, in itself, a trade calling for skill and, especially, patience. A roll lathe, as shown in Fig. 1, differs widely from the ordinary engine lathe, as it has neither carriage, ways nor cross-slide, the tools being clamped securely to the tool bed, directly in front of the roll to be turned. The tools are set up to the work by means of screws working through blocks set in the tool bed. Roll lathes are generally triple-geared, and the roll is always located from its necks or journals while turning the face and passes, this being necessary to avoid chattering.

In Fig. 2 are shown several roll turning tools. These are made of a good quality of tool steel, hardened in brine and drawn only enough to relieve the internal strains. The tools marked *A* are used in turning passes for square stock. The tools used for roughing and finishing the face of rolls are shown at *B*. The tools marked *C* are used in turning passes for angle-iron rolling. The shape of these tools is worked out by hand to fit the templets shown at *D*. The shape of tool generally used in roughing cast-iron rolls is shown at *E*. When the tools require grinding it is done by hand as shown in Fig. 3, the wheel used in this case being "Aloxite," 16 inches in diameter, 3-inch face, 24 grit, H grade, D 333 bond.

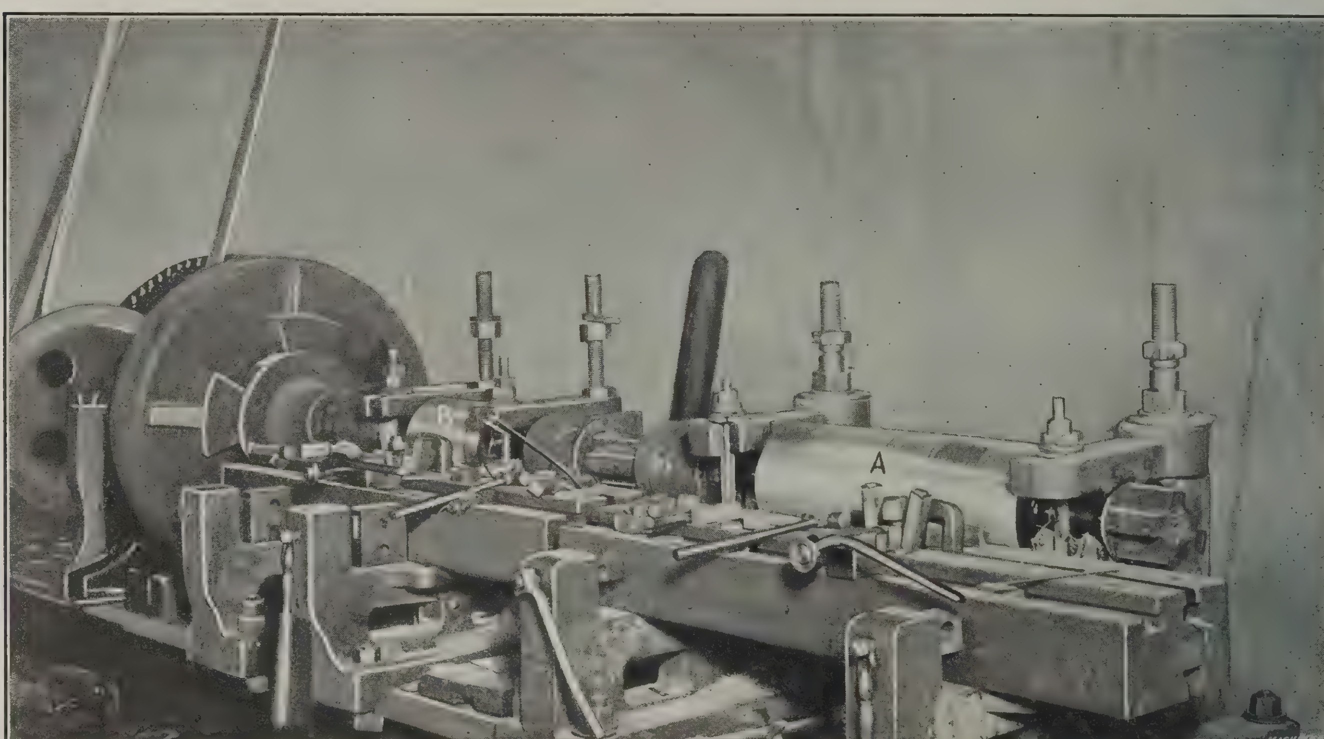


Fig. 1. A Roll Turning Lathe with Work in Place

The operation of roughing a strand roll is shown at *A*, Fig. 1. This roll is 26 inches long and 9½ inches in diameter. A chip 6 inches long is taken at a time, the tool being fed directly to the work. The time for roughing this roll, removing ⅝ inch of stock, is ten hours. To many this may seem rather slow work; however, it must be taken into consideration that the material is chilled iron, which is extremely hard and therefore calls for a slow speed—in this case one revolution in 55 seconds.

The roll shown at *B*, Fig. 1, is a small finishing roll for T-iron. The grooves or passes being turned are 3/16 inch wide and ¾ inch deep. The tool used in this case has the appearance

* See MACHINERY, September, 1895. "Roll Lathes and Roll Turning."

† Address: Care of Carborundum Co., 826 Arch St., Philadelphia, Pa.

* Wages paid rollers in the Pittsburg district run from $8 to $15 a day depending on the material rolled. The rollers are paid according to the tonnage they turn out, the $15 rate being earned in the large plate mills where the tonnage production is heavy. In sheet mills, tin-plate mills and bar mills, the rollers get from $10 to $12 a day. In hoop mills and other mills rolling light materials the rollers make from $8 to $10 a day. In union mills the wage scale is set on all materials by the Amalgamated Association and in the non-union mills the wage scale runs closely parallel to the union scale. Of course the stated wages are earned only when the day or night run is made without interruption from breakdowns or other causes.—EDITOR.

of an ordinary cutting-off tool. Let the average machinist consider for a moment what it means to cut grooves of the above dimensions in chilled iron, and he will realize why the roll turner has to have plenty of patience. It is quite necessary that the passes in all finishing rolls be of the required dimensions, and that the corners be square. In Fig. 4 is shown a large chilled iron strand roll, 48 inches long and 18½ inches in diameter. The time for roughing this roll, removing ¼ inch, was ten hours, the roll being revolved at one revolution in one minute and forty seconds. Another ten hours was consumed in turning five passes for 1¼ inch square stock. The photographs and data for this article were obtained in one of the smaller rolling mills that are to be found scattered all over the Middle West, and give a fair idea of the time required to turn chilled iron rolls under ordinary conditions.

When we stop to consider the fact that in the majority of the industries using chilled rolls they are invariably finished by grinding, either on a regular roll grinding machine, or on a heavy plain grinding machine of the type embodying a stationary platen and a traveling wheel carriage, the question naturally arises, why do not the rolling mills rough and finish the straight portions of their rolls by grinding? There are several reasons why they do not, one being that the roll turner who has had no experience at grinding is prejudiced against any method of finishing rolls other than the time-honored method of turning. He also argues that as it is necessary to have a roll lathe for turning the passes, it is more economical to finish the face of the roll by turning, the face and passes thus being finished at one setting of the roll. With the roll shown in Fig. 4 the time for roughing the body, as before stated, was ten hours, the amount of stock removed being approximately 384 cubic inches, or 38.4 cubic inches per hour.

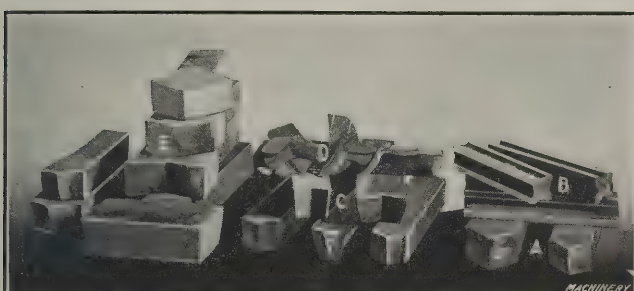


Fig. 2. Tools used in Turning Chilled Cast-iron Rolls

Some time ago the writer witnessed a very interesting roll-grinding operation on a heavy plain cylindrical grinding machine. The roll in this case was of chilled iron 32 inches long and 32⅛ inches in diameter. The grinding time for removing ⅛ inch from this roll was four hours. As approximately 192 cubic inches was removed, this equalled 48 cubic inches per hour. This work was done with a carborundum wheel 24 inches in diameter, 2-inch face, 403 grit, P grade, run at a speed of 950 R. P. M. The work speed was 6 R. P. M., and the advance of the traverse feed 1¼ inch for each revolution of the work. The finish left was superior to the finish left by the process of turning.

Fig. 3. Grinding the Tools for Roll Turning

From these data it is evident that the grinding machine shows an increase of 25 per cent in the amount of stock removed in a given time. Another point in favor of the grinding machine is that the wages of a skilled roll turner are about 30 per cent higher than the wages of a grinding machine operator. From this it would appear that the most economical method of finishing the straight portions of rolls used in rolling bar stock would be by the use of a grinding machine equipped with the proper wheels.

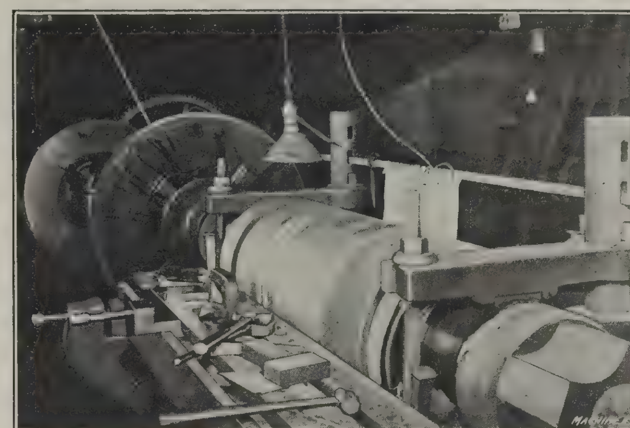
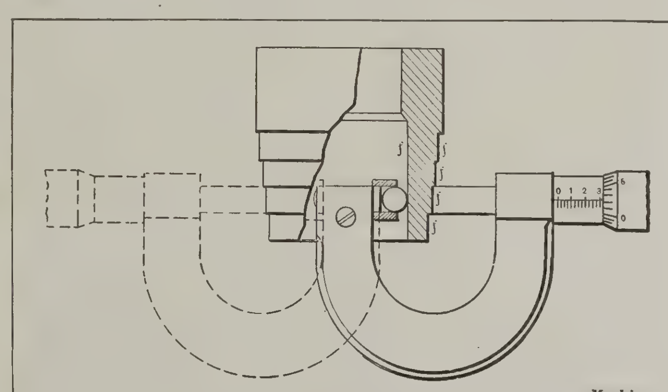


Fig. 4. Turning a Roll 48 Inches Long, and 18 1/2 Inches in Diameter. The Rough-turning removing 1/4 Inch, requires Ten Hours

* * *

METHOD OF TESTING LATHE SPINDLE ALIGNMENT

The accompanying line engraving shows a convenient and accurate method of testing the spindle alignment of New Britain-Prentice turret lathes. This method is used in the trying-out department of the New Britain Machine Co., New Britain, Conn., but is equally applicable to testing machines in use in manufacturing departments.



Method of Testing Spindle Alignment

A brass bushing is held in the chuck and bored out to any convenient internal diameter by means of the No. 1 spindle. With the same spindle a shoulder is turned on the outside for a distance of approximately ¼ inch. With the No. 2 spindle a second shoulder is turned of about the same width but of a slightly larger diameter. Likewise, with the No. 3 and No. 4 spindles, similar shoulders are turned, leaving the bushing, when finished, about as shown in the engraving.

By means of a micrometer, arranged as shown in the engraving, the variations in thickness at different points of each shoulder may be ascertained, and by taking readings of the diametrically opposite thick and thin portions of any one shoulder, the amount of spindle error for that particular spindle may be determined, bearing in mind that the difference in the two readings will be *twice* the amount of spindle error.

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INVENTIONS THAT REVOLUTIONIZE WORKING CONDITIONS

Few of the younger generation realize the change wrought by electric lighting in the working condition of shops and factories. Some fifty years ago it was necessary to so arrange the working hours that no artificial light need be employed. In order to average a ten-hour day for the whole year, the working hours in the summer had to be made unusually long, to make up for the short winter days. In New England shops the average length of the working day was about eight and one-half hours in December, while the men worked eleven hours a day in May, June, July and August.

Now conditions are in many cases reversed. The men in the shop are willing to work overtime, if necessary, during the winter months, but when summer comes they prefer as short a working day as possible in order to have an opportunity for outdoor recreation. This change has been made possible by the invention of effective artificial light—electric light, principally —which makes it easy to light a shop at night almost as well as it is lighted in the daytime. The advantages gained in improved working conditions from this source alone are manifold, and have added not only to the comfort and safety of the work in the shop, but to the rational enjoyment of the leisure hours as well.

* * *

COMPLAINTS DUE TO IGNORANCE

Manufacturers of machinery and tools are often put to considerable inconvenience and expense attending to unfounded complaints about their products. Often these complaints are due to the "fussy" or "cranky" disposition of the customer, but frequently they are simply due to the buyer's ignorance of the proper use of the machine or tool bought. As a rather extreme example, perhaps, may be mentioned the following case: A customer ordered a number of die hobs from a firm manufacturing small tools. In a few weeks complaints were received stating that the hobs were practically useless, that they would not cut freely, and that a great many had been broken while in use. An investigation showed that the purchaser had used the hobs to cut the threads in the die blanks without previous rough-threading by a die tap. As the hob is intended for a light finishing and sizing cut only, and consequently is fluted in a manner that gives very little chip room, it was a foregone conclusion that the chips would clog and the tools break when used in the manner mentioned.

Similar cases are not unusual. It is to the interest of every manufacturer to educate the users of machinery and tools in the proper and efficient use of his product. The best medium for this education is the mechanical journal. Special articles of general interest containing information of permanent value do more to increase the knowledge of the users of machinery than any other agency. The manufacturer who never cooperates with the technical journal in its work of education, and who then complains of the ignorance of his customers and the users of his machines and tools, has really little just cause for complaint. The more that is done to educate mechanics through the medium of mechanical journals, the fewer will be these exasperating complaints which are due purely to ignorance.

* * *

NEW FACTORS IN MACHINE TOOL DESIGN

There are many things to be taken into consideration by the designer of machine tools—too many to be properly enumerated here—but a few new ones have come into the designer's realm since the advent of the automobile which are of special interest now to users and builders of machine tools.

First are ball bearings. Whatever prejudice still exists against the use of reputable makes of ball bearings on all revolving parts of machine tools, other than the main spindles, is disappearing. The chief objection is the cost, and that is not very serious. In the case of a machine tool lately put on the market having ball bearings throughout excepting the work spindle, and costing about $750, the cost of the ball bearings is about $75, or ten per cent of the whole. An offset is about $40 for the plain bronze bearings displaced, which brings the net cost of the ball bearings down to about $35 more than plain bearings.

Second are hardened gears. These, also taken from automobile practice, are one of the latest refinements in tool design. The advantage of hardened gears is that they can be run at pitch line speeds considerably higher than 1000 or 1100 feet per minute, the practical limit of soft steel gears. The cost is more than unhardened steel gears and considerably more than cast-iron gears. In some machines built to order steel gears may have been specified without good reason, but that is not the case in the designs required to transmit heavy torques at high speeds efficiently.

Third is flood lubrication on the principal gears and important plain bearings carrying heavy thrusts. Whether it be of the splash or circulatory type, the essential requirement is to provide an amount of oil that will reduce friction to a minimum and carry away the excess heat generated without retarding effect. This is especially important in gear boxes, where, as has been demonstrated, too much oil has the effect of converting the gears into circulating pumps and thus wasting much power.

Why are ball bearings and hardened gears worthy of the serious attention of machine tool designers? The answer is because of the difficulty of conveying to the tool point sufficient power to utilize the best steels to the highest capacity when plain bearings and ordinary materials are used in the construction. Take, for instance, the case of a high-power drilling machine built to drive the best high-speed drills to the limit of their capacity, in which twenty-two horsepower is absorbed driving a one-inch drill. The machine is built with ball bearings, hardened gears and splash lubrication. Had plain bearings, cast-iron gears and common oil cup lubricators been used, the power required would have been considerably greater. But of more importance is the fact that belt widths and speeds, and face widths of gears, and lengths of bearings would have been so great as to be practically prohibitive. Ball bearings, hardened gears and flood lubrication may be regarded as essentials in the design of machine tools that are required to work the best high-speed steels to the limit of their capacities.

LEARNING BY TEACHING

There is no better way to acquire a thorough knowledge of a subject than to try to teach it to somebody else. In doing this, one will realize one's own shortcomings and find out that there are many points on which it is necessary to acquire more information. If this teaching of others is done in writing, one's own deficiencies will become all the more apparent, and that is the reason why writing for the technical press is, in itself, an excellent means of education. A man writing upon any subject usually digs up a number of questions that he cannot answer, and as he proceeds with the work he is thus impelled to acquire the information necessary to perfect the article. It is surprising how many details are involved in the preparation of even a simple but thorough treatise on machine shop work, and how necessary it becomes to study each one in order to acceptably present the subject to the readers of a mechanical journal.

Nystrom advised the mechanical engineer to collect the data for his own handbook. In giving this advice he probably did not consider every man capable of collecting the data he requires and putting it in better shape than could a trained compiler of handbooks. He thought, rather, that the educational advantages resulting from such a course are so great that, even in this day, with the large number of handbooks available, it would be of great educational value for any young man to collect for himself the data on his work which he considers especially useful to him. Should he then, in addition, try to put this data into form for publication, it would become his own mental property to a greater extent than if studied in any other way.

* * *

SPECIALIZATION IN LUBRICATION

The efficiency and working life of most machines are vitally affected by the lubricant provided for their bearings. If oil of poor quality or of insufficient quantity is supplied, the life will be short and the power wasted will be relatively great as compared with the friction loss under proper lubrication. The theory of friction between sliding surfaces is based on the fact that the smoothest metallic surfaces are relatively rough, and that the opposing inequalities interlock and shear off when rubbed together. The resistance to motion, known as friction, converts power into heat; and if the surfaces in contact are under considerable pressure and in rapid motion they will be quickly destroyed by the resulting attrition and high temperature. To prevent wear and reduce friction, an intermediary or lubricant is introduced which separates the opposing surfaces with a film that fills the inequalities of journal and bearing surfaces, making them smooth and supplying countless numbers of balls or rollers that support the load and move under heavy pressure with little resistance. There are many oils and greases and some mineral solids that have marked lubricating qualities, but which vary greatly in the characteristics necessary for the best results under certain conditions.

Years ago when machinery was generally run at comparatively slow speeds, the bearings being subjected to low unit pressures, the choice of lubricants was not of such great importance as now when high speeds and heavy unit bearing pressures are common. Specialization in lubrication has become necessary, and is carried out to a marked degree in textile mills, railway cars, locomotives, steam engines, gas engines, rolling mills, etc. Everyone knows, instinctively, that a lubricant which is satisfactory for watch pivots is not suitable for a rolling mill journal, but few are aware of the extent to which specialization in lubrication has been carried.

For example, take the automobile, which is essentially a road locomotive with an internal combustion motor. A natural inference is that a cylinder oil suitable for one make of car would be practically all right for all cars having gasoline engines, but the experts in lubrication say not. They claim that it is necessary for the highest efficiency to provide different oils for different makes of cars, and that even the various models of the same maker's cars may require different oils. "The correct oil for a Fiat, for instance, is absolutely wrong for a Packard. The spring strength of the piston rings must be considered, the fit of the piston ring in its recess, the length of the crankshaft and connecting-rod bearings, the feed systems and the length of the vacuum period while intake and exhaust valves are both closed, must be known and studied before the correct lubrication can be determined."

The users of all machinery, and especially automobiles, are advised to care for the bearings with the idea of reducing the friction loss to a minimum. While a car may have ample power when indifferently oiled, it should be remembered that the power wasted in overcoming friction is surely wearing it out. When it is considered that with indifferent lubrication the cylinder and bearing wear or general deterioration in mechanical fitness of a car may be as great in one season as it should be perhaps in three seasons with the best lubrication, the importance of proper attention to this feature can be better realized.

* * *

DEFINITIONS OF ENGINEERING

The public in general has a rather vague idea of the meaning of the word engineering, and of the work and duties of an engineer. Many definitions have been given, some of which have become classical, while others are quoted merely on account of the terse way in which the meaning the author intended to convey has been expressed. Thomas Tredgold's definition is well known. In 1828 he defined engineering as "the art of directing the great sources of power in nature for the use and convenience of man." This definition has been incorporated in the constitution of the Institution of Civil Engineers of Great Britain. There is a deeper meaning in this definition than is ordinarily appreciated at the present. The words "for the use and convenience of man" are especially intended to draw a distinction between the civil engineer and what was at that time termed the "military" engineer, whose work was confined mainly to the building of forts and the design of means for destruction. Tredgold aimed in his definition to show how the civil engineer was one who used the power in nature for the good of mankind and for the progress of civilization.

In 1885, A. M. Wellington, who was for many years editor of the *Engineering News*, defined engineering as "the art of doing that well with one dollar which any bungler can do with two, after a fashion." This definition differentiates the trained engineer who has specialized in any one particular line and devoted time and study to ascertaining the best methods of doing certain work, from the man who may be able to accomplish the same results, but on account of his lack of training, at an excessive cost.

A third definition by an unknown author, quoted in Ernest McCullough's book, "Engineering as a Vocation," defines an engineer as "a compound of common sense and mathematics. If he has not enough mathematics his lot in life will be hard. If he has not enough common sense, God pity him." This last definition brings up the importance of the theoretical training of the engineer. While there is not a great deal of mathematics used in the ordinary routine work in engineering, and while there are many "rule-of-thumb" and "pocketbook" engineers who advise that theoretical training is by no means as important as the college professors would want us to believe, yet it remains a fact that, as a rule, the men who have received the broadest training in mathematics and similar theoretical subjects, afterwards, when they have acquired the requisite practical training, become the most reliable, and frequently the most successful men, in the engineering field.

* * *

An engineering education is not only an introduction to strictly engineering work but is also becoming recognized as a useful preparation for numerous lines of business. More and more, technically educated men are making good in administrative and executive positions, because, along with business ability, their engineering knowledge, even though it has been fixed by only a very brief practical experience, gives them an advantage over those who are without such information. A knowledge of men is needed for even moderate success, but when it is coupled with a knowledge of rational construction, the two make a most forceful combination for getting many things done well.—*Engineering Record.*

SCIENTIFIC MANAGEMENT FROM A SOCIAL AND ECONOMIC STANDPOINT*†

The author of this paper wishes it to be understood that he is not an authority on "scientific management." His viewpoint is that of an outside observer with an investigating turn of mind. This position of outside observer is often a very advantageous one. An inside view alone gives us no perspective or sense of distance.

To be strictly scientific we should begin with definitions, but it is difficult for an outsider to attempt to define this new movement. In a general way, one might say, however, that the scientific management of a manufacturing concern involves the direct control by the management of every detail, and of every, even the smallest, move of every person employed, and the management of every piece of equipment or apparatus—all in accordance with thoroughly investigated and applied standards—to the end that the profits of the employers and employes alike may be increased to the highest degree possible.

Capable men all through the country are striving to put into actual working form the ideal roughly stated above. They are meeting with a large measure of success in their work, and in their enthusiasm they are making claims that look forward to great social reforms and the permanent betterment of industrial conditions. Among the things hoped for are: the permanent increase of profits and wages; the decrease of unemployment; and the growth in character and intelligence of those now classed under the general term "unskilled labor." These are the claims it is now proposed to investigate.

Comparison between Scientific Management and Labor-saving Machinery

We cannot reason about a thing whose qualities are unknown. The object must be thoroughly studied, and almost invariably when this is carefully done we find that the particular object of our study is in no sense unique, but belongs to some clearly defined class. By studying the past history and the recognized present effects of that class, we can form a clear idea of the future history and the effects of the new object or movement under consideration. This is the way in which we can investigate scientific management. The more we analyze and study its nature the more clearly do we see that it belongs to the class of labor saving machinery. All that labor saving machinery has done for the world, scientific management will do; that which labor saving machinery has failed to do, scientific management will fail to do. It should do as much—it can do no more.

Let us first ask what is the effect of scientific management on the worker. As with almost any labor-saving machine the effect is that of specialization. In place of broad, general skill and a wide range of activities, the work is confined to a few regulated motions, the necessary information for which is presented to the worker in blueprinted, typewritten or printed form. This complete specialization has aroused opposition of workers everywhere, especially where scientific management has never been tried, or is just about to be tried, or has been only half tried, or has been unwisely and clumsily tried. Where the scheme has been worked out with scientific thoroughness, the workmen have finally received it in a friendly spirit.

The reasons for this are plain: In the first place, the goal should be, and usually is, more work with the same effort; that is, easier work—not harder—but more of it. In the second place, the vast increase of the so-called "non-productive" labor, foremen, clerks, etc., necessitates in the end a change of employment throughout the whole force. The man with brains and experience enough to be a skilled mechanic, and who would object to minute supervision, is too valuable to waste on the mere mechanical machine work. He becomes a functional foreman or a productive specialist of some other kind. The unskilled man is raised from his lowly position to that of a trained machine operator, and the still less experienced man takes his former place as a helper. Of course, there are some skilled and intelligent men—but not many—who are unable to adapt themselves to the change. That has always been the case when new labor saving machines or processes have been introduced. These men may be assisted individually until they have re-adapted themselves, but, since the beginning of things, it has never been possible nor wise to stop the course of improvement for their sake.

When we consider the effect of scientific management on the profits of the employer, the analogy with labor saving machinery is especially striking. This analogy has been fully developed by Mr. Fred J. Miller, of the Union Typewriter Co. A few of his analogies are as follows:

Scientific management, like labor saving machinery, is best adapted to shops manufacturing in large quantities where the separate operations are comparatively simple, or may be made so.

Like the machine, it must be specially and skillfully adapted to the particular work in hand. An adjustable machine, supposed to be adaptable to a wide range of conditions, is likely to prove a failure. The expert designer must construct his machine or system for some particular work and for no other.

The first cost and operating cost of the machine or system must not be greater than any possible saving to be made by its use.

The most important analogy, however, is that from the business or financial point of view. The likeness between scientific management and labor saving machinery in its effect on wages and profits is absolute. Says Mr. Miller:

"When a labor saving machine has been designed for certain work and put in operation in a certain factory, which factory is only one of a number of factories doing similar work, the profits from the use of the machine may be very large because the price obtainable for the work done by it will be based upon the cost of doing the work by the least efficient of the older machines still necessary to be employed on that work in order to supply the demand. But when all the manufacturers have similar machines at work, competition will lower the price to the ordinary return on capital invested in that general line of manufacturing.

"Similarly, those who first successfully install a system of management materially better than that possessed by their competitors, may make higher profits until such efficient systems become the regular thing—and no longer. Those who are among the last to adopt a labor saving machine do not make more than regular profits. They simply are obliged to take the forward step in order to make any profit at all, or to remain in business. It is the same with systems of factory management.

"Workmen who operate new labor saving machines may receive more than the ruling rate of wages, one of the reasons for this being the lowered cost of production and greater relative ability to pay higher rates; but in the end, sooner or later, the law of supply and demand will regulate this as it does all other competing or unmonopolized businesses. When the use of the labor saving machine has become general, an owner of such a machine can no longer continue to pay materially higher wages than other and competing users of similar machines.

"In every way, so far as I can see, the effect upon factory employes of the use of labor saving machines and of labor saving systems of management is exactly the same, and their attitude toward them should be the same."

So we see that a system, wisely planned and carried out, may effect a substantial though temporary increase in the earnings of employer and employe alike, and it should be welcomed by both at its face value. Least of all should the workman in the engineering trades—machinery building and the like—place himself on record against it. His business in life is the building of labor saving devices for others to use; and can he object when an improvement of the same type is introduced into his own field?

Some Difficulties of Scientific Management

We have seen that substantial benefits, even though of a temporary kind, may be expected from the introduction of scientific management. We have found no logical reason for the objection of either employer or employe to a wise use of this new labor saving device. Are there any positive dangers in the idea itself or in the operations of those who are promulgating it? That there are such dangers and errors, is beyond question.

The first error is a purely commercial one, born of the zeal of the organizer. The system is not in itself the end, but only the means to an end. The true object is the simultaneous increase of the profits, wages, and good-will for all concerned, but a few organizers have mistaken this goal and have focussed

* Abstract of paper read by Mr. Ralph E. Flanders, of Springfield, Vt., before the American Society of Swedish Engineers, Brooklyn, N. Y., April 20, 1912.

† For information previously published on this subject, see "Industrial Efficiency," May, 1912, and articles there referred to.

their eyes on their pet system, instead of on the results to be obtained.

The second danger is that of obstructing invention and development along new lines. Two tendencies are constantly opposed to each other in management—the tendency toward new invention and the tendency toward standardization. Each is profitable in its place, but it takes ability and courage to balance the two properly. Consider the conditions. An immense mass of data collected at great cost is at hand. This data relates to the most efficient performance of certain operations which have been standardized for years. A new machine or process is then developed which attacks the problem in an entirely new way and with superior results. It is then difficult for the organizer to see his years of standardizing overthrown without making a struggle to save the system.

The introduction of a new system must not tend to block the development of automatic machinery by the desire to preserve the costly data for older processes. The improvement of mechanisms, after all, should be the larger vision of industrial management. With the increase of skill in our designs, the reign of the automatic machine will become supreme. With the hand-fed machine, the workman is like a slave to a master of steel and iron; but not so with the fully automatic, self-feeding mechanism. More and more will our shops approach the ideal shop of the future where the workman, as master, shall move among his servant machines, adjusting this one, changing the work of that one. In such a shop the system organizer would find his work reduced to the minimum, but progress is in that direction and the system must not stand in the way.

The third possible source of weakness in the work of the systematizer, if he has not a clear conception of the fundamentals of his work, is the misunderstanding of the most important element in his problem—the human element. Some fifteen or twenty years ago, during the height of what might be called the "biological period" of philosophy, an engineer might have been pardoned for believing that man is a machine, subject to invariable action under the laws of cause and effect, but we are now beginning to perceive that the laws governing man's actions are infinitely more complex and far beyond the powers of his own intellect to comprehend in their fullness.

There are two sources of trouble from the human factor. One is misunderstanding on the part of the workman. To overcome this requires first of all that the systematizer shall have firm assurance of the justice of his position; and then he must have tact, determination, and a real liking for the men he deals with. Confidence, willingness and enthusiasm must be built up on the solid foundation of square dealing. The second source of trouble from the human factor is a corollary of the first. The organizer must have the right attitude toward the men under him. The cause of scientific management has suffered much in this matter from some of its chief exponents. Originating as it did in the steel mills, with their vast armies of ignorant and unskilled workmen, it is natural that the system in its origin should have treated these men as so many machines, but even these men are mighty reservoirs of spiritual forces, before which laws of averages and tables of motion study are mere straws in the wind; and when the same attitude is carried into dealings with skilled and intelligent men, the scheme becomes hopelessly unworkable. It would have been better for the cause if some pages of its most authoritative tracts had never been written. There breathes through them, in spite of their protests, the feeling that the mission left to the workman is the mission of a machine—that his effectiveness to himself, his country, and the world, is measured accurately and absolutely by his output per hour in the factory. Such a view is false. The aim of the existence of the meanest laborer and the greatest captain of industry are alike—growth in individuality, character and social service. Scientific management may and sometimes does include all of these; where it does not, it is doomed to failure and deserves it.

Does Scientific Management solve the So-called Industrial Problem?

Scientific management, so far as its social and economic effects are concerned, stands, as we have seen, in exactly the same category as labor saving machinery. For a century or more the labor saving machine has been infinitely multiplying the efficiency of the individual workman. Even with the old systems of haphazard management, the labor saving machine has raised the individual efficiency to an exceptional degree. This new labor saving machine — scientific management—again multiplies this efficiency by a new factor. But does it solve the industrial problem—the labor problem? As stated, scientific management will do all that labor saving machinery has done to solve our problem—it can do as much; it can do no more.

What then has labor saving machinery done? It has multiplied the capacity to produce wealth. It has given to the workman comforts and conveniences of which the most wealthy were ignorant a century ago. So far it has done well; but it has done vastly more for the few than for the many. The difference between the wealth of the highest and the lowest has been vastly accentuated. The number of those who reap where they did not sow has been increased, and the sense of injustice in the breasts of those who are allowed to sow but not to reap is rendered keener by the greater intelligence of the present age. Hence, the doctrine of efficiency solves no problems—it makes them; it has never leveled inequalities and injustice—they have kept pace with its growth.

We will, therefore, have to look elsewhere for the solution of the industrial problem. Fortunately, the world is beginning to look elsewhere, and is beginning to see the outlines of monopolies and special privileges which have used the blessings of efficiency for their own satisfaction. We are beginning to understand that the problems that cause industrial disturbances are not the problems of production, but problems of just distribution. The immediate need of our age is not more efficiency, but better distribution of the products of the efficiency already at hand and here the engineer meets with a new responsibility. He has made the modern world what it is, but he does not ride the creature he has formed. His logical brain, his executive hand, his sympathetic heart, are all needed in the work of changing conditions for the better—in introducing greater efficiency in the distribution of wealth as well as in production. The management of society has been left long enough to the lawyers, merchants and financiers. They are good enough in their way, but the time has come when we must also call upon the engineer to take his part in the work of social service.

* * *

LIFE SAVING AT SEA

The American Museum of Safety has just made public the fact that Judge Elbert H. Gary, on behalf of the United States Steel Corporation, has presented the museum with $5000 toward obtaining a collection of the best devices for saving life at sea, as a permanent exhibit for demonstration and study, free to the public. Dr. W. H. Tolman, director of the museum, and its safety inspector, have gone abroad to attend the International Congress of Accident Prevention at Milan, and to study the best European methods for life saving at sea, and the prevention of injurious effects of occupational diseases. The policy of the museum is now being guided by Arthur Williams, who has just assumed the presidency, succeeding Philip T. Dodge, who felt obliged to withdraw on account of ill-health and absence from the country. President Williams announces another gift of $5000 from an "unknown friend" for research work in connection with industrial poisons. Dr. Charles A. Doremus is chairman of this section of the museum's activities. The public is not only invited to visit the museum, at 29 W. 39th St., between 9 A. M. and 5 P. M. every day to study its collections, but in addition, its jury on exhibits, requests inventors and anyone else with practical ideas for life saving at sea, to submit them at the museum.

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The executive committee of the American Brass Founders' Association decided at a recent meeting to propose changing the name of the organization to the American Institute of Metals. It is stated that the reason for the proposed change is that the present name does not adequately describe the scope of the association.

MACHINE HANDLES—1

A STUDY OF THE VARIOUS TYPES OF HANDLES AND HANDWHEELS USED ON MACHINE TOOLS

By FRED HORNER*

Handles and handwheels constitute important elements in the design of machine tools and machinery in general. Many different types and modifications are met with. Different types are required according to the particular function of the handle or wheel, and sometimes the differences are due to the individual ideas of the designer. In order to facilitate manufacture, however, the variations in the forms of handles should be limited whenever possible.

Certain types of handles, one might say, are almost national in character, as, for example, the ball handle, which was first introduced in America on account of the convenience with which it could be turned from the bar. At one time it was seldom found on English or Continental machines, although at the present time it is frequently found in Europe. On the other hand, there are many English firms which have not been influenced by American or Continental practice, and which use forged handles of a particular type on practically all machines. This peculiarity is specially noticeable in the Manchester and Glasgow districts. The size of a machine tool also has an influence on the type of the operating handles, because the conditions of work are essentially different in a large and small machine. In small machines there are many hand movements for which convenient ball handles are suitable, while in large machines the power feeds eliminate most of the hand operations, and star handles are better suited for the less frequent movements required. Frequently some kind of a wrench or ratchet lever is all that is necessary for the occasional movements or adjustments to be made.

The question of whether or not a handle should be loose on its shaft or fixed to it is sometimes settled by the conditions of service, while sometimes it is a question that can be decided according to the designer's fancy. If it is impossible or inconvenient to give a complete revolution to a handle it should be fitted loosely, or a ratchet employed. Occasionally, when a number of screws or shafts are adjusted at infrequent intervals, it is the practice to supply but a single handle for their manipulation. A combination of a fixed and a loose arrangement is sometimes desirable, and is accomplished by a friction or other clutch arrangement, so that the handle or wheel can be coupled to the shaft or disconnected from it at will.

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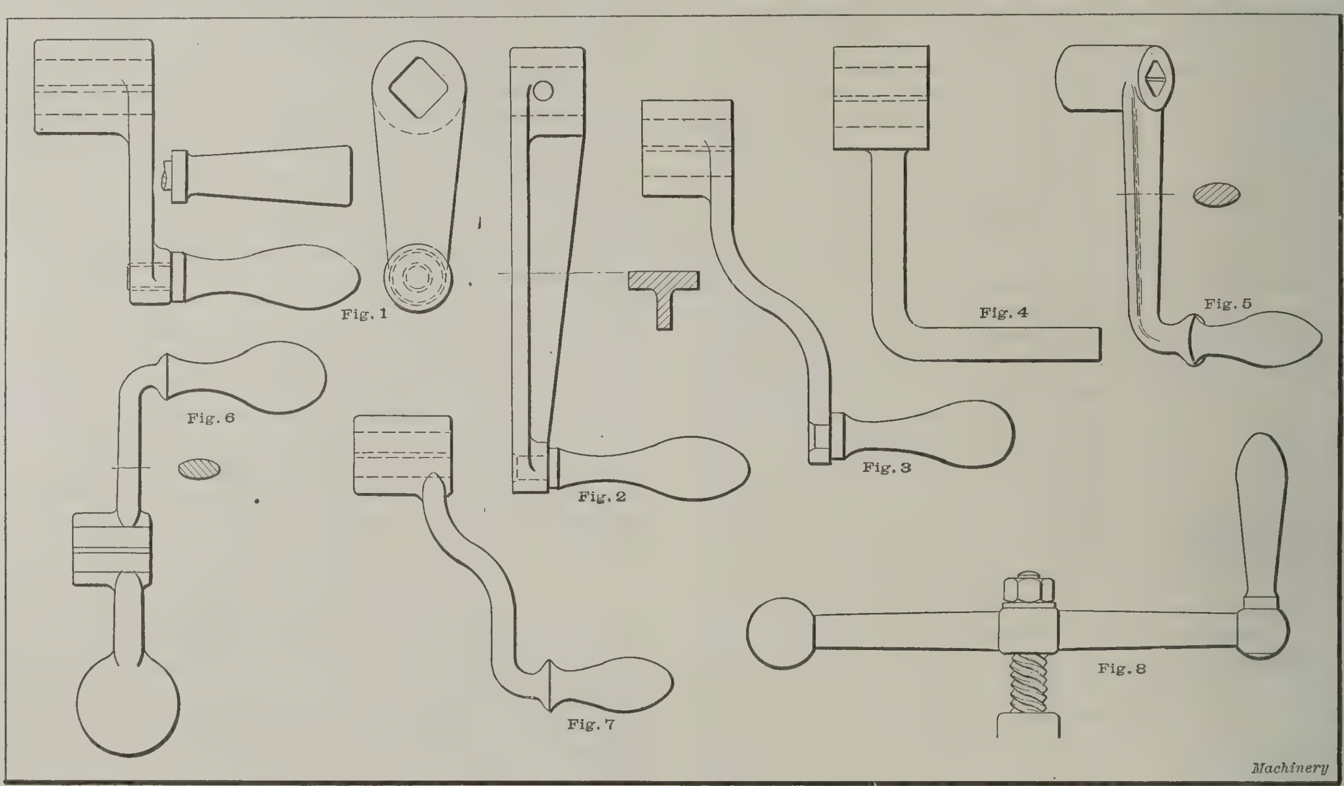
Sometimes, when the ends of two or more of the shafts come close together, a single handle must be used, which is slipped onto either shaft as required. The waste of time involved in this has caused some designers to so modify the arrangement as to eliminate this proximity of the shafts, and to place them so that the distance between them is sufficient to permit a fixed handle or handwheel to be attached to each. When adjustments are required frequently, it is more convenient to have individual handles on every shaft.

In the following is given a selection of the more typical designs of handles. It should be understood that these are intended to illustrate types only, and that slight differences in design are frequently met with. However, it is believed that this collection of handles shows practically all of the types that are in more or less common use.

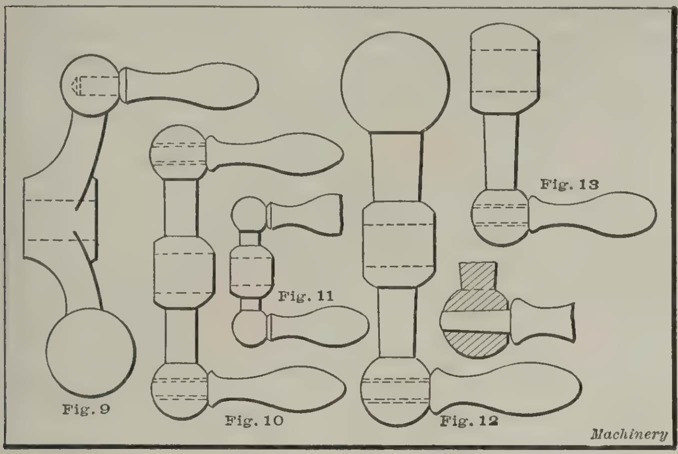
Perhaps the simplest, and, at one time certainly the most commonly used handle, is that shown in Fig. 1. The lever part was in the past usually made of an iron casting, but is, at the present time, often cast in gun-metal. It is used generally for small lathes and other small machines. The handle is either riveted or screwed in. The plain straight handle also shown in the illustration is not as comfortable to the hand as the rounded shape. The cast-iron handle shown in Fig. 2 is occasionally used, but does not present a very neat appearance. In Fig. 3 is shown a handle with a bent lever. This form is necessary when the handle comes inconveniently close to projecting parts, such as nuts and adjacent bearings, etc. Long handles are occasionally bent out in a straight line and then bent just at the tip where the handle portion is screwed in. A handle or "screw-key" frequently used in English designs is shown in Fig. 4. This is forged in one piece with the handle portion formed simply by bending the circular stem. It is not a very good looking handle, but seems to be a favorite among many machine-tool makers, particularly in the Manchester and Glasgow districts.



Figs. 1 to 8. Types of Handles used on the Machine Tools

The solid drop-forged handle, with a shaped portion for the hand, shown in Fig. 5, is probably employed to a greater extent in America than elsewhere, although, with the spread of drop-forging practice, its use is continually extending. The type shown in Fig. 7 is necessary in designs where on account of clearance, or for other reasons, the straight shape is impracticable or at least inconvenient. The most popular style of handle for ordinary use on slides and other parts that have to be frequently adjusted or manipulated is the balanced ball handle shown in Fig. 12. This is turned out of solid stock with forming tools and provided with a screwed-in handle, as

shown. Sometimes the handle is fitted with a taper, as indicated in the detail view. Ball handles with much longer arms, as in Fig. 8, are used to a moderate extent where greater leverage is required. French makers are particularly fond of using them, the example shown being taken from a French screw machine. The drop-forged style, shown in Fig. 6, has the handle formed in one with the body. This handle has a pleasing appearance, and the choice between this and the turned type depends entirely upon manufacturing conditions.



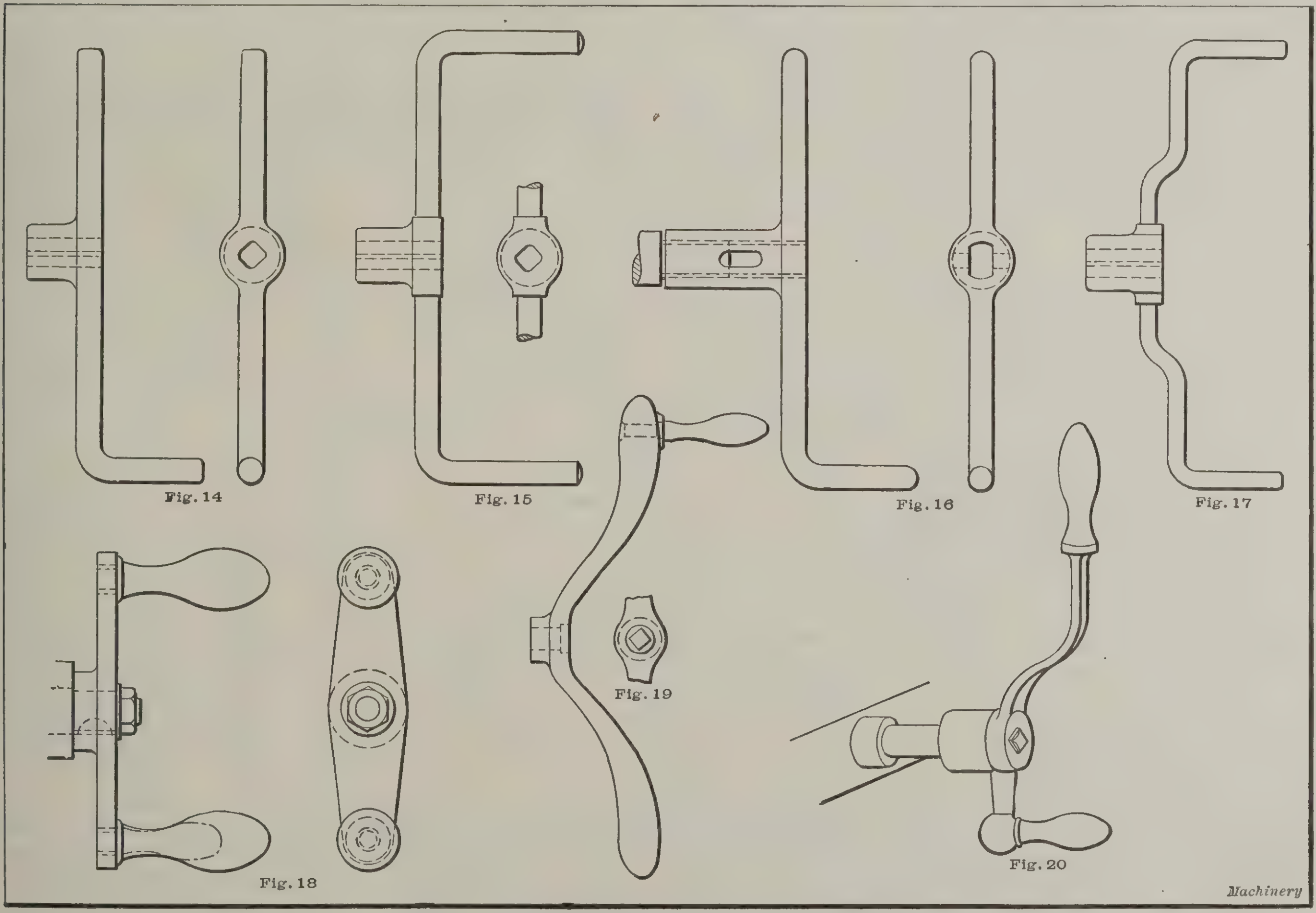
Figs. 9 to 13. Types of Handles used on Machine Tools

Ball handles are seldom used in cases where the unbalanced action is of no consequence, as, for instance, when the screw to be operated stands in a vertical position, as the feed-screw of a shaper tool-box. The handle shown in Fig. 13 would, however, be objectionable where the extra weight on the one side would tend to let the handle gradually drop under the influence of vibration, so as to move a screw or other portion and thus alter the adjustment. The balanced ball handle, if accurately designed, obviates this tendency. Ball handles with the balls on the ends in line with the center of the hub cannot always be used where the clearance space is limited, and the forged type shown in Fig. 9 is then employed.

The double-ended ball handles, shown in Figs. 10 and 11, give a more perfect control over the movements of a slide, and the handle is always within easier reach than in the case of the single-handled form. A type of double-ended handle much used in certain English and Scotch machine tools is that shown in Fig. 14, which is forged with round bar ends, one being bent as indicated. The type shown in Fig. 15 is also employed to a large extent; in this, both ends are bent. It is sometimes made in the shape shown in Fig. 17, when the clearance is limited. Handles of this type are sometimes fitted upon flatted spindles, as indicated in Fig. 16, and are also made with a cotter-way cut through it as illustrated. The object of this is to enable a cotter to be driven in to draw the handle off, if it should be jammed in place.

A frequently used type of double handle, having a web or plate body with the handles screwed or riveted in place, is shown in Fig. 18. The handles are either of equal size as shown, or one is made smaller than the other, as indicated by the dotted lines, so as to leave the hand and wrist less encumbered for rapid rotation. A different type intended for the same purpose is shown in Fig. 20. This is used on a hand milling machine; the leverage for one handle is long and is intended to give the required power for feeding, while the leverage of the other is short for rapid turning when making quick adjustments. A similar principle is embodied in the handle shown in Fig. 19, intended for turning a chuck, in which the ends are alike, but one has a transverse handle riveted to it for rapid rotation.

In Fig. 21 is shown how the movement of a handle is conveyed to a vise on a Lincoln milling machine, where the square on the vise screw happens to come over the table, thus preventing the full rotation of the handle were it attached directly to the end of the screw. A supplementary spindle is, therefore, provided for rapid manipulation, this spindle being supported in a bracket bolted to the table, and the handle applied to it.



Figs. 14 to 20. Types of Handles used on Machine Tools

Loose handles which turn on a stem or central spindle are used to a considerable extent. These can be rapidly operated with less friction and fatigue to the hand. Either steel, glass, horn, wood or other similar substances are employed for the loose part; horn is more durable than wood, and is a very

popular material for this purpose. A steel or brass handle, as shown in Fig. 22, fits directly on the pin fastened to the handle or wheel, but wood and horn handles require a bushing, as indicated in Fig. 23. In Fig. 22, it will be noticed that an oil groove is provided for lubrication.

The two-ended type of handle, shown in the previous illustrations, and also illustrated in Figs. 24 and 25, does not meet with all requirements in machine-tool operation, particularly when rapid movements are desired, and where considerable power must be exerted, as, for example, in the operation of turret lathe slides, lathe carriages, drilling and boring machine slides and spindles, etc. Star handles or "spiders" are then employed for this purpose. The simplest type of star handle is shown in Fig. 34. It is made of a steel forging with flat handles, which are either straight or bent as shown in the alternative design in the upper part of the right-hand view. A more neatly designed type, forged with round tapered handles, either straight or bent, is shown in Fig. 33. In Figs. 27 and 29, other forms are indicated.

In very large spiders, such as those sometimes used on boring mills and large turret lathes, the four or more star handles are screwed into the short arms of the central cast-iron boss. This type is used on account of the simplicity in making. As these star handles grow larger, however, the usual design takes the form of a central boss of cast iron into which forged or turned steel handles are screwed or pinned or held with nuts, making a graceful and light design, and one that is easy to manufacture and assemble. Handles of this type are shown in Figs. 30 and 32, the one having four and the other three handles. The handles are tapered or formed to prevent the hands from slipping off too easily, or are sometimes knurled.

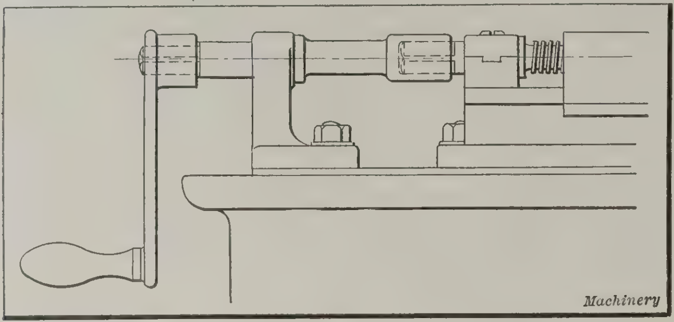
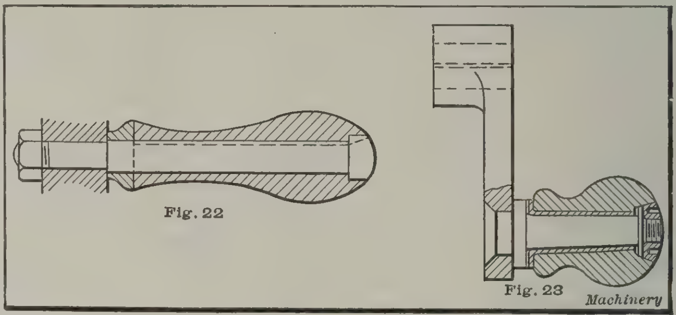


Fig. 21. Extension Spindle and Handle on Lincoln Milling Machine

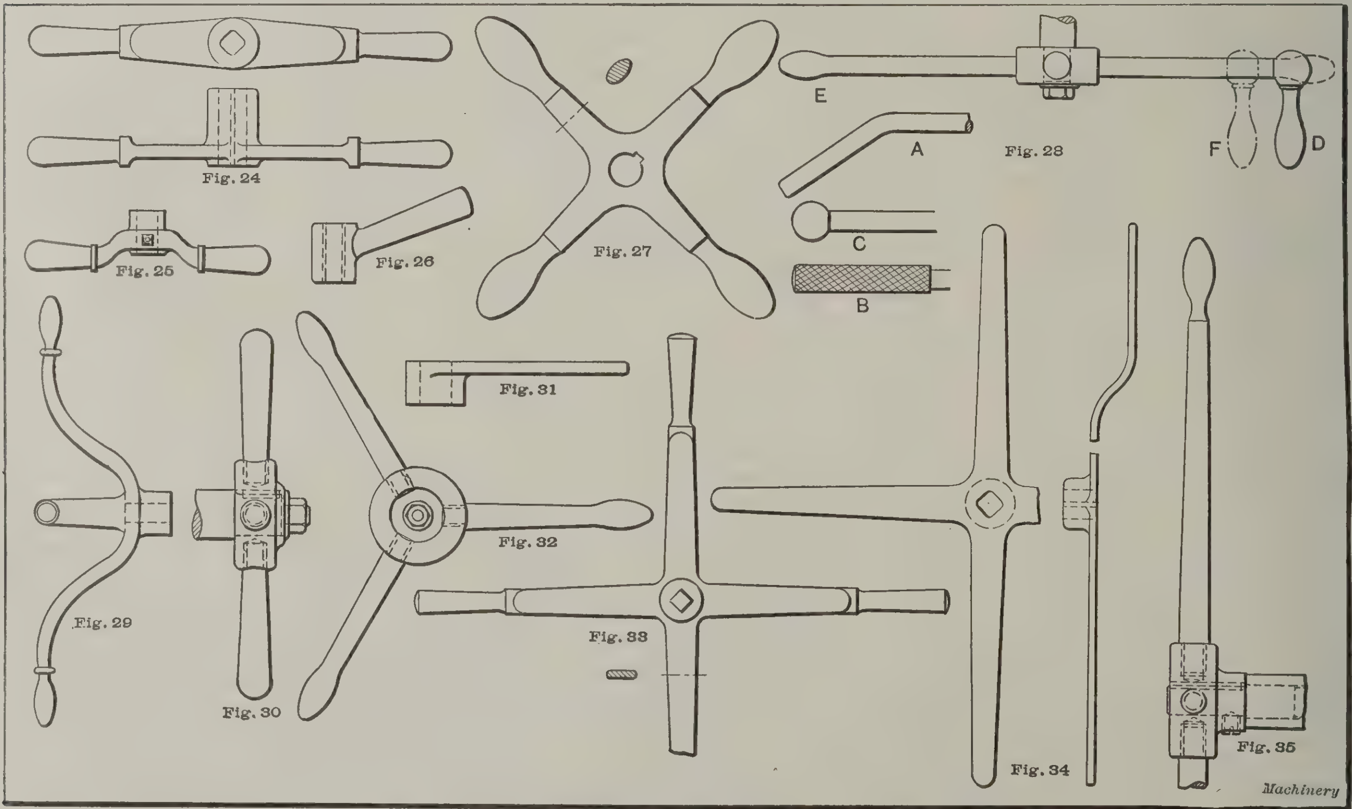


Figs. 22 and 23. Examples of Loose Revolving Handles

In Fig. 35 is shown a large "spider" for a chucking-lathe turret slide where the bearing of the spindle is brought out so as to avoid the necessity for bending the star handles outward. When it is necessary to bend these handles, however, this is done either as indicated at *A* in Fig. 28, or by putting them in at an angle as indicated in Fig. 36, the dotted lines showing a case where the angularity is considerable. Returning to Fig. 28, this figure shows the alternative designs *B* and *C* for the handle ends, the first being knurled for a certain distance, and the second having a knob or ball end. All these handles are used on turret lathes and for similar purposes. The handle shown at *D*, Fig. 28, provides a means for rapidly rotating the spider. This handle is attached to but one of the star spokes. This arrangement is varied by leaving all the handles as indicated at *E* and putting handle *D* further in on the spoke, as shown by the dotted lines at *F*. This leaves the star for feeding and provides a handle for rapid rotation.

A practice still more common is that of fitting handles *D* or *F* loosely, so that *D* can be attached to any plain bar and also adjusted for radius, to suit the throw which each particular operator prefers. The usual method for designing such a handle is with a split and a set-screw, as shown at *A*, Fig. 40. Occasionally a plain set-screw bearing on the bar is used. Another method is to use a grip-bolt as shown at *B*, drawn up by its nut to press on the bar and thus lock the handle.

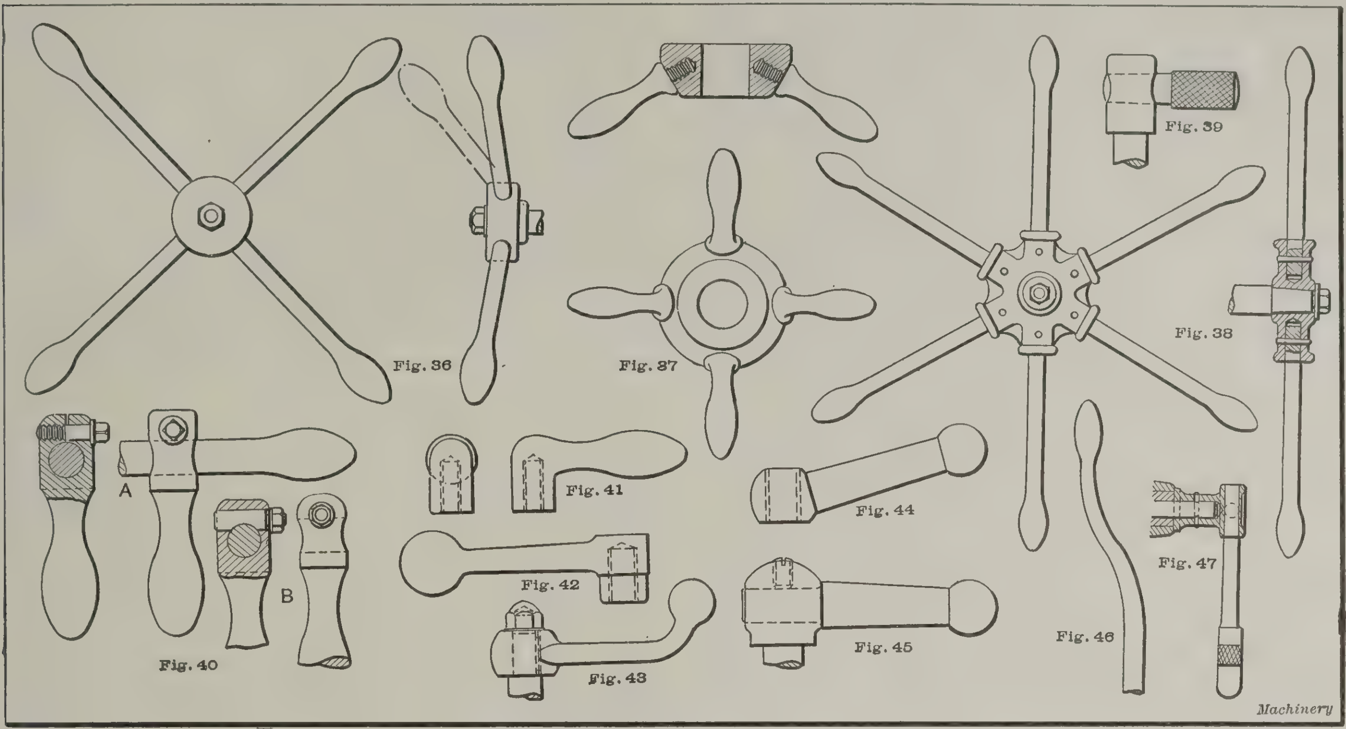
Other types of star handles are illustrated in Figs. 36, 37 and 38. The first is a simple design of star handle with a cast-iron boss, the handles being screwed in at an angle. This type is largely used in connection with certain feed motions. That in Fig. 38 is used for large turret lathes, the handles fitted having plain or slightly tapered ends and being fastened by taper



Figs. 24 to 35. Types of Handles and Star Wheels used on Machine Tools

pins. Star or pilot handles of this design are provided with up to eight or ten handles, and when two of them are placed adjacent, one in front of the other, on a shaft and a sleeve, respectively, the number of handles in each is occasionally varied, and the outer handle is provided with shorter arms than the inner, for convenience in manipulation.

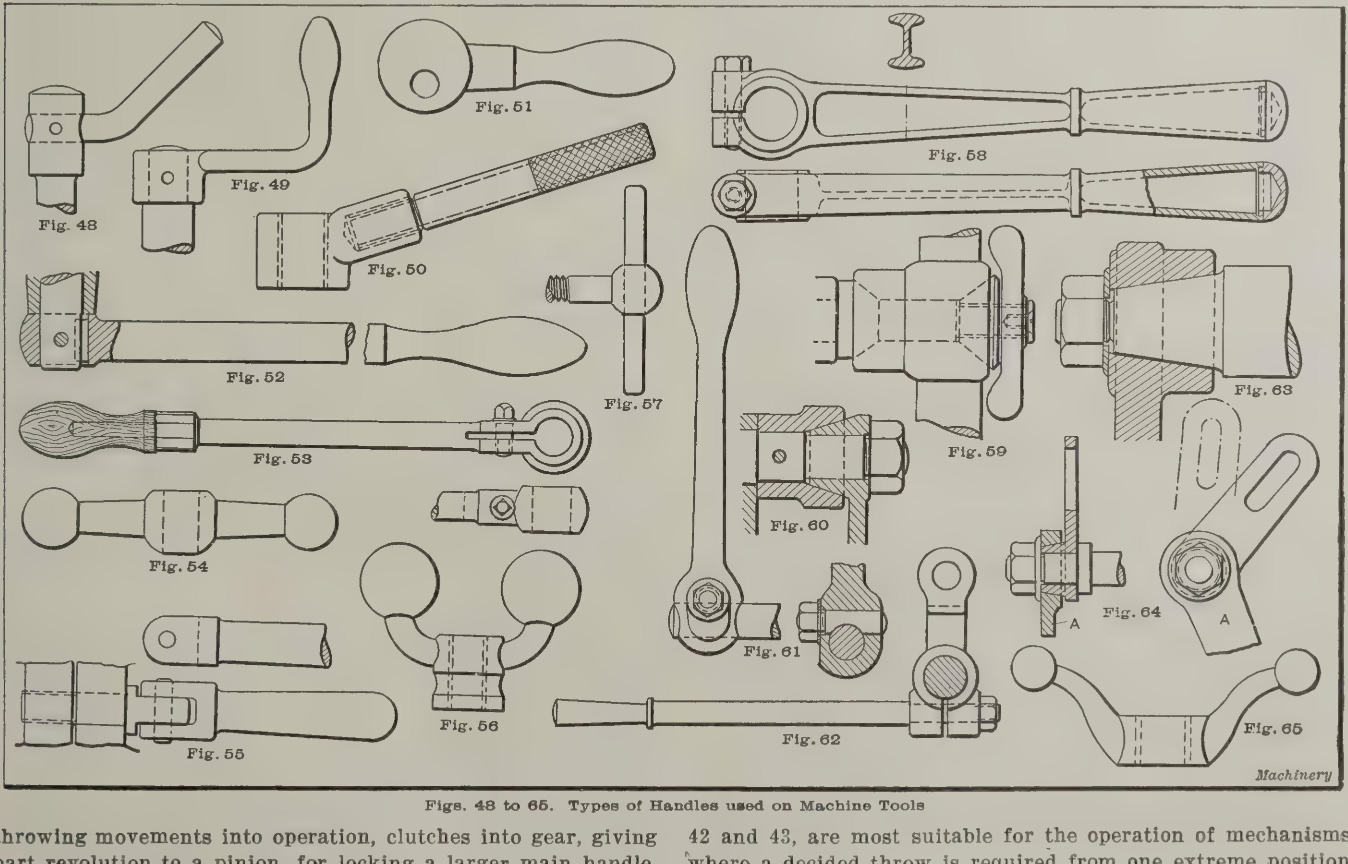
cation of a loose wrench. Others are wrenches, pure and simple, with a square or hexagonal hole, and with the usual handle portion of a different type from that of the ordinary wrench. Others, again, are nothing but nuts, with some kind of handle, wing, or ear. One of the plainest kind of handle of this type is shown in Fig. 31, and consists of a boss with a



Figs. 36 to 47. Types of Handles and Star Wheels used on Machine Tools

The handles so far illustrated have been principally intended for operating screws, pinions or other parts requiring a complete revolution, but there is a large and more varied class employed chiefly for partly rotative movements of a fraction of a circle. These are for such functions as locking or for

threaded, square, or hexagonal hole and a flat handle. Sometimes the handle is circular and tapered as shown in Fig. 26; this type of handle is more convenient to manipulate and is used when it is frequently operated. A drop-forged type with a nut portion is shown in Fig. 41. Ball-ended handles, Figs.



Figs. 48 to 65. Types of Handles used on Machine Tools

throwing movements into operation, clutches into gear, giving part revolution to a pinion, for locking a larger main handle, a slide, or a quadrant, feeding a slide, operating a chuck, and many similar functions. Some of these are really wrenches in the forms of handles, and are used to avoid the frequent appli-

42 and 43, are most suitable for the operation of mechanisms where a decided throw is required from one extreme position to the other, as for clutches, clasp-nuts, and similar mechanisms. The ball end is also well suited for larger handles or levers in places where a belt-shipper or clutch or similar strik-

ing gear is thrown in very suddenly. Figs. 44 and 45 show two variations of turned ball-handles, the one made solid and the other fitted into the head of the screw or spindle, and locked with a headless set-screw.

When but a small leverage is required, an arrangement like that in Fig. 39 is often adopted; or like that in Fig. 48, if the space for the hand is obstructed at the surface of the slide or other part of the machine, by nuts or other outstanding objects. Not only nuts, but other details are frequently made solid with their handles, pinions or quadrant teeth, or eccentric or cam portions, as indicated in Fig. 51. This makes a solid construction and eliminates the key or other fastening required.

Lightness is not usually a point in handle designs except when the handles are used in portable machines, and for certain devices, as opening dies. In certain instances, however, a piped form of handle may be provided, as shown in Fig. 50. In Figs. 47 and 49 two types of handles are shown, one for operating the tailstock spindle of a bench lathe, and the other for turning a vertical feed-screw, where occasional rapid complete revolutions are alternated with slight adjustments. A handle long familiar on certain designs of upright drilling machines, is shown in Fig. 46. This handle is forged directly to an extension of an adjusting screw. It is, of course, nothing but a bent forging, but illustrates that in certain instances even long handles may be made in one piece with the part being operated.

Longer levers for operating movements requiring considerable power are either of the plain type shown in Fig. 52, which is simply keyed or pinned onto the spindle or screw, or they are attached by a split boss and set-screw, as shown in Fig. 53. This latter design permits of adjustment in radial position to suit the convenience of the operator, and is met with in the feed lever of cross-slides and vertical forming slides on hand-milling machines, etc. The wooden handle on the end of the lever is used because it is more comfortable than a steel handle for constant operation. Fig. 58 illustrates a cast handle with a web of H-section, and a hollow handle portion with a cap screwed onto it. Instead of using a split boss for clamping, the draw- or grip-bolt method, as shown in Fig. 61, may be utilized.

The adjustment of the radial position of the handle is provided for in other ways besides those just illustrated. A favorite method is that of utilizing a cone as shown in Fig. 63, the handle being forced on by the nut. Another method is shown in Fig. 60, where the cone is fitted inside a collar which is pinned on the spindle. In Fig. 64 an arrangement is shown which is adopted for a turret lathe cross-slide. The handle *A* is locked to a slotted link (which moves the slide) by a cone and nut, so that the relative angular setting can be varied to bring the handle *A* into a higher or lower position, according to the setting of the tools and the diameter of the work. Another method for making a handle adjustable, or for allowing it to swing freely, is by a friction clutch device, as shown in Fig. 59.

The shapes of double-ended handles for the same purposes as those just mentioned depend chiefly on the size and the function of the handle. For simply tightening a plain cross-handle, the type shown in Fig. 57 is sufficient, or a more comfortable ball-handle, Fig. 54, may be employed. Two varieties of ball-ended handles are shown in Figs. 56 and 65. The ball ends give a flywheel effect that helps in rapid tightening and loosening, which is a feature of value when these operations are repeated at frequent intervals.

A handle attached to the end of the spindle, for operating a belt-shifting mechanism for a small countershaft, is shown in Fig. 62. When it is necessary to hinge handles so that they may be folded back out of the way after use, the type illustrated in Fig. 55 is used.

* * *

One of the few available materials that will stand the high heat of the blow-pipe used for melting platinum, is lime, and this material is almost exclusively used for crucibles for melting platinum. The lime used is regular burnt lime and not limestone. Large pieces free from fissures and foreign matter should be selected.

SOCIETY OF AUTOMOBILE ENGINEERS SPECIFICATIONS FOR STEEL*†

In a report by the Iron and Steel Division of the Society of Automobile Engineers, January, 1912, very complete specifications for the composition, heat treatment and properties of various kinds of steel, are given. In the following article the most important parts of these specifications will be reviewed. Tables relating to the composition, heat treatment, etc., of carbon, nickel, nickel-chromium and chromium-vanadium steels are given in the accompanying Data Sheet Supplement.

The steels specified may be of open hearth, crucible or electric manufacture, and must be homogeneous, sound and free from physical defects, such as pipes, seams, heavy scale or scabs, and surface and internal defects visible to the naked eye. The figures given in the tables for physical characteristics or properties of the various steels refer to sections common in automobile construction that is, to bars from 1 to 1½ inch round. The high elastic limits can be obtained only on small sections with very careful heat treatment, while the low elastic limits can be expected on heavy sections with less refined or severe heat treatment.

Carbon Steels

The 0.10 per cent carbon steel is usually known to the trade as soft, basic open hearth steel, and is commonly used for seamless tubing, pressed steel frames and brake-drums, sheet steel brake-bands, etc. It is soft and ductile and will stand a great deal of deformation without cracking. In its natural or annealed condition it should not be used where a great deal of strength is required. The quality of this material, however, is improved by cold drawing or rolling. An important fact to remember is that this steel when cold drawn or rolled is returned to the characteristics of the annealed material by heating. This remark also applies to all materials the elastic limit of which has been increased by cold working.

The 0.10 per cent carbon steel in its natural or annealed state cannot be easily machined. It will tear badly in turning, threading and broaching operations. Heat treatment has little effect upon it, and does not increase its strength but only the toughness. The heat treatment which will produce some stiffness is to quench it in oil or water at a temperature of 1500 degrees F. No drawing is required. This steel will caseharden but is not as suitable for this purpose as 0.20 per cent carbon steel. This latter steel is often known to the trade as machine steel and is intended primarily for casehardening. It forges well and machines well, but is not suitable for screw machine work. Its particular use is for forged, machined and casehardened parts, where strength is not of especial importance. It can also be drawn into tubes and rolled into cold rolled forms and is a good frame material. It can be interchanged with 0.10 per cent carbon steel for cold pressed shapes.

Heat treatment of 0.20 per cent carbon steel does not increase its strength to any degree, but causes a refinement of the grain after forging and increases the toughness; all that is necessary is to quench it in oil at 1500 degrees F. The casehardening treatment specified in the accompanying Data Sheet Supplement is the most important treatment for this quality of steel. The heat treatment specified as "A" is for parts which do not need to carry a great deal of load or withstand shock, but simply must have a hard surface. Heat treatment "B" is for the parts which must not only be hard on the surface but also must possess strength, as, for example, gears, cam rollers, steering-wheel pivot-pins, etc.

The 0.30 per cent carbon steel is primarily a structural steel. It forges well, machines well, and responds to heat treatment in regard to strength as well as toughness. It is used for such forgings as axles, driving-shafts, steering pivots and other structural parts. This quality of steel is not intended for casehardening, but, by careful treatment, it may be safely casehardened, although it is used for this purpose only as an emergency. In that case, it should be given a double heat treatment, followed by a drawing operation.

The 0.40 per cent carbon steel is a structural steel of greater strength than that previously mentioned. Its uses are more

* With Data Sheet Supplement.
† See MACHINERY, September, 1911, "Composition and Heat Treatment of Carbon and Alloy Steels."

limited and generally confined to such parts as demand a high degree of strength and a considerable degree of toughness. It is commonly used for crankshafts, driving shafts and propeller shafts. It has also been used for transmission gears, but is not quite hard enough for casehardening, and when casehardened, not tough enough to make safe transmission gears. When properly annealed it machines well, but is not suitable for screw machine work. The 0.50 per cent carbon steel differs but little from that just described, although owing to its higher carbon content, it is somewhat harder to machine and also somewhat stronger.

The 0.80 per cent carbon steel is ordinarily known to the trade as spring steel, and is generally used for springs of light sections. The 0.95 per cent carbon steel is also generally used for springs. When properly heat treated extremely good results are possible. The quenching temperature, as specified in heat treatment "F" in the Data Sheet Supplement, should, if anything, be lower than that specified. Because of the high carbon content, the steel is used considerably for heavier types of springs.

Screw Stock

The composition of ordinary screw stock is not given in the accompanying Data Sheet Supplement, but should, in general, be about as follows: Carbon from 0.08 to 0.20 per cent; manganese, 0.30 to 0.80 per cent; phosphorus, not to exceed 0.12 per cent; sulphur, 0.06 to 0.12 per cent. The characteristics and heat treatment of this steel were given in an article on "Composition and Heat Treatment of Carbon and Alloy Steels," published in MACHINERY, September, 1911, engineering edition.

Nickel Steels

With regard to the use of all alloy steels it should be borne in mind that such steels must be heat treated and not used in the annealed or natural condition. In the latter condition they are but slightly superior to plain carbon steels. In the heat-treated condition, however, a marked improvement in physical characteristics is shown.

The 0.15 per cent carbon nickel steel, the analysis of which is given in the accompanying Data Sheet Supplement, is suitable for carbonizing purposes. Steel of this character properly carbonized and heat treated will produce a part with an exceedingly tough and strong core and a hard exterior. This steel can be used for structural purposes, but is not especially suitable for this purpose. It is intended for casehardened gears and for such other casehardened parts as require both strength and hardness. The 0.20 per cent carbon nickel steel may be used interchangeably with that just described. It is intended primarily for casehardening purposes, but may, with suitable heat treatment, also be used for structural parts. The 0.25 per cent carbon nickel steel may also be casehardened successfully and is satisfactory for gears—either of the transmission or the rear axle bevel type. The treatment for carbonizing must be slightly modified to meet the increase in carbon content. It can also be used for many structural parts if subjected to heat treatment "H" or "K."

The 0.30 per cent carbon nickel steel is primarily used for structural parts where strength and toughness are required, for example, such parts as axles, crankshafts, driving-shafts and transmission shafts. Wide variations as to elastic limits are possible by varying the quenching mediums—oil, water or brine—and by variations in the drawing temperatures. This material may be casehardened, but is not suitable for that purpose. The 0.35 per cent carbon nickel steel is very similar to that just described.

The 0.40, 0.45 and 0.50 per cent carbon nickel steels are not widely used, but are available for certain purposes. A greater hardness is obtainable in these steels than in those of the lower carbon contents, but as increased brittleness accompanies the greater hardness the treatment given must be modified to meet these conditions. For example, the final quenching must be at a lower temperature in order to produce the desired toughness and other properties. The strength of these steels depends upon the heat treatment and may be controlled closely over a wide range.

Nickel-chromium Steels

There are three types of nickel-chromium steels in common use, known as low, medium, and high nickel-chromium steels. In general, it may be said that the heat treatment and properties of these steels are much the same as those of the plain nickel steels, except that the effects of the heat treatment are somewhat augmented by the presence of chromium. The low nickel-chromium steels with carbon contents up to 0.20 per cent are intended primarily for casehardening, while those with carbon contents from 0.25 to 0.40 per cent are intended primarily for structural purposes. Those with carbon contents from 0.45 to 0.50 per cent may be used for gears and other structural parts where a high degree of strength and hardness is demanded and where toughness is not of first importance.

The medium nickel-chromium steels are of the same composition as the low nickel-chromium steels except that they contain more nickel and chromium. Their general usage is practically the same as already mentioned for the low nickel-chromium steels.

The high nickel-chromium steels require different heat treatments from the other two types mentioned on account of the amount of nickel and chromium that they contain. Annealing before machining will be found necessary for these steels. The higher percentages of nickel and chromium make machining in a natural condition difficult. The steels with low carbon contents are casehardened the same as in the case of low nickel-chromium steels, and those with higher carbon contents are used for structural parts. In general, these steels are used for parts of an important character, and where unusual strength is demanded. The 0.45 per cent high nickel-chromium steel, for example, is used for gears where extreme strength and hardness are necessary. The carbon content is sufficiently high to cause the material to become hard enough to make a good gear when quenched, without being casehardened. This steel, however, is difficult to forge. During the forging operation it should be kept at a high or plastic heat and should not be hammered or worked after dropping to ordinary forging temperatures, as cracking is liable to follow. On the other hand, too high a temperature is not advisable, as the steel then becomes red-short and breaks.

Chromium-vanadium Steels

Chromium-vanadium steels are used for many automobile parts, particularly springs, axles, driving-shafts, and gears. They are used interchangeably with carbon steels, nickel steels and nickel-chromium steels. Those qualities which contain from 0.15 to 0.20 per cent carbon are intended primarily for casehardened parts, while those of from 0.25 to 0.50 per cent carbon are used for structural parts. The 0.25 per cent carbon steel may be casehardened, but is not suitable for this purpose. The 0.40 per cent carbon steel is of a very good quality, to be selected where a high degree of strength is desired coupled with a moderate measure of toughness. It is a first-class material for high-duty shafts. The 0.45 per cent carbon steel may be used for gears and springs. When used for structural parts, if an exceedingly high strength is desirable, heat treatment "T" should be used instead of treatment "U." The 0.50 per cent carbon chromium-vanadium steel is suitable for springs and gears. The final drawing temperature must vary with the section of material being handled; it must be taken into account, for example, whether light spiral springs or heavy flat springs are being heat treated.

Valve Metals

Specifications for valve metals are not given in tabulated form in the Data Sheet Supplement. Nickel valve metals, however, may be made to two specifications: Valve metal No. 1, which should contain not less than 96 per cent of nickel, and valve metal No. 2, which should contain from 28 to 35 per cent of nickel. These metals also contain carbon, not over 0.50, manganese, not over 1.50, and phosphorus and sulphur, each not exceeding 0.04 per cent; the remainder to be iron. These metals do not respond to heat treatment. The best that can be done with them is to treat them for the purpose of securing uniformity of structure by annealing or quenching at 1500 degrees F. or thereabouts.

Steel Castings

The specifications for steel castings are not given in the Data Sheet Supplement, but the following composition is desired:

Carbon, from 0.30 to 0.40 per cent (0.35 per cent desired);
Manganese, from 0.50 to 0.80 per cent (0.65 per cent desired);
Phosphorus, not to exceed 0.05 per cent;
Sulphur, not to exceed 0.05 per cent;
Silicon from 0.10 to 0.30 per cent.

This composition refers to genuine steel castings and not to malleable iron or complex mixtures often found in the market masquerading under the name of steel. Genuine steel castings should be annealed and may be heat treated to great advantage. A steel casting of the composition given in the specifications should be tough enough to bend to a considerable angle without breaking. The elastic limit of such a casting in an annealed condition is in the neighborhood of 35,000 pounds per square inch. Like other castings, steel castings are subjected to blow-holes. They are, therefore, not to be used in vital parts of the mechanism. It is impossible to inspect against blowholes, and steel castings for axles, crankshafts and steering-spindles are used only at great risk. The specifications given furnish a fair commercial analysis. Freedom from blowholes and proper physical conditions are of more importance than the exact adherence to the analysis given.

* * *

THE TITANIC TRAGEDY

Immediately following the wreck of the White Star steamer *Titanic*, which sunk April 15, a few hours after colliding with an iceberg 800 miles off the coast of Newfoundland and carried down over 1600 of the passengers and crew, an investigation was started by a United States Senate committee appointed to determine the facts of the disaster. Appalling as is the tragedy the facts of the contributing causes brought out in the sworn testimony of survivors are no less so:

It was shown that the captain had received wireless warnings of the proximity of icebergs, that a speed of approximately twenty-one knots was maintained in the face of the known danger, that the vessel was undermanned, that the passengers were not promptly warned of the imminence of sinking after the collision, that the lifeboat equipment was sufficient for less than half the passengers and crew, that the crew had not handled the lifeboats and were unfamiliar with the vessel, that the boats were not systematically filled, and that the wireless equipment of this and other vessels is inadequate.

The theory of the unsinkableness of modern vessels fitted with bulkheads dividing them into compartments, is based upon the supposition that collision would, at most, cause the rupture of not more than two compartments, but the experience with the *Titanic* shows the fallacy of the idea. When the iceberg was sighted a quarter mile dead ahead, the helmsman immediately shifted the rudder hoping to avoid the obstruction but instead the vessel "sideswiped" it and tore her side open, making a great rent probably over two-hundred feet long. Foundering was inevitable.

Great as is the loss of life, it is but a small fraction of the total annual human destruction due to accidents of the industries in the United States alone, which goes on year after year, creating hardly a ripple of protest in the world at large. To the average engineer the fact that this great vessel could be lost so quickly and so hopelessly is probably a greater shock than the loss of life. His pride of achievement is humbled; he is brought face to face with the grim fact that all the practicable improvements in marine vessels so far devised will be of little avail if the commanding officers are required to break speed records when dangers of fog, derelicts and icebergs are imminent. The energy of a vessel displacing 66,000 tons and moving at twenty knots is so great that almost any structure that can float will be torn asunder if that force is suddenly expended on it. Airtight compartments, that is bulkheads and airtight decks between, with pipes connected to a compressed air supply, might have saved the *Titanic* had the crew been disciplined to act promptly in a great emergency, but under the conditions existing as brought out by the Senate committee, it is doubtful.

* * *

Idler gears should be made as large as possible, because the wear on the teeth of these gears is twice as great as on the driving or driven gear.

HEAT-TREATMENT OF STEEL BY THE ELECTRIC FURNACE*

By H. RALPH BADGER†

In properly managed shops, the heat-treatment of steel is today receiving thorough attention. To produce a tool of such high quality that it will give several times the service of a tool that has not been properly heat-treated, is an important factor in shop economy. To accomplish this result it is necessary to know the laws governing the hardening of steel. If we clearly understand the causes underlying the changes which take place when steel is subjected to various heat-treatments, we have the basis for a positive control of the quality of the finished product. "Electric heat" is a new and important means to this end.

Heat-treatment of Steel

We heat and quench a tool because we want it to be harder. In every case the object of this treatment is to change, in some degree, certain of the physical properties of the steel. The effect of heat upon a piece of steel depends on the nature of the steel—that is, upon its composition, its form or external shape,

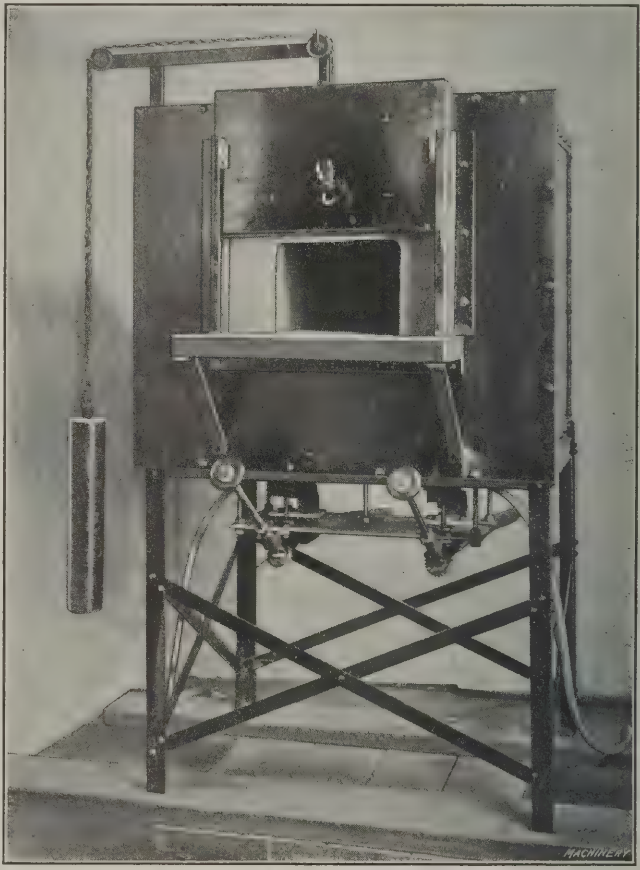


Fig. 1. Hoskins Electric Furnace for Use in Hardening and Tempering Carbon and High-speed Steel Tools

and its internal structure. The raising of the temperature of the piece sufficiently will produce a change in the form, so as to increase its volume by causing a lengthening in some directions. In the structure of the steel itself this may introduce mechanical strains in the fibers. Mostly, however, these are but temporary changes, and, with proper heat-treatment, they disappear when the piece is again cooled.

Changes in the chemical arrangement of the elements composing the steel are produced when the temperature of the

* For additional information on this and kindred subjects see the following articles previously published in MACHINERY: February, 1912, "Enamelite for Selective Hardening," and "Notes on Quenching Fluids"; January, 1912, "Hardening Solution for Tool Steel," "A Hardening Solution," and "Mixture for Hardening Tool Steel and Casehardening Machine Steel"; December, 1911, "Cramer Process for Hardening High-speed and Carbon Tool Steel"; November, 1911, "The Correct Use of Hardening-room Terms"; September, 1911, "Composition and Heat Treatment of Carbon and Alloy Steels"; April, 1911, "The Use of Barium Chloride for Heating Steel for Hardening"; August, 1910, "Hardening High-speed Steel"; June, 1910, "Heat Treatment of Carbon Steel," and "Apparatus for Hardening Milling Cutters"; June, 1910, engineering edition, "The Hardening of Carbon Steel," and "Hardening Carbon and Low Tungsten Steels"; March, 1910, "Hardening Small Blanking Dies"; January, 1910, "Hardening Carbon Steels." See also the previously published information referred to in connection with the last-mentioned articles, and MACHINERY's Reference Book No. 46, "Hardening and Tempering," and No. 63, "The Heat Treatment of Steel."

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piece is raised to a sufficient degree. These are the changes that are effective in hardening and tempering. If the piece, once heated to a sufficient temperature to produce hardening, is allowed to cool very slowly, these "changes" of chemical arrangements revert to their original condition; but if the piece is cooled quickly — quenched — immediately upon removing it from the source of heat, the changes are made permanent.

For steels of different composition, that is, made up of either different elements or of different proportions of the same elements (iron, carbon, etc.), there are different critical temperatures at which these changes take place. Corresponding differences in the heat-treatment are, therefore, necessary to produce the best results. Even two pieces of the same steel which vary greatly in their form must be treated differently. This is true also of two pieces of steel whose composition and form may be identical, but whose ultimate use may be different.

Examples of all three of these conditions occur constantly in shop practice. The intelligent hardener knows that a complicated die must be handled differently from a straight lathe tool, and a shaper tool for soft metal need not be as hard as one for hard metal, even though all of these pieces be made from the same steel. The next step ahead is to treat different kinds of steels according to their particular requirements. Various high-speed steels, high-carbon steels, and low-carbon steels are given individual treatment. Each is subjected to the conditions of heating and subsequent handling that will bring out the maximum of its useful characteristics. To meet the wide range of requirements and to avoid the losses of tools spoiled in hardening, there are three factors in the heating of steel which should be observed: First, the quality of the heat; second, its uniformity; and third, its degree.

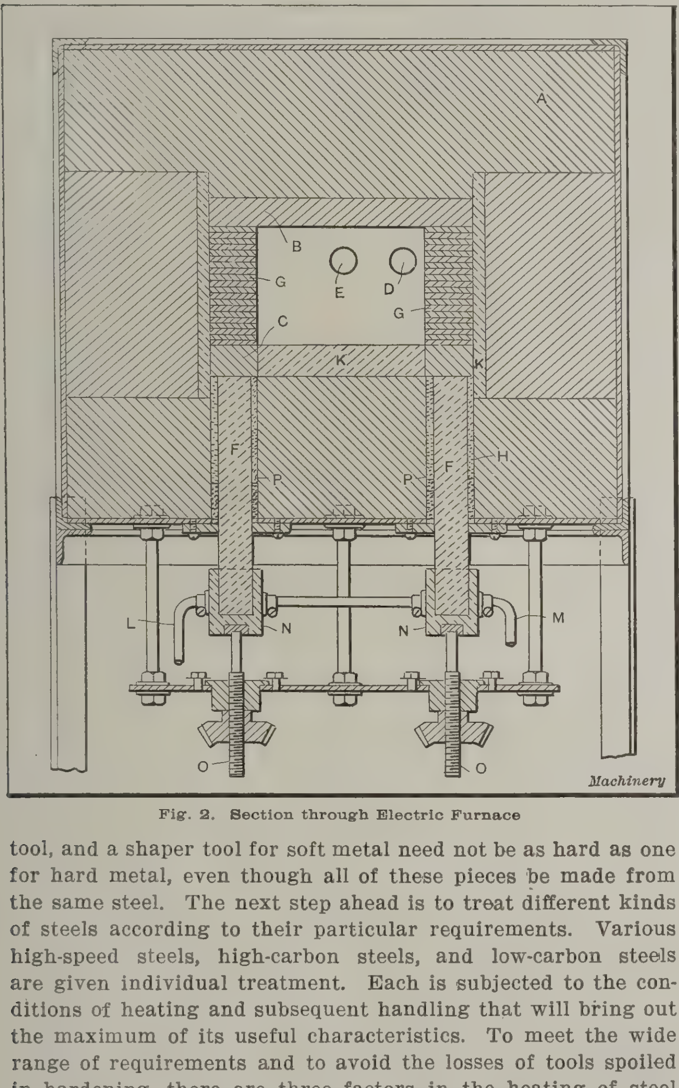

Fig. 2. Section through Electric Furnace

Under ideal conditions the steel would be subjected to a heat effect only, as this alone is necessary to produce the desired changes. In practice, however, it is difficult to produce heat of the necessary intensity without having the quality of it impaired by the presence of flames or oxidizing gases and sulphur and other injurious fumes. Freeing the heat from such attendant defects would obviously greatly improve the quality of the finished product; also the more uniformly heat can be applied to all parts of the piece, the more uniform will be the hardening or tempering. These two factors are positive and constant in their desirability for all ordinary work. The third factor—the degree of heat—is the variable quantity. It is this factor, the temperature, that is chiefly manipulated to meet the requirements of different steels and of the same steels for different purposes. While other conditions have a certain influence, the temperature is the controlling factor in all heat-treatment. The evil effects of too high a temperature—the common failing—are well understood.

The length of time during which the steel is actually heated is an important point closely connected to that of the temperature. With a heating chamber of sufficient size to supply the necessary heat to the piece, the internal change in the steel that results in hardening can be effected, in general, in one of two ways; either the piece may be heated for a short time at a relatively high temperature, or for a longer interval at a lower temperature. Both may produce hardness. The writer has seen fractures of small pieces of steel which after preheating were heated for but thirty seconds at a temperature 300 or 400 degrees higher than the hardening point, that compared very favorably with similar fractures of the same steel heated for four or five minutes at a temperature but little above the critical point. Thus the quantity of heat absorbed by the piece being treated is seen to be practically a product of the temperature of the heating chamber and the time the piece is left in it. In other words, the time of heating varies inversely as the temperature of the chamber in which the piece is heated. This still further emphasizes that "temperature should be the controlling factor," because, of the two extremes, the ordinary dangers of burning the steel on account of too high a temperature, and of causing it to crack due to too rapid, irregular heating, are far greater than those of "over-soaking" at lower temperature. To heat at the lower temperature is plainly the safe course, due both to its cutting down the grave danger of over-heating and to the greater uniformity with which heat is absorbed by the piece.

It is clear, then, that the heat-treatment of a particular steel can be greatly improved by definitely knowing beforehand the correct temperature at which it should be hardened. Also, when a large number of tools of approximately uniform sizes and shapes are being handled, the time necessary for proper heat absorption should first be determined, using an experimental tool that represents a fair sample. It will be found that the time element varies practically in proportion to the thickness of the steel. From the furnace standpoint, therefore the accurate and flexible control of the temperature is a most important consideration. A positive means, such as a pyrometer, for indicating at any time just what the temperature is, becomes, of course, an incidental requirement.

Until recently, the only known way of producing heat of the required intensity was by combustion—the burning of some fuel. The attendant disadvantages of this are well known. The crude open coal forge is capable of heating the steel, but leaves much to be desired as regards the quality of the heat, its uniformity, and the temperature control. In order to produce heat at all, the carbon in the coal must be combined with the oxygen of the air, and a strongly oxidizing flame is unavoidable. The steel exposed to this action, or to the inevitable results of it suffers accordingly. The coke-burning furnace offered some improvements, but only in detail. Now there are highly-perfected furnaces for burning oil and gas, and some of these offer still further advances, but the principle at the basis of all of these is the same—there must be a "burning" process to produce the heat; oxidization must be present with all fuel-combustion furnaces.

Through what means, then, may we obtain the proper quality of heat, uniformly applied, and of the right degree? The electric furnace for the heating of steel brings the answer. It overcomes all the objections to the "combustion process" by introducing a new principle.

Electric Heat

The heat of the electric furnace is produced in an entirely different way from that of the process of combustion. Electric heat can be produced by means of the electric arc, as in the arc lamp, and by the resistance of a conductor, as in the incandescent lamp. It is the latter principle—due to its greater flexibility and convenience—that was utilized by Albert L. Marsh in the electric furnace developed by the Hoskins Mfg. Co., Detroit, Mich., for the heat-treatment of steel. Fig. 1

shows a complete furnace of one of the larger sizes, the chamber in this being 18 inches deep (front to back), 12 inches wide and 8 inches high. The two hand-screws, directly under the operating shelf, are for the temperature regulation. In Fig. 2 the relation of the various constructional parts is clearly shown; *A* shows the fire clay insulation; *B*, the carbon connector plates; *C*, the graphite bottom plates; *D*, the draft hole; *E*, the pyrometer hole; *F*, the electrodes; *G*, the resistor plates; *H*, fire sand; *K*, cement filling; *L*, the inlet for the water used for cooling the electrode clamps; *M*, the outlet for this water; *N*, the electrode clamps, and *O*, the pressure regulating screws. The electrodes are surrounded by asbsetos at *P*.

The full length of the side walls and the entire roof of the chamber are formed by the heating elements; the walls are composed of a series of thin carbon plates resting on the top of a heavy block of the same material, and the roof, of a thick graphite plate connecting these two columns at the top. One graphite electrode projects up to the middle of each side-wall plate and connects electrically, through water-cooled clamps at the lower end, with the source of energy. The chamber floor is of cement. Outside of the carbon plates there is a lining of the same material. This lining, with a carefully designed backing of heat resisting material, retains the heat developed within the furnace. The counterweighted door fitted with a peep-hole serves as a quick access to the chamber, while in the rear wall are holes for the insertion of a pyrometer tube and for draft regulation. A rigid enclosing case of steel holds all parts securely.

The principle of operation is simple. A heavy low-voltage electric current is supplied through the electrodes to the resistor plates forming the side walls of the working chamber. Heat is generated here, due to the resistance offered by these plates to the passage of the current. The electrical "resistivity" of the carbon causes each plate to heat exactly as the carbon filament in the incandescent lamp "lights" when the current is turned on. In addition to this action, advantage is taken, in the furnace, of a second form of electrical resistance —that of the contact of one plate with another. This may be readily varied by altering the mechanical pressure on the plate columns by means of the hand-screws. The turning of these, changes the resistance of the circuit and hence the resulting temperature produced.

While the furnace is "electric" in its nature, it is not at all necessary that the hardening man handling it be an electrician. The simple electrical features of the furnace are quickly grasped. It is also safe, both because it practically eliminates the fire hazard and because it brings a corresponding protection to the operator. Normal working temperatures are acquired in a little over an hour's time after the switch has been closed. An average of 12½-kilowatt energy consumption will maintain the chamber at approximately 2250 degrees F.; higher temperatures, up to 2500 degrees F., which is even above the requirements of high-speed steels, or lower, as desired, may be obtained by increasing or decreasing the energy supply.

The life of the various parts of the heating unit is shown to be from 150 to 200 operating hours (for the side-wall resistor plates) to 500 hours (for the electrodes). Based on ten hour day operation, it is found that the upkeep cost of these items, even on this larger-sized furnace, is less than 40 cents a running day. The rest of the furnace does not depreciate rapidly.

The Advantages of Electric Heating

The atmosphere in the heating chamber of the electric furnace is inherently "reducing" in its nature, due to the fact that the hot carbon plates absorb all of the atmospheric oxygen. By raising the door slightly, and opening the draft-hole at the rear, a slight current of air may be admitted which will counteract this tendency. Leaving the door open slightly more would allow an excess of air to enter, so that an oxidizing atmosphere could be produced. Between the extreme points fine shades of atmospheric conditions can be obtained. Thus the quality of the heat can be absolutely and easily regulated.

Because of the arrangement possible with the electrical resistor, the heat may be generated within the working chamber itself. In the furnace described, the very walls of this chamber constitute the heat-generating device. The "resistivity" of the carbon plates is uniform—the same electric current runs through them all—with the result that an equal radiation of heat into the chamber takes place from practically every point in the walls.

In any type of furnace the temperature is varied, within limits, by varying the amount of energy transformed into heat. The regulation of the energy supply thus becomes the means of the temperature control. The electric energy control lends itself with exceeding exactness to meeting this principle. In the furnace described both a very fine and a wide regulation of temperature may be obtained by slight variations in the mechanical pressure between the carbon plates.

Commercial Importance

Mr. Samuel S. Roberts, testing engineer of the Carnegie Steel Co., is among the men who are carefully investigating the subject of steel heating furnaces. In an interesting report of a series of tests which he, together with a number of steel experts, recently made on the heat-treatment of carbon and high-speed steel tools in the electric furnace, he says in part:

"A realization of the inadequacy of the prevailing furnace designs usually employed for the specific purpose of hardening and tempering specially formed tools of high-speed steel, such as formed milling and gear cutters, twist drills, taps, threading dies, reamers and other tools that do not permit of being ground to shape after being hardened, and where any melting or fusing of cutting edges must be prevented, has created a demand rather than prompted the large tool steel consumers to welcome the advent of refined heating appliances, whereby the destructive influences hitherto encountered, are eliminated.

"The modern electric resistance furnace, with its perfect heat control, evenly distributed heat maintenance at any desired point, reducing atmosphere, absence of all products of combustion, and thermo-electric pyrometer for measuring the temperature, offers not only the most attractive method whereby the consumers of tool steel are insured maximum efficiency, but has caused the science of treating the rapid cutting tools, to take a long step forward."

The commercial importance of increasing the endurance and efficiency of the some 2400 cutting tools that Mr. Roberts points out require special heat-treatment monthly at the Homestead Steel Works, is self-evident.

Practical Application

As to the cost of operation, it is a demonstrated fact that the higher the temperature it is desired to produce, the lower the cost of electric heat in comparison with fuel heat. At the lower ranges, considering only the production of the necessary heat alone and with electric power at the usual commercial rates, heat from this source costs considerably more than heat from fuels, especially the cheaper ones. Where water-power supplies of electric current are available, this ratio decreases in favor of electric heat; but the cost of producing the energy for the heat-treatment is only a part of that of the whole operation involved. When we consider that this broad factor includes the resulting service of the finished tool, as well as the labor, material and overhead charges to produce it, we see how comparatively small this part is. It is from such a view of the entire cost of production that the improved hardening of steel in electric heat is seen to be a real economy. The electric furnace, due to its advantages, makes possible a higher quality of product than is possible with fuel heating.

* * *

The immense inertia overcome and the speed developed in electrically-driven machinery of recent years is almost inconceivable. One example is that of the reversing motor drive for a large plate mill installed by the Crocker-Wheeler Co. last year in the works of the American Sheet & Tin Plate Co., at Gary, Ind. The weight of the revolving parts of the reversing motor is about 100,000 pounds, and it is ten feet in diameter. The reversing of this motor and of the rolls from fourteen revolutions per minute in one direction to fourteen revolutions per minute in the other is accomplished in the amazingly short time of nine-tenths of a second. This means that this electrically-driven mill reverses more quickly than any other of its class. Thus a point on the face travels in one minute a distance of 15,708 feet or practically at a rate of 180 miles an hour. Power for operating this reversing motor is supplied by a motor generator set having a 60,000-pound steel flywheel ten feet in diameter running at 500 revolutions per minute.

HOW CAN THE MECHANICAL JOURNALS BE MADE OF THE MOST VALUE TO THEIR PATRONS?*

By FRED E. ROGERS†

The answer to the question can be put in one word, and that is cooperation. This paper will then be for the most part an explanation of my views on what cooperation between the reader, advertiser, publisher and editor means and how it can be promoted. I am, of course, addressing men who are chiefly interested in the machine business, but much that is said applies to technical journalism generally.

Trade and Technical Journals.—The term "trade journal" is indiscriminately and improperly applied to many specialized publications. A trade journal is one that is exclusively devoted to the news of a trade, giving prices, sales, accounts of new projects, changes in personnel of concerns, combinations and other matters of a purely commercial nature. This term cannot be properly applied to the leading mechanical journals, as they are really technical publications containing little of a purely news character, as news is regarded by the daily papers. They are chiefly given over to the science and practice of a specialized business and are recognized mediums for the exchange of the best ideas on theory and performance. They are, in short, the invaluable records of progress which have materially assisted in the upbuilding of the industries they represent.

Specialization in Journalism.—Not many years ago the leading journals in the mechanical field published matter on railway operation, locomotive running and repairs, car building, machine shop practice, general manufacturing, steam engine and boiler design and construction, foundry work, bridge building and many other topics with which the old-time engineer was supposed to be generally conversant. In America there is now a well-defined specialization among engineers, and the technical journals are sharply differentiated by the subjects to which their pages are chiefly devoted.

Printing and Publishing.—Contrary to a not uncommon belief, the business of publishing periodicals is quite distinct from printing them. Not all publishers are printers any more than all printers are publishers. I mention this to show that the business of publishing a technical journal is somewhat intangible, consisting essentially of an organization having three definite objects—first, to produce a journal which readers will subscribe for; second, to obtain a circulation which makes the advertising space valuable to manufacturers in its field; and third, to secure advertising patronage from the manufacturers in the field which the journal represents. This is the logical order in which these different departments of the business should be placed, but frequently inexperienced publishers endeavor to reverse the order, putting the advertising first and the circulation last. Advertising is necessary for any periodical under present conditions, and the advertising income is more than three-quarters of the total. The subscription income is barely sufficient to pay for the white paper and postage.

But though I have placed the editorial function, that is, the collection and presentation of suitable reading matter in the first place it is really one leg of the tripod on which a publishing business is supported. The reading matter is that which gains and holds a paid circulation among the men to whom the products displayed in the advertising pages appeal; without circulation the advertising will not bring returns; and without advertising patronage the modern trade journal cannot be maintained.

Value of the Reading Pages.—For the sake of emphasis we will expand a little in following around the circle of relative values. It is the circulation of a paper which gives the advertising pages their value, and it is the reading pages which maintain that circulation, although we are not unmindful of the fact that a paper may be of little value, or it may contain no matter at all, and still have a circulation. There is a vast difference, however, between a paper containing high-grade technical matter and one having little or no material that would interest an engineer, superintendent or foreman. One is creative, the other a drone in the hive; one educates and contributes much toward mechanical development by the interchange of ideas between superintendents, designers, foremen and machinists, whereas the other is a non-producer and contributes nothing. The real value of a mechanical journal, then, can be gaged to a large extent by the educational value of its reading pages, because the demand for modern equipment is directly proportional to the knowledge possessed by those who are to use the equipment. A journal without interesting reading pages has no backbone. What that means is clearly stated in the little girl's definition: "The backbone is something that holds up the head and ribs and keeps one from having legs clear up to the neck."

Technical Advice.—Every technical journal acts in an advisory capacity to many readers who look to it as being an authority on machine design, mechanics, kinematics, patent law, mechanical history, etc. We have no fault to find with this attitude, but encourage it, as we believe that while it is not the province of a technical journal to run a free consulting bureau on every topic, we do feel that there are many subjects on which the readers naturally turn to us for information, and which is practically their inherent right. To make our work of greater usefulness we have recently retained a well-known engineer in a consulting capacity to advise upon those technical matters in which he is especially proficient. I mention this to show you what our conception is of the relation of a trade or technical journal to its readers.

While it may be that the problems that stump you will also stump the editor unaided, remember that he is in close touch with an army of men—machinists, toolmakers, draftsmen, engineers, superintendents and others—who are up against almost every conceivable problem in the world of mechanics. Your mechanical perplexities turned into the editorial sanctum will act as suggestions, if nothing more, for articles and editorials on subjects of timely and vital interest. You probably know that the mechanical journals receive many more contributions than they can publish. The ratio of articles rejected to those accepted in the case of the journal I represent is about as one to one. More than fifty per cent of the number offered cannot be used. Many of these articles are well written and sound in argument. Their rejection is mainly due to lack of available space. No doubt in some cases we return articles that would be very helpful to some and which we would have used in preference to others had we received an intimation from any reader that he was interested in the subjects treated.

Make Advertising Interesting and Instructive.—The advertising pages of a mechanical journal should be and can be made as interesting and as instructive to the progressive and ambitious mechanic, whatever his position may be, as the so-called reading pages. Years ago mechanical journal advertising was stereotyped and lifeless; it was hardly changed from one year to the next. Electros were run until worn out and changed only when the advertising solicitor came around to secure a renewal of the contract. We believe no advertisement should be repeated consecutively, and that the copy should be changed every issue; also that those who devote as much attention to the furnishing of live copy as to any other branch of their selling organizations will realize as definite results.

The advertisers should cooperate with one another as well as with those who publish the journal. It may seem strange to speak of cooperating in an arena where you are seeking to gain advantage over competitors, but it can be done. To show what I mean let us think of a plant that is to be equipped with machine tools for building, say, gas engines. The engineer who selects the equipment will first decide on a certain number and size of so-called standard machine tools to be installed. In other words, he plans an ideal shop according to his understanding of the needs of the case and then specifies in general terms the equipment that should be purchased. He has planned for that which certain ones of you will furnish. Now why can there not be established an understanding between groups of machine tool builders to the end that they will advertise in harmony, having in mind certain combinations of equipment which are most often specified? Take, for ex-

* Paper read before the semi-annual convention of the National Machine Tool Builders' Association, Atlantic City, N. J., May 16-17.
† Editor of MACHINERY.

ample, ten machine tool builders. They could use ten pages of advertising space in conjunction to much greater advantage than when working independently. In this space plans and specifications of much value could be set forth and the references to the various makes of tools would be read with an entirely different understanding by a large part of those whom you seek to interest. This, of course, is a very rough idea, but I leave it with you as a suggestion for cooperative work in plant engineering that may be worthy of your consideration.

Photographing Work of Interest.—You should know that a camera and a dark room properly fitted up is one of the best investments for publicity that you can make. It is not necessary to hire a regular photographer, if the amount of work is comparatively small; the equipment can be turned over to one of your men who has a taste for photography, with instructions to photograph every interesting job of work having features out of the ordinary; also to photograph the erecting floor regularly, say once a week. These photos should be dated, and a sure way to prevent confusion is to display the date in the foreground, using a suitable changeable sign for the purpose. These photographs will serve you in more ways than one. They will give you a record of the shop conditions from week to week and in the case of special work often secure valuable publicity. Editors traveling in the interest of their publications are hungry for such photographs and will often gladly publish them with descriptions. To make these photographic records of the greatest value they should be accompanied with memoranda giving the main features of special work, such as weight of castings, time of operations, nature of operations, tools employed, etc. These photographs are, of course, valuable also for your catalogues and advertising.

Editors and Advertising Men.—One of the things that distresses the editor is to be mistaken for an advertising man and to be treated as such. In the first place he feels that his salary is not commensurate with the responsibilities of that exalted job, and in the second place his training has not given him that confidence of approach which is one of the best assets of your successful "ad" man. But although the editor does not come to you as an "ad" man, he nevertheless believes in advertising and will gladly advise you about advertising copy and the best way to obtain the widest publicity for your new machinery and tools.

This subject of publicity for new products is, by the way, one of the greatest importance to you. Every manufacturer should know how to introduce his new products to possible customers to the best advantage. He should know that a description of a machine embodying new principles or combinations is news matter to the field covered by the journals and is so regarded by their editors. But news is no longer news to an editor when it has been published by his contemporaries weeks or months before being offered to him. It may be argued that the competing journals do not go to the same general readers, which is in the main true, but they do go to the same advertisers; and the moral effect of stale news is detrimental in the long run to the journals that publish it.

"Write-ups" and Descriptions.—All of you, of course, are aware of the great change that has come about in the ethics of technical journalism during the past few years. Twenty years ago an advertising contract in a mechanical journal virtually carried with it the right to publication of "write-ups" of any old tool or machine at the discretion of the advertiser, without regard to the value of the matter or the truth of the claims made for the machines. The technical journals were worked to take as much of this free advertising as the editors would stand for. One firm of machine tool builders actually used to send electros requiring a full page space. Today none of the leading technical journals will insert anything of this character; the use of reading matter is strictly based on its merit, and if this policy is consistently adhered to no manufacturer has just cause for complaint. No journal that is filled with write-ups can obtain or hold any considerable number of readers, and without the readers of course the advertising space has no value.

You can help the editors and that means benefiting yourselves when writing descriptions of new things to include all matters that a customer is likely to inquire about. No doubt many points obvious to you may seem trivial, but on the plan of leaving nothing in doubt, put it down in black and white. A specification list is the most useful data you can furnish if disinclined to write letters fully describing the features, but never omit to call attention to those points in which the machine differs from its predecessors. Standard engine lathes are about the most difficult things to describe enthusiastically, but even these can be made interesting to possible buyers by giving spindle bearing dimensions, weights, back-gear ratios, power of motors required, etc.

Eligibility of Descriptions of New Products.—The specialization of technical journals and consequent narrowing of the fields to which the editorial pages are principally devoted, of course restricts descriptions of new machinery and tools generally to those classes displayed in its advertising pages. This may at first appear to be a narrow policy, but it is founded on very good reasons. First the demands for space in the reading pages for descriptions of new products often tax the available space to the limit, and second the appearance of those things that are distinctly foreign to the general character of the reading matter lowers the tone, being, of course, uninteresting to the average reader. For example, a description of a new road roller in a journal devoted principally to machine shop practice, machine design and closely related topics could not be justified on the ground that the subject is of general interest to the readers of that publication. The only justification for publication of a description would be that the mechanism is inherently interesting and that novel principles are employed that might be applied in other machines, and for that reason would be of interest to designers.

The test that you can readily apply to determine for yourselves whether a description of a new product would be welcomed by the editor of a technical journal is to decide whether or not you would advertise it in that journal. If you believe that advertising would pay, that means the general character of the journal should appeal to the class likely to be interested in your new machine.

Syndicate Matter.—If you have a piece of general news matter for distribution among technical journals it should be sent to the selected publications with a letter stating frankly that it is being sent to several and setting a release date, that is, a date some days or weeks ahead when it is to be published. This practice of syndicating, borrowed from the daily and weekly newspapers, is not favorably regarded by the editors of technical publications. Newspapers circulate in a limited territory, having a radius of say three or four hundred miles. The technical publications go all over the world and though not two per cent of the ordinary subscribers regularly read more than one, manufacturers often subscribe to several and their engineers see them all. The cheapening effect of the same articles in all makes the distinction obvious. However, the distribution of syndicated matter will often result in publicity in many journals in the way of extracts, abstracts and editorials, and some will publish in full. The editors under such conditions feel free to make such use of the matter as their judgment dictates and if you play fair with them they will generally be good to you.

Illustrations.—Remember that the day of the electrotype for editorial purposes, in the mechanical field at least, has practically passed away. Don't waste postage by sending electrotypes of your new products to illustrate descriptions that are to be published in the reading pages. They rarely will be used. In the first place they are hardly ever of the right width to suit the columns, and in the second place the style is hardly ever in harmony with the style of illustrations used. Instead of sending electros, send good photographs, either gelatine prints or glossy velox for halftones and regular blueprints for line illustrations. If the photographs have required much retouching to bring out details clearly you can keep them in your possession and send photographs of the retouched photographs. For line illustration copy it is not necessary to go to the trouble of making special drawings without dimensions. Simply blue pencil the dimensions and parts you do not want used. All that the editor is generally concerned with are the principles of construction and operation, and dimensions are preferably omitted.

Changes in Personnel.—We welcome all news regarding changes of personnel in your organizations. These should be sent to the journals in all cases whether they are to be published or not. Of course important changes should always be published for the information of those who have dealings with you in any way. So much for the business side. Recognition of the personality of employes is a policy that almost invariably pays and often you can please a man immensely without unduly swelling his head by sending in a personal item on his promotion to a position of some importance.

Catalogues and Other Literature.—All new catalogues and other advertising literature should be sent to the journals in your field as soon as published. We strongly advise that a letter be sent at the same time advising that the matter has been sent and calling particular attention to the new machines and tools listed. You will be pleasantly surprised sometimes no doubt to have your own words used in the notice if you have taken pains to express accurately and concisely what the contents are. Now don't think that we want you to fix up everything nice and easy so that we will have nothing to do, but on the principle that tne knowledge anyone has on a given subject because of his intimate connection with it is better than that of one who can only devote a few moments to it, we ask for an expression of your ideas of what should be of general interest in your line to our readers.

Criticism.—Criticism is of two kinds—constructive and destructive. We call the latter "knocking" and no one relishes it, but all enlightened men, which, of course, includes all editors, welcome honest criticism of their publications, by which we mean the pointing out of mistakes and errors of statement. I suggest that you can do no greater service to the technical press than by systematically writing to the editors and telling them which articles you like best and which ones do not meet with your approval; by this I mean, the collective opinions of your men as well as of the management. These criticisms should be made with the knowledge that the editors endeavor to publish matter that will be helpful to men in every mechanical pursuit besides the building of machine tools.

Playing Favorites.—Don't believe that editors favor one concern at the expense of another. If your competitor gets considerable free publicity in the reading pages, you may be sure that "he has the goods" and has afforded the editors the opportunity to see his practice and describe it fully. They will be glad to do the same for anyone else and will be your willing slaves if you have stuff for good copy.

Discussions and Disputes.—Sometimes an article will be published, perhaps unconsciously, in the interest of a competitor which puts forth certain claims that you take exception to. You are entitled to a hearing and should take advantage of the columns of the same paper for a rebuttal if you have a good case, but that rebuttal should never descend to abuse or personalities, for it is not likely to be published if it does. Do not put the editor in the "undesirable citizen" class because of such outcome without carefully weighing the case and looking at it from all possible points of view.

Filing Articles for Future Reference.—Hardly any engineer commits to memory a large number of rules and formulas for deducing the strength and proportions of machine parts. The volume of specialized mechanical lore is so great that the human mind cannot retain in an orderly and workable shape the mass of data available. The engineer's education is chiefly on means and methods of applying a science, the record of which is mostly in books and periodicals. To apply the known laws accurately we must employ the methods of mathematical analysis. Hence the engineer is more or less of a mathematician in his manner of thought and the way he attacks a given problem. But in order to profit most from what others have done as recorded on the printed page, systematic records are necessary; hence the importance of keeping card indexes of the articles in the technical journals in your field. The present speaker is not in favor of clipping files where space is available to keep the bound volumes of the journals themselves. A clipping file is generally of value to the compiler only, and to even him its value is problematical. A change in his position, or a change in the activities of his concern may make necessary an entirely new line of research and if his bound volumes are available the articles that he previously cared nothing for may have become of great value.

Manufacturers should keep files of the leading journals in their industry properly arranged and indexed for the benefit of the engineers or draftsmen. The latter can hardly afford to do it for themselves. Many a man is working over a drafting-board for a draftsman's salary who is truly an engineer within the limited range of his activities and should be credited with all the ability he displays and be encouraged to keep records of engineering data at your expense.

Trade Secrets.—One of the troublesome things that gall editors is the attitude of many manufacturers toward "trade secrets" and alleged trade secrets. We realize that commercial prestige and success in some cases depend upon keeping certain processes and methods closely guarded, but in the manufacture of metal products there is very little indeed that is not known to a large number of men who are well-versed in their trades. The plant that excludes visitors in order to keep its specialized knowledge *in*, by that policy generally keeps *out* the knowledge of what is going on elsewhere. A close corporation—close in the sense of keeping its methods secret—will eventually die of dry rot. A policy of secrecy puts the management at the mercy of its superintendent and foremen and workmen. The writer has found in a few cases that superintendents foster the idea that many of the methods introduced by them are original and should be carefully guarded, when as a matter of fact they originated elsewhere. These employes build themselves up by deceit and lull the management into a state of fancied security when their supposed monopoly of special processes has existence only in their imaginations.

Now as to the best policy to accord to editors in regard to real secret methods. It is our belief that the best way to guard them so far as general publicity is concerned is to take the editors of reputable journals into your confidence and show and explain to them the general principles employed. You will thus preserve the methods from publication in the first place if they are actually known only in your plant, or in the second place you may learn that you have been deceived and that your supposed secret is no secret at all.

To illustrate how effectively the confidence of a manufacturer may safeguard his interests, the following example is taken from personal experience:

A manufacturer of small tools notable for his courtesy to visitors some years ago personally conducted the speaker through his plant and in the course of the inspection showed him the principal features of the toolmaking practice followed in making certain tools. This work was of extraordinary interest, and permission was asked to publish a description, which was courteously denied for good and sufficient reasons. In the course of a few weeks the editor received a contribution describing minutely a system of making tools that seemed strangely familiar and which upon reading closely was recognized as a literal description of the practice of the concern mentioned, although no name was given. Of course we could not publish that article, much as we wanted to. If our friend had not taken us through his plant and shown us his practice, we would have known nothing about it and would naturally have published the contribution. The fact that the article has never been published elsewhere leads us to suspect that other editors also have been muzzled in this very effective manner.

The Advantages and Disadvantages of Publicity.—A manufacturing enterprise that produces dividends for its stockholders has to solve two main problems which are: the making of a product and the marketing of it. That the manufacturing of most goods is easier than selling them is generally conceded. It is a curious anomaly of our present commercial system that to induce a customer to purchase a thing he wants and intends to buy often costs more than to produce it. Whether this condition is due to the machinations of the middlemen, the stupidity of customers, or economic relations too subtle to define, is not our province to determine. The fact is that publicity is the breath of life of modern business.

The cautious man objects that his competitors will find out all about his methods, and says that would never do. The cautious man is right in saying that his competitors will learn about his methods—but most of them they already know. They will know, however, what the methods of the cautious

manufacturer are and that may be of some disadvantage, even if they are common to the industry. In fact, general advertising sometimes works to one disadvantage in that it usually stimulates competition; but that is unavoidable. The thing that must be kept clearly before the manufacturer's eyes is his public. What matter if he does give away some information to a few competitors, when at the same time he gains the appreciation of thousands of possible customers? Let the manufacturer educate his public and take them into his confidence and never mind about the competition. When he has the public tagging after him the competitor will have to do some shouting for himself to keep the wolf from his door.

Technical Journals Educational Forces.—The technical journals should be recognized as one of the most valuable aids in selling machinery and accessories. The reason is, they are educational. To sell anything you must first create a demand. There are several ways of creating a want for that which you produce. Your salesmen can go to manufacturing plants and tell their managers all about the economy and accuracy of your machines; you can tell the same story by advertising, but lastly and most effectively your representative journals by editorials, descriptive articles and discussions of the principles of design create in the minds of your possible customers ideals which you will be required to fulfill. In other words the educational force of the technical journals rightly directed influences users of machinery unconsciously to want the best that is produced. Thus the more you help to make the mechanical journals more valuable to their readers, the more you contribute to your own success.

Help us to help you.

* * *

AN EXPERIMENT IN EXTRUSION*

By CHESTER L. LUCAS†

The success with which aluminum, copper, and brass tubes and shells have been made by the extrusion process led the writer to experiment with the extrusion of wing-nuts and similar articles. While the results of these experiments were not wholly satisfactory, an outline of the work done may be of interest, and should be of value to others working along the same lines.

Most of this experimenting was done in trying to produce a brass wing-nut similar to that shown at *A*, in Fig. 1. The wing-nut, with its principal dimensions, is also shown in the line engraving, Fig. 2. The desire to produce such a piece arose from the fact that on the outside of each of certain instruments that were being manufactured at the rate of two thousand per week, two of these wing-nuts were required. Cast brass wing-nuts were being used at the time, and as the rest

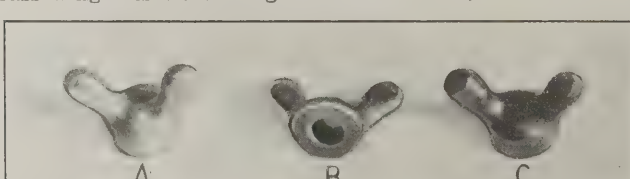

Fig. 1. Extruded Wing-nuts—A, Aluminum; B, Zinc; C, Brass

of the instrument was finely finished, the contrast between the rough cast wing-nuts and the rest of the instrument was marked, especially as the wing-nuts were not polished. A small wing-nut is a difficult piece to polish cheaply.

An experimental pair of dies was first made on the principle shown in Fig. 4. This first set of dies, however, was not as large in proportion to the size of the wing-nut as that shown in the illustration. First, a ring was turned from carbon steel, hardened and tempered to a very dark straw color, after which the interior was ground out true with the bottom face. Within this cylindrical opening were fitted the two die sections, which, together, fitted the interior of the ring closely. In the face of each of these sections one-half of the shape of the wing-nut was cut, so that together the two halves comprised a steel mold. It was very necessary to have the outline in one half match perfectly with the outline in the other half. Referring to Fig. 3, it will be noticed that the impression for the cylindrical part of the wing-nut was made considerably longer than that part of the nut itself. This was done to provide a guide for the extruding punch as it acted upon the metal.

The extruding punch was made of one piece of carbon steel, with its largest diameter ground a sliding fit for the ring; the smaller diameter was a sliding fit in the circular impression in the two die-sections, and the purpose of the pilot on the end of the punch was to form the central hole in the wing-nut. This pilot was made slightly tapering, so that it could be easily withdrawn from the finished work. Both sections of the

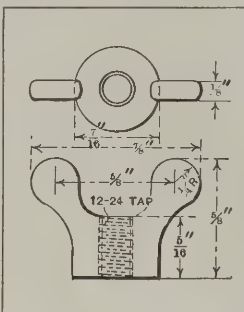

Fig. 2. Dimensions of Wing-nut to be extruded

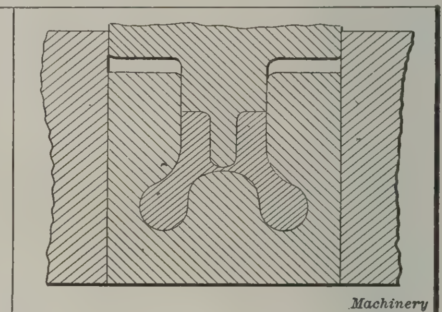

Fig. 3. Section of Die and Wing-nut after Extrusion

die, as well as the punch, were hardened, and the temper was drawn to a light straw color, except for the tip end of the punch, which was drawn to a purple color.

While the object of this die was to ascertain whether or not it would be possible to extrude a brass wing-nut, the softer metals were tried first, to see how the dies would work. Accordingly, a piece of lead was turned to 7/16 inch diameter, and several pieces, each about ½ inch long, were cut off. One of these pieces was placed in the die cavity as shown in Fig. 4, the punch placed on top and pressed in under a hand screw press. The dies were then pushed out of the ring, separated, and a perfect lead wing-nut was picked out of the dies. Aluminum was then tried in the same manner, with equal

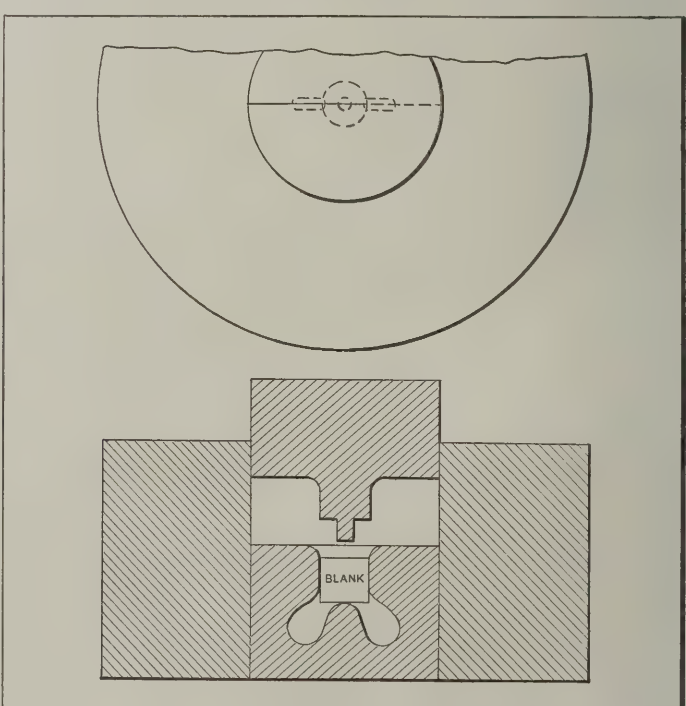

Fig. 4. An Extrusion Die, Punch and Ring, with Blank in Position

success, being extruded in the hand screw press very easily. Zinc, which is looked upon as a "dead" metal, extruded without trouble. Aluminum and zinc extruded wing-nuts are shown at *A* and *B*, Fig. 1. It was also found that several small scrap pieces of any of these metals could be used in place of a solid blank, and the resulting wing-nut was apparently as homogeneous and strong as one made from a solid blank. The pressure required for extruding seemed to unite the particles

* See MACHINERY, October, 1911, engineering edition, "The Extrusion Process"; November, 1911, "The Extrusion of Shells and Tubes"; December, 1911, engineering edition, "Making Collapsible Tubes by the Extrusion Process."

† Associate Editor of MACHINERY.

of metal in a permanent manner. By varying the amount of metal in the blank, the body of the wing-nut could be made longer or shorter as desired. It was not considered practical to put the hole entirely through the wing-nut when extruding, on account of possible injury to the die or punch; the idea was to put the hole nearly through and rely upon the tap in tapping to push through the remaining 1/64 inch of metal.

The extrusion process gave the nuts made of these soft metals considerably more strength than the cast brass wing-nuts possessed; in fact, the zinc and aluminum wing-nuts were very much stronger than the cast brass wing-nuts, but "their color was against them." As the studs upon which the wing-nuts were used were made of brass, and as the other instrument trimmings were also of brass, it was thought desirable to have these parts of brass also.

When experimenting in brass, however, the troubles began. Although the softest brass possible was obtained, and although all methods of annealing were tried, the pilot on the punch would invariably break before the extrusion had fairly begun. After making several new punches of different degrees of temper, it was decided to omit the pilot, drilling the hole in a subsequent operation. Next, trouble in the extrusion itself arose; the brass would extrude about half way into the wings, at which point the limit was apparently reached. In order to make the brass flow at all, a power screw press was necessary, and upon forcing the metal beyond the point mentioned, the dies cracked.

A pair of dies was then made from Ajax high-speed steel, and in the meantime the leading brass manufacturers were applied to for samples of their softest brass rod. The new dies proved to be all that could be desired, but the brass would not go beyond the apparent limit—half way into the wings of the nut. Upon striking harder blows with the press, a wing-nut, shown at *C*, Fig. 1, was produced. This wing-nut, except for the tip of one point, was "full," and several others, all more or less defective, were extruded. The few brass wing-nuts that were made were found to be extremely hard and close-grained; in fact, they were a great deal harder than necessary and would have been very difficult to drill and tap. After making two or three of these brass wing-nuts, however, the dies broke, owing to the excessive stress.

About this time it was decided that the extrusion of a brass wing-nut was impracticable, and the experimenting stopped. It would, however, seem as if it should be possible to obtain a grade of brass or composition having a faint yellow color that possesses some of the extruding qualities common to zinc and aluminum, or that at least would be softer than commercial brass. With such a metal, wing-nuts and similar articles could be easily extruded, and dies could be made that would work automatically, receiving the blanks from a hopper feed, and permitting the press to be continuous in its operation. If anyone else has had experience along this line, the results would undoubtedly be of interest and value if published.

[The question may be raised as to the propriety of including the foregoing experiment as an example of extrusion. The extrusion process ordinarily produces shapes conforming to the opening of a die, the product taking its ultimate form as it is ejected by pressure, exerted through a punch or ram. In this case the ears of the wing-nuts are not extruded beyond the die but are forced, by the pressure exerted through the punch, into cavities in the die which have the shape required to be reproduced. This process seems to be a combination of extrusion, and cold swaging or die-forging.—EDITOR.]

* * *

The U. S. S. *Florida*, which has just won the title of the world's fastest battleship, broke all speed records off the Atlantic Coast with propellers of monel metal. The *Florida* attained a greater speed than its sister ship, the *Utah*, which was not equipped with that material. Monel metal is very suitable for propellers. It has the strength of steel, shines like silver, and is less corrodible than bronze. The non-corrodibility is a strong asset, as it assures the propeller's cutting the water cleaner. Propellers of this material have been furnished battleships of the United States and foreign navies.

WUEST HERRINGBONE GEARS

Having read the article in the January, 1912, number of MACHINERY, engineering edition, entitled "Herringbone Gears," the writer is prompted to make a few remarks. Let

P = normal diametral pitch,
P_n = normal circular pitch measured on the normal helix (pitch measured on the pitch cylinder perpendicular to the face of the teeth),
P_c = circular or circumferential pitch measured on the circumference of the pitch circles,
N = number of teeth,
d = pitch diameter,
D = blank diameter,
α = angle of teeth with axis of gear. (In this case $\alpha = 23$ degrees.)

Then, for spur gears, with teeth cut straight, we would have:

$$d = \frac{N}{P} \qquad (1)$$

and for spiral gears:

$$d = \frac{N}{P \cos \alpha} = \frac{N P_n}{\pi \cos \alpha} = \frac{N P_c}{\pi} \qquad (2)$$

As herringbone gears are spiral gears, Formula (2) will hold true. In the article mentioned, however, Formula (1) is applied. Apparently, the author of that article assumes the pitch to equal a certain quantity p, as follows:

$$p = \frac{\pi}{P_c} = P \cos \alpha = \frac{\pi \cos \alpha}{P_n}, \text{ and } d = \frac{N}{p}$$

This, however, is not standard practice, as it is not p but P which is the quantity commonly called the diametral pitch in spiral gears.

Furthermore, in order to keep the center distance to some even dimension, the author simply reduces the pitch diameter of the gear to suit the center distance. By doing this, and keeping all the other quantities the same as before, the pitch of a gear is changed without changing the pitch of the pinion; hence, the gears will not mesh perfectly. The difference may be small, but interchangeability cannot be claimed on this basis.

Rheydt, Düsseldorf, Germany. G. R. HULSBERG

Reply by Percy C. Day, Milwaukee, Wis.

Your correspondent, Mr. G. R. Hülsberg, evidently finds it difficult to regard herringbone gears as spur gears. He has applied the same methods as are used for calculating ordinary spiral gears, and has complicated the problem to an unnecessary extent. Spiral gears are usually employed for connecting shafts which are not parallel to each other. Under these conditions the circumferential pitch of gear and pinion may be quite different, but the *normal* pitch of both must be the same.

In herringbone gears, if the spiral angle is made constant, there is a definite and fixed relationship between the normal and the circumferential pitch. This is the case with Wuest herringbone gears. It is a great convenience to discard all reference to the normal pitch and treat the gears just like spur gears on the basis of the circumferential pitch. When this is once done, it makes no difference whether the circular or diametral pitch system is used. It is, of course, necessary for the gear cutter to set his calipers to the normal tooth thickness, and if circular cutters or inclined hobs are used they must be designed for the normal pitch; but the designer of machinery involving the use of these gears need not be troubled with any such complications.

Wuest herringbone gears are cut by specially constructed hobs which are used with the hob axis perpendicular to the gear axis. The pitch of each hob, measured along the axis in the same way as the pitch of a screw is measured, is the same as the circumferential pitch of the gears which it cuts. The normal pitch line thickness of the hob is a matter for the toolmaker alone.

The point raised in regard to the use of enlarged pinions is not so easily understood and requires a clear definition of what constitutes the "pitch diameter" and the "pitch" of a gear.

Let us suppose that we wish to connect two shafts a and b by means of a pinion and gear. Let

L = distance between shaft centers,

$$V = \text{velocity ratio} = \frac{\text{R.P.M. of } a}{\text{R.P.M. of } b}$$

N_a = number of teeth in pinion,

N_b = number of teeth in gear,

R_a = pitch line radius of pinion,

R_b = pitch line radius of gear,

P_c = circular pitch of gear and pinion.

Then

$$V = \frac{R_b}{R_a} = \frac{N_b}{N_a};\ L = R_a + R_b;\ R_a = \frac{L}{V+1}$$

$$R_b = L\left(\frac{V}{V+1}\right);\ P_c = \frac{2\pi R_a}{N_a} = \frac{2\pi R_b}{N_b}$$

If the center distance and velocity ratio are given, then the true pitch diameters of the gear and pinion are fixed. Now it is well known that involute gears will run satisfactorily when set farther apart than the designed center distance. In other words, L may be varied to a limited extent. This variation of L does not affect either the number of teeth or the velocity ratio, but it alters the pitch. The foregoing arguments lead to the curious conclusion that the pitch of a pair of involute gears has no definite value, but depends on the center distance and velocity ratio. Conversely, if we maintain a fixed center distance and ratio for a given pair of gears, we can cut involute teeth in various ways without altering the pitch.

For instance, if we require a small pinion to mesh with a large gear, we may generate the teeth to standard thickness on their true pitch diameters or we may enlarge the blank diameter of the pinion and reduce that of the gear by a corresponding amount. The teeth will be generated from the same base circles in each case, and the true pitch diameters and pitch will be the same, but the shape of the teeth will be quite different in the two cases. The pinion which is cut on standard lines will probably have badly undercut teeth with consequent weakness and loss of wearing surface. The enlarged pinion, on the contrary, will have teeth with broad bases and unimpaired shape. Since the center distance and velocity ratio have not been altered, the true pitch circles and the pitch remain unchanged; but the change in outside diameters has increased the addendum of the pinion and decreased the addendum of the gear.

There is nothing new in this method,* as it has been in use on bevel and worm gears for many years; the most curious thing about it is that it continues to be so little understood by the majority of gear users. It is the writer's practice to give progressive enlargement to all pinions with less than twenty teeth and to reduce the corresponding gears in proportion, so as to maintain standard center distances.

An enlarged pinion will mesh correctly with any gear in its series, whether reduced or not, but if the gear is of standard proportions the center distance will be greater than standard by half the enlargement of the pinion. This applies to all involute gears with generated teeth, no matter whether they are hobbed, shaped or planed. When this method is applied to herringbone gears, the enlargement or reduction of the blank is left entirely out of consideration, and the machine is set to cut the correct spiral angle on the true pitch circle. Given a proper degree of accuracy in the cutting and reasonable care in setting up, such gears are perfectly interchangeable, bear evenly from end to end, and do not jam. There is no question of approximation. These methods have been in use for several years, and there are thousands of gears in service which bear eloquent testimony that your correspondent's misgivings have no foundation in fact.

* * *

It is stated in *Power* that hydro-electric installations in Switzerland have been developed and utilized to such an extent that there are some towns in that country where no coal is being used. Power, light, and heat are furnished by electricity throughout the towns.

* See also the article entitled "Noisy Gearing," published in MACHINERY, engineering edition, November, 1911.

MOTOR-DRIVE IN THE MACHINE SHOP*

By GEORGE H. HALL†

For the shop where electric power is already installed, all kinds of machine tools may be purchased completely equipped with individual motors. When, however, it is desired to institute a change in a shop that has been employing belts and shafting, and to substitute electric power, it becomes necessary to consider each of the belt-driven tools separately, so as to secure as nearly as possible the same results that are obtained with the tools built for motor drive. At the same time excessive expenditures in the alterations must be avoided. It is the purpose of this article to outline the principles of motor application, and to suggest methods by which the belt-driven tools may be accommodated to motor drive.

The first problem to consider is that of the transmission of the power. In large plants, covering acres of ground, alternating current is employed in order to permit the use of high voltages with the corresponding saving in the copper used for wiring. In plants consisting of but a few buildings, grouped fairly close together, the use of direct current possesses advantages in variable speed possibilities that far outweigh the gain to be secured by the use of the high-voltage alternating current. It is, therefore, the general practice at the present time to use 230-volt direct current for the operation of plants of the nature of machine shops, in which a large part of the load will consist of motors driving tools requiring variable speed. Where long transmissions make the distribution of power by alternating current a necessity, a motor-generator may be installed at the point of distribution for the purpose of supplying direct current to the variable-speed motors. This is often the system employed in the case of railway shops which are spread out over a considerable territory and contain a large proportion of constant-speed tools. Here the transmission current is 440 volts, alternating, and the constant-speed motors are operated on this current, while the motor-generator supplies 230-volt direct current for the operation of the variable-speed motors.

Types of Motors

In the first place the three types of direct-current motors should be thoroughly defined, so that the proper type may be selected for the particular tool to which the motor is to be applied. These three types are series-wound, shunt-wound, and compound-wound motors.

The series-wound motor is one in which the field winding is in series with, or forms a direct continuation of, the armature circuit, so that all of the current that passes through the armature passes also through the fields. The amount of current drawn from the line by a motor depends upon the work, or horsepower, which the motor is developing. It therefore follows that in the series motor the strength of the fields will depend upon the load which is placed on the motor, and as the speed of the motor depends inversely upon the field strength, the speed of the series motor will be inversely proportional to the load. Since the speed of a motor also depends upon the voltage that is impressed upon the armature, the speed of a series motor may be controlled by introducing resistance in series with the armature, and this is accomplished by means of a controller which is used also for starting the motor. The use of the controller enables the operator to start the motor slowly under light loads, and also prevents too great a flow of current when starting under heavy loads. The characteristics of the series motor are heavy starting torque and a speed dependent upon the load.

The shunt-wound motor is one in which the field winding is connected across the main lines, or is said to be in shunt with the armature circuit. The amount of current passing through the fields is inversely proportional to their resistance,

* The following articles on this and kindred subjects have previously been published in MACHINERY: December, 1911, engineering edition, "The Selection of Direct-Current Motors for Factory Use"; April, 1911, engineering edition, "Electric Motor Supports"; November, 1910, engineering edition, "Wiring on Motor-Driven Machinery"; May, 1910, engineering edition, "Methods of Applying Motors to Machine Tools"; April, 1909, engineering edition, "Improvements made by Motor-driven Tools in a Repair Shop"; February, 1909, engineering edition, "The Application of Motors to Machine Tools"; June, 1908, engineering edition, "Reliability of Motor Drives for Machine Tools"; January, 1906, "The Simplicity of the Electric Drive."

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and, except in the case of the variable-speed motor which will be treated later, remains practically constant under all conditions of load. This results in a constant-speed motor whose output, in horsepower, is dependent upon the current, in amperes, which passes through the armature. The characteristic of the shunt-wound motor is approximately constant speed under all conditions of load.

The compound-wound motor is one having both a shunt and a series field winding. The shunt field is connected to the main line as in a shunt motor, while the series field is in series with the armature and carries all of the current passing through it as in the series motor. The field of an average compound motor is composed of about eighty per cent of shunt winding and twenty per cent of series winding, although this proportion may be varied to suit the class of work for which the motor is to be used. The speed of a compound motor is more nearly constant than that of a series motor, but the drop in speed from no load to full load is considerably more than in a shunt motor, owing to the action of the series part of the winding. The characteristics of the compound motor partake of those of both the series and the shunt motors in about the same degree as the relative proportion of the two windings composing the field.

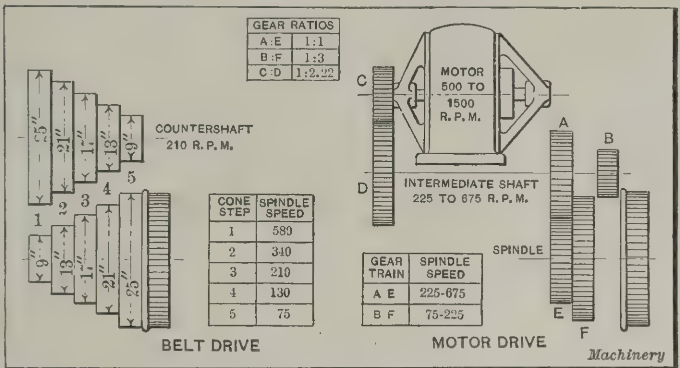

Fig. 1. Comparison of Belt and Motor Drive of Engine Lathe

Selection of Motors

To determine the type of motor to be employed for the different classes of tools in the machine shop, the character of the power requirements of the tools should be carefully analyzed. In the case of lathes, boring mills, milling machines, etc., in which the work of cutting is continuous, it will be seen that the tool is required to run at a speed which can be adjusted to the character of the work being machined, and when so adjusted, will remain practically constant. Also, the tool is usually started before the work of actual cutting begins, so that no excess of power is needed to start. The foregoing requirements correspond to the characteristics of the shunt motor, and for this class of work this motor should invariably be used.

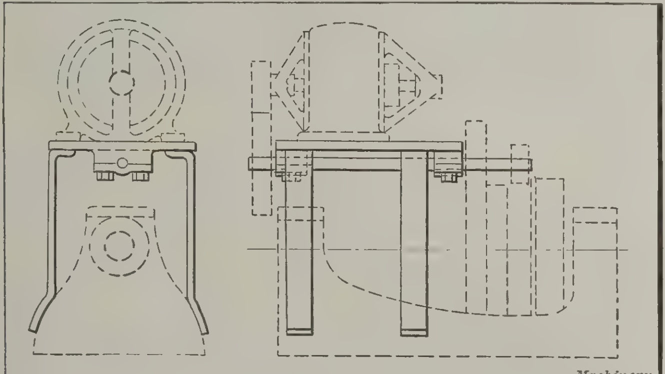

Fig. 2. Plate and Brackets for Supporting Motor

In the case of planers, shapers, slotters, etc., the work is intermittent, being far greater at some portions of the stroke than at others, and for this class of work the compound motor is best suited. The same type of motor is also used for the operation of punches, shears and other tools having heavy flywheels, as the motor will slow down at the period of greatest load, which is just after the completion of the stroke. The actual cut is effected through the inertia of the flywheel, and the maximum load on the motor is that of accelerating the flywheel and bringing it back to normal speed after it has carried the tool through the work.

When operating hoists and cranes, the motor must be started under the full weight of the load to be handled and at the same time slowly enough to prevent the shock of too sudden acceleration. These requirements are best met by the series motor with a controller having a heavy starting resistance, as it provides high torque at low speeds. This type of motor is also used for auxiliary purposes such as raising the cross-rails of planers and boring mills, traversing the carriages of large lathes, and elevating the tables of horizontal boring mills.

Constant-speed shunt motors are, of course, used for the operation of groups of machines that are driven by a common countershaft, but for individual drive the constant-speed motor is little used, as one of the greatest advantages of individual drive is the ability to vary the speed of the tool to suit the requirements of each piece being machined. This naturally brings up the question as to where the line should be drawn between tools that should be arranged for group drive and those which may advantageously be equipped with individual motors. No fixed rules can be laid down in answer to this question, but, in general, it is customary to group the smaller tools, as the initial expense of separate equipments for such tools as bench drills, tool grinders, emery wheels, and sensitive drills, often equals or exceeds the cost of the tools themselves. In the tool-room, also, the value of individual equipment is questionable, as the work on each tool is intermittent and there is not the demand for high efficiency from the tools that obtains in the case of tools used in the manufacturing departments. If the product of a given tool is especially valuable, or forms a very important part of the shop's output, the first cost of the drive is of minor consideration, and an individual equipment which will secure the greatest output is warranted.

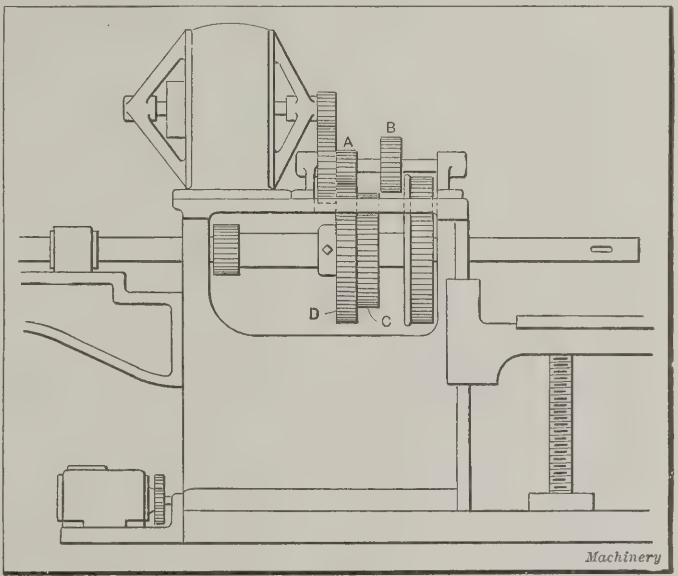

Fig. 3. Motor Equipment of Horizontal Boring Machine

Variable-speed Motors

Variable-speed motors, in the generally accepted use of the term, are, strictly speaking, adjustable-speed motors, in that the speed may be adjusted by means of a controller. There are two methods in common practice by which this adjustment of speed may be accomplished. These are known, respectively, as armature regulation and field control.

The first method consists of introducing resistance in series with the armature circuit, thereby reducing the voltage that is impressed on the armature. With constant field strength, as in a shunt motor, the speed of the motor will be directly in proportion to the impressed voltage. If the load on a motor remains constant, the speed will be inversely proportional to the resistance inserted in the circuit, as the torque is in proportion to the current in amperes, and the voltage equals the amperes divided by the resistance. From the

foregoing it will be seen that if the motor load varies, the voltage and, therefore, the motor speed will, with a fixed resistance, vary with the load.

Now, consider the output of the motor when armature control is employed; the torque, or turning effort, is proportional to the amperes drawn by the motor, while the horsepower is a function of the product of the volts and the amperes. Thus a motor developing a given horsepower draws from the line a definite amount of current and produces a torque corresponding to that horsepower. If, now, we cut the speed in half, by halving the impressed voltage, while the torque remains the same, the product of the volts by the amperes will be but one-half, and the motor will be delivering but one-half its former horsepower, although it will be drawing just as much current as when delivering the full horsepower. Thus it will be seen that this method of control is uneconomical and gives a speed varying with the load, while the demand of most machine tools is for a drive that will give a desired speed regardless of the load. In employing the method described it is almost impossible to secure slow motor speeds with very light loads. For this reason this method of control is but little used in connection with machine tools.

The second method, that of field control, is most generally used for motors employed in the operation of machine tools. With the voltage impressed on the armature constant, the speed of a motor will be inversely proportional to the strength of the fields. This field strength is directly proportional to the ampere-turns in the field, and as the actual turns of wire must remain constant, the ampere-turns may be easily regulated by inserting resistance in series with the field winding and thus decreasing the current in amperes passing through the field. The torque of the motor is, in this case, proportional to the field strength, and, as the field strength varies inversely as the speed increases, the horsepower of the motor will remain practically constant.

Considering the average class of tools, such as lathes, boring mills, etc., we can readily see that the foregoing motor characteristics correspond to the requirements. When the cutting tool is run at a high speed, the cut taken by the tool is light, and when taking heavy cuts, the speed is slow, thus calling for a practically constant horsepower throughout the working range of the tool.

As the field current is but a small proportion of the total current used by the motor, the total current consumption of motors using this type of control is practically in proportion to the work being done, so that this is an economical method. The speed, also, being regulated by the field strength, is independent of the load, so that for a given controller position it will be practically constant regardless of the power developed. As a matter of fact, the shunt motor with constant field strength will vary about 5 per cent from no load speed to full load speed.

Application of Motors to Machine Tools

Considering the application of motors to specific tools, we can best divide the problems presented into two classes. The first class comprises those tools in which the removal of metal is continuous, such as lathes and drilling machines. The second class contains those tools in which the removal of metal is intermittent, as with planers, shapers and slotters.

For use with machine tools of the first class, variable-speed shunt motors will be employed, and the next point to be considered is the speed range for which they must be adapted. For a given horsepower the size of the motor will be inversely proportional to the minimum speed, and as the use of gearing or chain drives places a practical limit on the maximum speed, the minimum speed, and consequently the size of the motor, will depend upon the speed range. The best idea of the actual results that can be obtained with field controlled motors may be secured from a table showing the outputs and speed ranges of a standard line of such motors. Although different makes vary somewhat in their ratings from those given in Table I, this gives a correct average of the various lines upon the market.

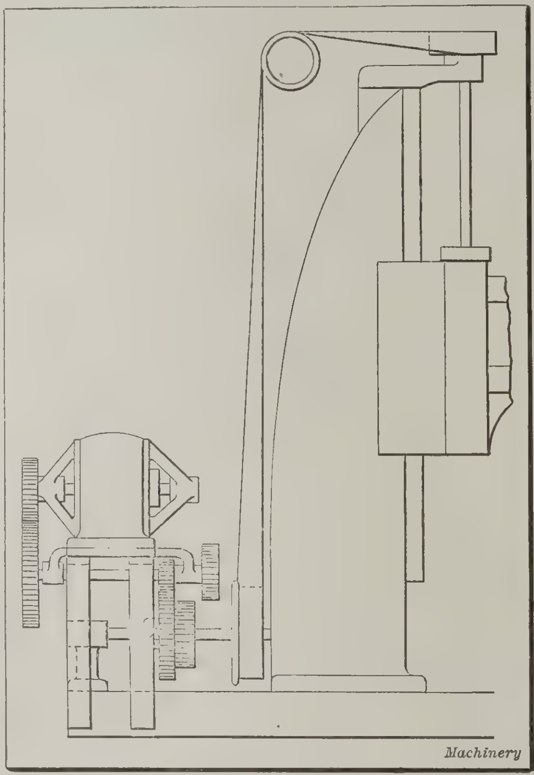

Fig. 4. Motor applied to a Radial Drill

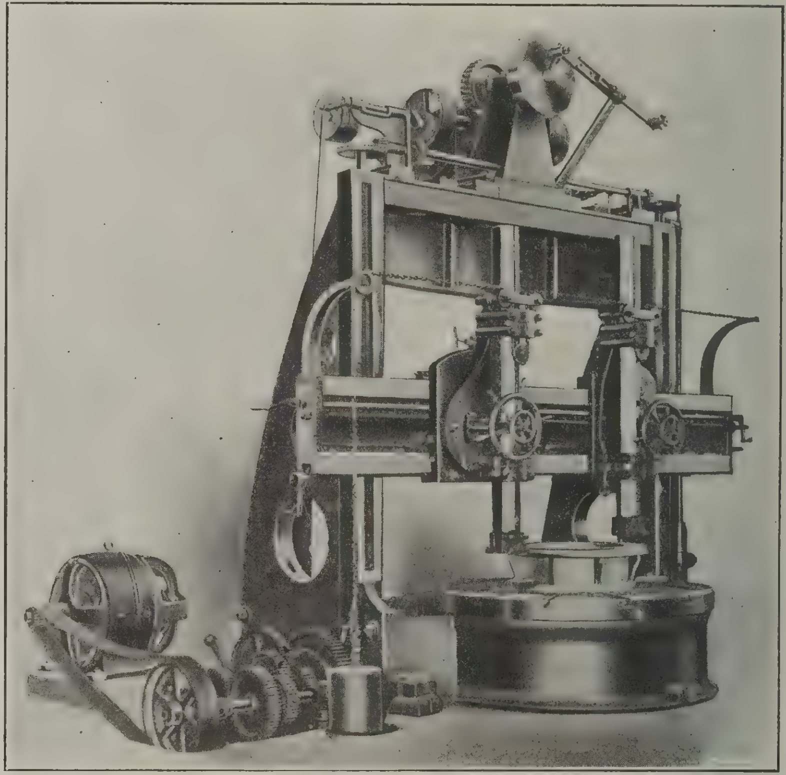

Fig. 5. Motor Equipment of Large Boring Mill

With a wide motor speed range, a larger part of the working range of the tool is, of course, covered than with a more limited range, but as it is impracticable to cover the entire working range of such a tool as a lathe or boring mill by a corresponding motor range, it is customary to use one or more mechanical speed changes to augment the electrical range. The problem is, therefore, to select a motor speed range that will give satisfactory results without involving too elaborate mechanical changes. Actual experience has shown that, under average conditions, a motor speed range of 2½ to 1 or 3 to 1, together with two mechanical speed changes, will cover practically any range of speed that is obtainable with a cone-pulley drive on any of the ordinary types of machine tools.

To show just how this works out, we will take an actual case of an engine lathe provided with a five-step cone pulley. In making applications to old lathes it is desirable to retain the back-gearing, while the cone is removed from the spindle sleeve and two gears mounted thereon as shown in Fig. 1.

The motor is placed above the headstock, on a bracket, and is geared to an intermediate shaft running directly below. This shaft carries two gears, *A* and *B*, either of which may be meshed with its corresponding spindle gear *E* or *F*. The en-

TABLE I. TYPICAL LINE OF VARIABLE-SPEED SHUNT MOTOR RATINGS

Frame	2 to 1 Range			3 to 1 Range			4 to 1 Range		
	H. P.	Min. R.P.M.	Max. R.P.M.	H. P.	Min. R.P.M.	Max. R.P.M.	H. P.	Min. R.P M.	Max. R.P.M.
No. 1	½ ¾	625 800	1250 1600	⅜ ¾	475 800	1425 2400	¼	500	2000
No. 2	¾ 1¼	525 800	1050 1600	¾ 1¼	525 800	1575 2400	⅝	415	1660
No. 3	2 2½	675 900	1350 1800	1½ 2	500 675	1500 2025	¾ 1	450 550	1800 2200
No. 4	2 3½	400 625	800 1250	2 3½	400 625	1200 1875	2	400	1600
No. 5	2½ 3¼	500 725	1000 1450	2½ 3¼	500 725	1500 2175	1½ 1¾	450 550	1800 2200
No. 6	2½ 4	400 550	800 1100	2½ 4	400 550	1200 1650	2½ 3	400 550	1600 2200
No. 7	4 5½	400 525	800 1050	4 5½	400 525	1200 1575	5½	525	2100
No. 8	5½ 7½	650 800	1300 1600	3¾ 5½	450 650	1350 1950	3¾	400	1600
No. 9	5 7½	325 460	650 920	5 7½	325 460	975 1380	6	450	1800
No. 10	10 12	875 1000	1750 2000	7½	625	1875	3 5	300 450	1200 1800
No. 11	15	750	1500	12½	600	1800	5 7½	300 350	1200 1400
No. 12	20	800	1600	15	575	1725	10 12½	375 450	1500 1800
No. 13	25	750	1500	20	600	1800	12½ 15	375 425	1500 1700
No. 14	35	825	1650	20 25	500 600	1500 1800	15	375	1500
No. 15	40	675	1350	25 30	400 525	1200 1575	20	350	1400

graving shows a comparison of the spindle speeds obtained with the original belt-drive and those that may be secured by the application of a 3 to 1 motor. Not only is the range of spindle speeds increased, but whereas in the belt range of

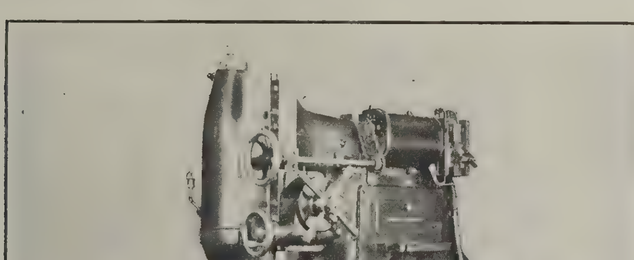

Fig. 6. Motor applied to a Vertical Milling Machine

75 to 580 revolutions we obtained but five distinct speeds, with the motor and a twenty-step controller we obtain a range of 75 to 675 revolutions with forty different running speeds, varying by about 6 per cent. This calculation considers only the range of speeds obtained without the back-gearing of the lathe and the range is, of course, repeated at correspondingly lower speeds by the introduction of the single or double back-gearing with which the lathe is provided.

Just here it may be well to point out one of the greatest advantages of the motor drive. It will be noticed that the belt drive, which gave a range of 75 to 580 revolutions, did so in five steps varying by at least 60 per cent per step. If the lathe is running on, let us say, the fourth step it may be found that the cutting speed, owing to the size of the work or the condition of the tool, is not as high as could be used to best advantage. To jump to the next speed, however, increases the cutting speed over 60 per cent, which will be too much, and the work will consequently be done on the fourth step, although this may be 30 or 40 per cent below that at which the best economy would obtain. With a motor drive giving speed increments of 6 per cent or less, the work can at all times be done at practically the best speed, and the increase of output that will be thus secured will be readily appreciated.

Another typical case where the advantage of the motor drive is clearly shown is in the facing of a large surface such as a flange. The ordinary practice is to adjust the speed properly for the cut at the largest diameter and then cover the

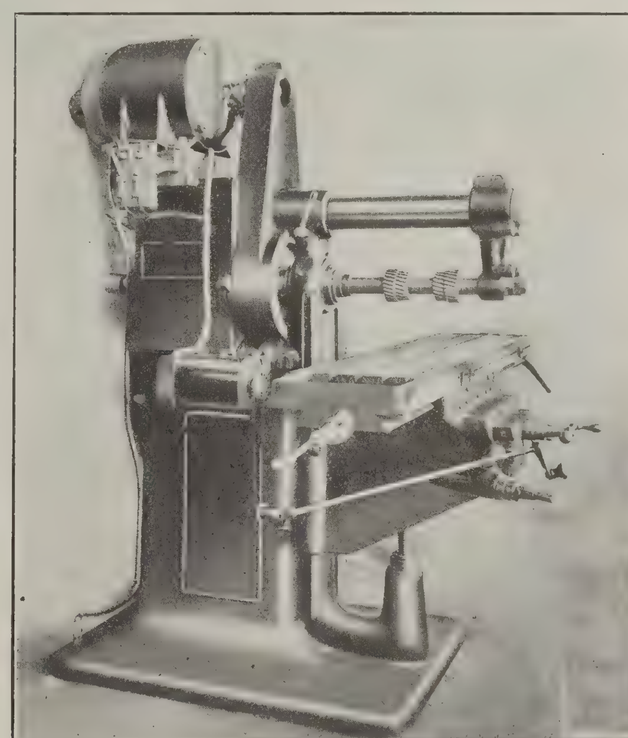

Fig. 7. Motor Equipment of Universal Milling Machine

entire surface at this speed, although, as the tool approaches the center, and the cutting diameter becomes smaller, the cutting speed will be too low. To be sure, an energetic lathe hand can shift his belt from time to time as the work progresses, but this is practical only after a reduction in speed of the 60 per cent made necessary by the large intervals between the cone steps. With the motor drive, requiring only the slight movement of the controller handle to adjust the speed, the operator will continually "notch-up" his controller, so that the entire surface will be covered at practically maximum speed.

In making this application to belt-driven lathes, if a considerable number are alike, it will be found economical to make a pattern and cast a bracket that can be attached neatly to the headstock. This bracket will be provided with bearings for carrying the intermediate shaft below the motor. As this entails expensive pattern work, it will be cheaper, if the number of similar lathes is small, to use wrought-iron brackets to support a plate on which the motor can be placed. This plate will require a very simple pattern which can be readily changed to suit different sizes of motors for various tools with which it can be employed. Fig. 2 gives a general idea of such a bracket, and indicates the method of supporting it over the headstock of a lathe.

The same scheme works out very satisfactorily for applying motors to other types of tools, although certain modifications may be needed in order to obtain the best results. Fig. 3 shows a horizontal boring machine which has been equipped in a manner similar to that of the lathe. The cone is replaced by the two gears *C* and *D*, but in this case the pinions *A* and *B* are fast on the intermediate shaft, while the gears *C* and *D*

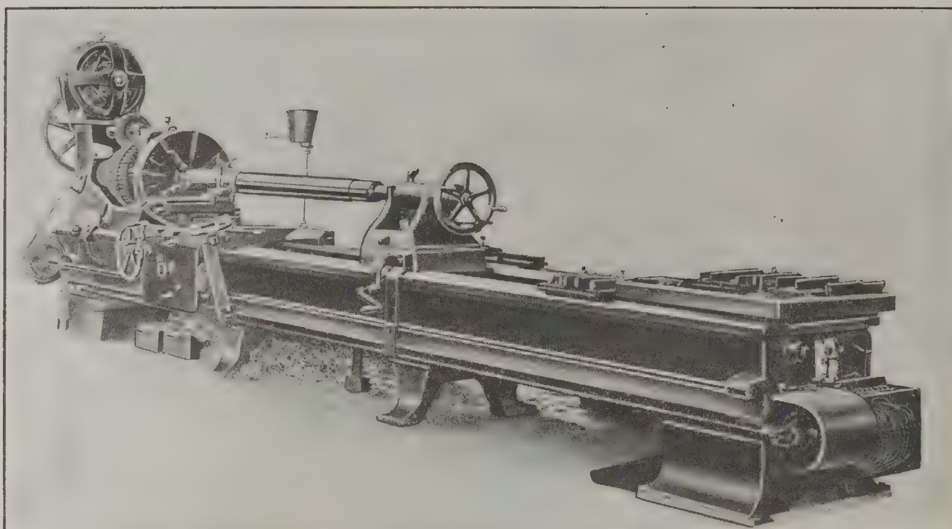

Fig. 8. Motor Equipment of Engine Lathe

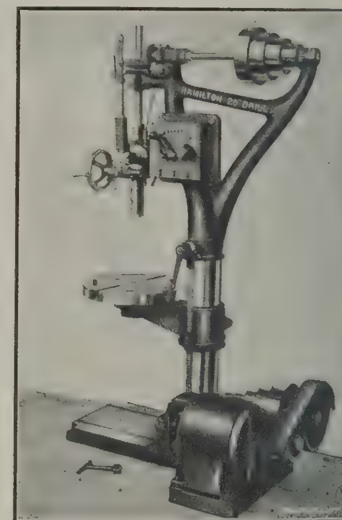

Fig. 9. Motor applied to an Upright Drill

are free to slide on a feather in the spindle quill, so as to be engaged at will with their corresponding pinions. The intermediate shaft, in this case, is carried in brackets in front of the motor rather than beneath it. Fig. 4 shows how this type of drive, with underneath intermediate shaft, may be applied to a radial drill, and the same arrangement will be found readily applicable to upright drills.

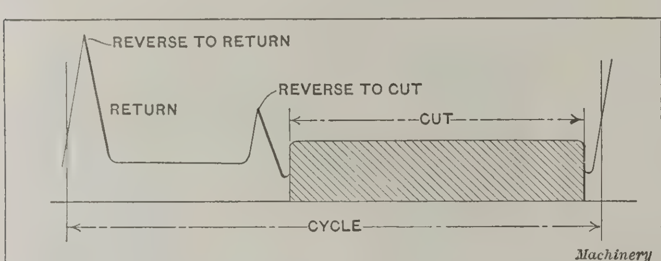

Fig. 10. Cycle of Operations of Planer

The halftone Fig. 5 shows the application of a motor drive to a large boring mill. The arrangement is extremely simple, consisting of replacing the driving pulley with a chain sprocket, and driving from the motor which is set at any convenient nearby point. The two pinions for the gear changes are seen in front of the original driving gears of the mill.

For operating milling machines the most successful appli-

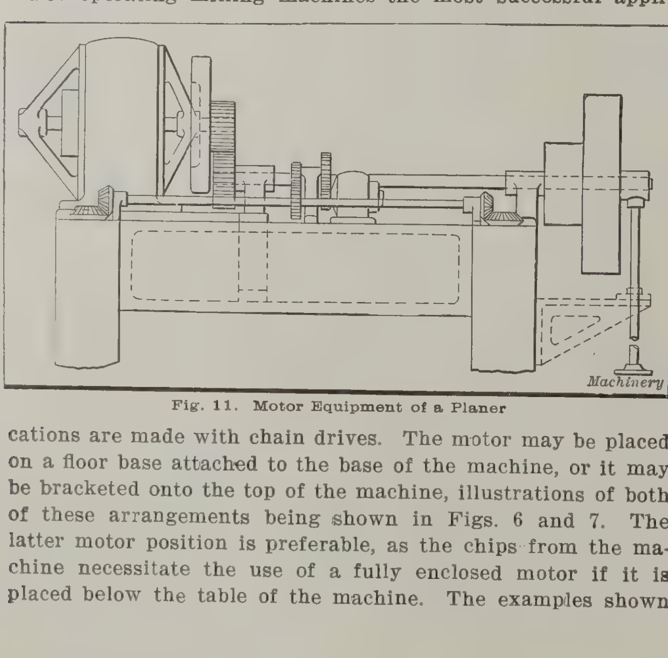

Fig. 11. Motor Equipment of a Planer

cations are made with chain drives. The motor may be placed on a floor base attached to the base of the machine, or it may be bracketed onto the top of the machine, illustrations of both of these arrangements being shown in Figs. 6 and 7. The latter motor position is preferable, as the chips from the machine necessitate the use of a fully enclosed motor if it is placed below the table of the machine. The examples shown are offered mainly as suggestions, as the construction and speeds of each particular tool will call for separate consideration.

Horsepower Required

Having decided upon the desirable speed range and the mechanical details of the application, the next problem is the selection of a motor of suitable power. Upon this point no positive rules can be followed, as so many factors enter into the consideration. For the operation of a lathe for general work a 5 horsepower motor might be fully adequate, while for driving the same size of lathe for manufacturing purposes, and using only high-speed steel at maximum cutting speeds, a 10 or even a 15 horsepower motor might be needed. For running a milling machine, for example, it is obvious that a much smaller motor could be employed if the machine were to be used only for finishing work, with light cuts, than would be needed on the same machine if it were to be used for heavy

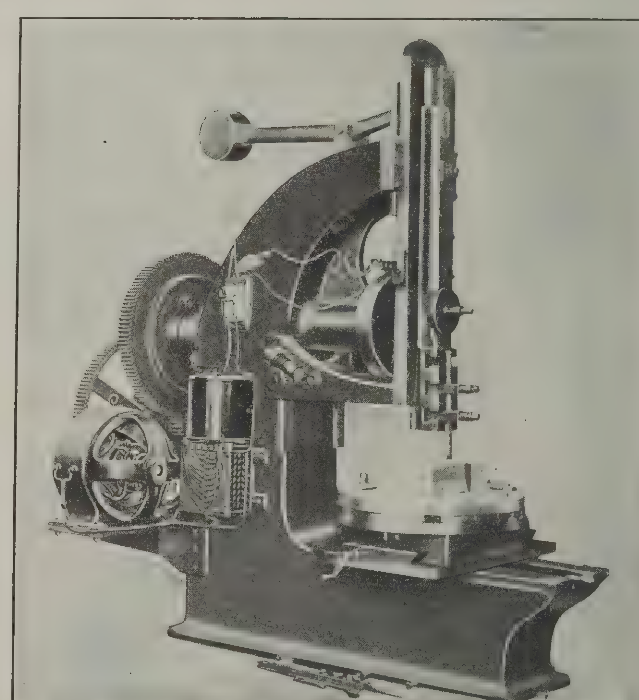

Fig. 12. Motor applied to a Slotter

roughing work. Any tabulated data, therefore, based on the size of the tool, must necessarily give averages only, and should be modified by one's best judgment, based on the actual conditions obtaining.

A most excellent plan is to determine the power requirements, by actual test, before purchasing the motors. This can be done, at a comparatively small expense, by belting a test motor to each tool successively, and taking readings with a recording ammeter for a day or two while the tool is running under actual operating conditions. Remember that all

good motors have a 25 per cent overload capacity for periods of at least two hours, so that if the day's run on a certain tool shows about 7½ horsepower as the average load, with occasional peaks for short runs, of 8 or 9 horsepower, a 7½ horsepower motor will be sufficient. The following tables which have been compiled from the recommendations of the tool builders and from actual tests, will, with the modifications mentioned, serve as fairly accurate guides in the selection of proper motors.

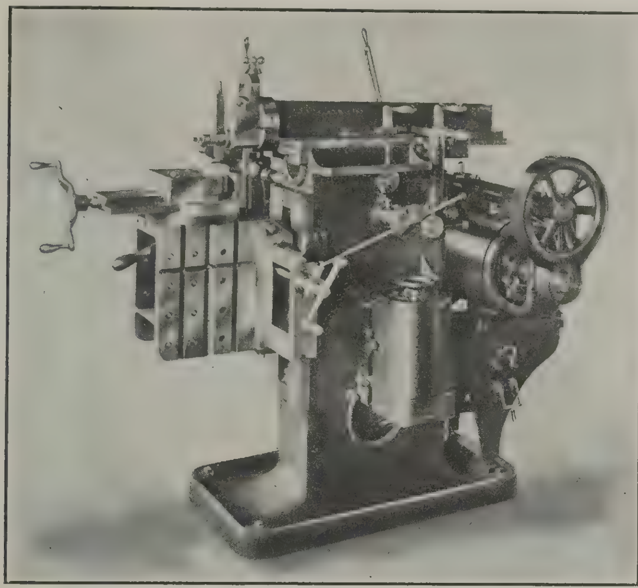

Fig. 13. Motor Equipment of Gear-driven Shaper

TABLE II. AVERAGE POWER REQUIREMENTS OF ENGINE LATHES

Swing, Inches	Character of Work: Light, H. P.	Heavy, H. P.
12	½	1
16	1½	2
18	2	2½
20	2½	3
24	3	5
30	3	5
36	5	7½
42	7½	10
50	7½	15
60	10	20

TABLE III. AVERAGE POWER REQUIREMENTS OF BORING MILLS

Swing, Inches	Horsepower	Swing, Inches	Horsepower
20	1 to 2	72	10 to 12½
30	3 to 4	84	12½ to 15
40	5 to 6	96	15 to 20
50	5 to 7½	120	20 to 25
60	7½ to 10		

TABLE IV. AVERAGE POWER REQUIREMENTS OF DRILLING MACHINES

Swing, Inches	Upright, H. P.	Radial, H. P.
18	1 to 1½	
24	1 to 1½	
36	1½ to 2	2 to 3
42	2 to 2½	2 to 3
48	2 to 3	3 to 4
54		3 to 5
60		4 to 6
72		5 to 6

As universal milling machines are usually rated by numbers, rather than by any dimension, a tabulation of their requirements is somewhat difficult, but for comparison the figures are given for the Brown & Sharpe machines, and these will serve as a guide for the equipment of machines of other makes.

TABLE V. AVERAGE POWER REQUIREMENTS OF BROWN & SHARPE UNIVERSAL MILLING MACHINES

Machine No.	Horsepower	Machine No.	Horsepower
1	1½ to 2	3	7½ to 10
1½	2 to 3	4	10 to 15
2	5 to 7½	5	

For horizontal milling machines the power requirements may be based upon the machine capacity as expressed by the width between the housings.

TABLE VI. AVERAGE POWER REQUIREMENTS OF HORIZONTAL MILLING MACHINES

Width between Housings, Inches	Horsepower	Width between Housings, Inches	Horsepower
12	3 to 3½	36	9 to 10
18	4 to 5	42	12½ to 15
24	7 to 7½	54	15 to 20
30	8 to 9		

Application of Motors to Planers, Shapers, etc.

The second class of tools comprises those in which the cutting stroke alternates with a non-cutting return stroke, as in the case of planers, shapers and slotters. Here the successive operations of the tool occur in cycles, as shown in Fig. 10. The highest points in the cycle are those which occur when reversing takes place. As the return stroke is taken at two or three times the speed of the cutting stroke, the power required to accelerate the bed of the planer or the head of the slotter to its return speed usually constitutes the greatest power-demand, while a somewhat lower point is reached on the reverse to cut. It is not, however, necessary to power the tool to meet the extreme peak, as the overload capacity of the motor will take care of this demand. Instead, the average cutting load represents the desirable nominal rating of the motor.

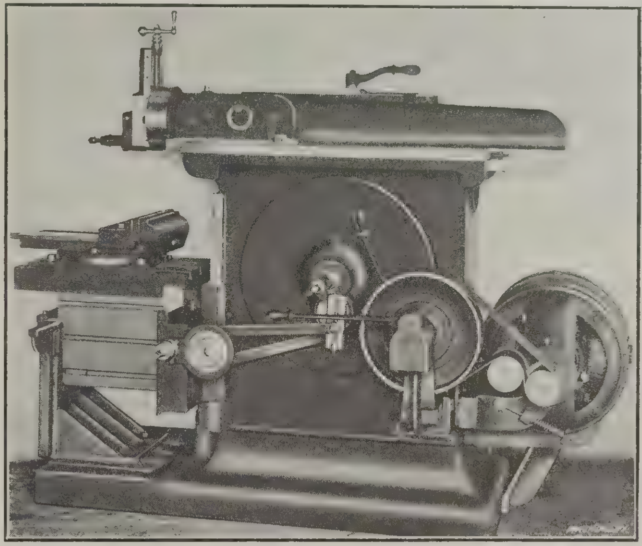

Fig. 14. Motor Equipment of Belt-driven Shaper

In this class of work, a constant speed of the motor is not of as great importance as with constant cutting tools, but it is, rather, desirable that the motor shall be designed to take care of the overloads that occur at the reversals, and for this reason motors for use with tools of this class should be compound-wound. The result is that, as greater demand is made on the motor, the increase of current that passes through the fields strengthens them, and thereby increases the torque of the motor. This also causes the motor to slow down, so that the speed for which the motor should be adjusted is that desired when operating under cutting load. On the return, when the load is light, the motor will consequently run faster than during the cutting stroke.

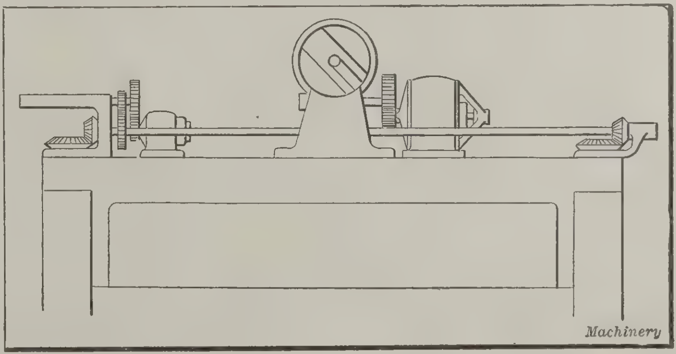

Fig. 15. Auxiliary Motors on Large Boring Mill

The average cutting speed of any of this class of tools will be between 25 and 50 feet per minute, so that a 2 to 1 range

motor is sufficient for nearly all cases and often a range of 1½ to 1 will be found satisfactory. Compound-wound motors are not used for such wide speed ranges as the shunt-wound motors, since any considerable weakening of the shunt field so changes the relation of the shunt to the series winding as to cause the motor to attain the nature of a series motor, which is undesirable.

In some new planers on the market, pneumatic or magnetic clutches are used for reversing, but in equipping old tools it will be found more practical to retain the cross-belt drive with belt shipper. A diagram of such an application is shown in Fig. 11. The motor is mounted on the top of the planer housings, and geared to a countershaft which carries the driving pulleys. The use of the flywheel on the motor shaft is most desirable, as it greatly relieves the motor on the peak loads. By mounting it on the motor shaft, instead of on the slower running countershaft, the flywheel effect is much increased. It is also well to provide the driving pulleys with extra heavy rims for the additional flywheel effect that they will produce. On slotters it will usually be found convenient to place the motor on a bracket on the side of the frame, and employ a gear drive, while shapers may be either geared or chain-driven, or belt-driven by using an idler as shown in Fig. 14.

The remarks regarding the power requirements for constant-cutting tools apply with equal force to this class of machines.

TABLE VII. AVERAGE POWER REQUIREMENTS OF PLANERS

Width between Housings, Inches,	Length of Bed, Feet	Horsepower
20	6	4 to 5
30	8	6 to 7½
42	10	8 to 10
60	12	10 to 15
72	16	15 to 20
84	18	20 to 25

The figures in Table VII are based on the use of two toolheads and a return speed having a ratio to the cutting speed of about 3 to 1. If more than two heads are used, or if the planer has a longer bed than that given, the horsepower should be somewhat increased.

TABLE VIII. AVERAGE POWER REQUIREMENTS OF SHAPERS (SINGLE HEAD)

Stroke, Inches	Horsepower	Stroke, Inches	Horsepower
16	2 to 3	24	3 to 5
18	3 to 4	30	5 to 7½

TABLE IX. AVERAGE POWER REQUIREMENTS OF SLOTTERS

Stroke, Inches	Horsepower	Stroke, Inches	Horsepower
10	4 to 5	24	10
12	5 to 6	30	10 to 15
18	7½		

In addition to the motors employed for operating the tools of the above classes, there are a number of uses for auxiliary motors as will be noticed in some of the illustrations. In Fig. 3 is shown an auxiliary motor used for raising and lowering the table of a horizontal boring machine, while Figs. 11 and 15 show similar motors employed for elevating and lowering the cross-rails of a large planer and boring mill, respectively. On large lathes auxiliary motors are often used for moving the tailstock along the bed, and they may also be arranged for turning the turret heads on heavy turret lathes.

Series motors only are used for these purposes, as they are always started under full load, and have their speed regulated by armature control. No rules can be laid down for the power of these auxiliary motors, but the requirements are comparatively small, from 2 to 5 horsepower covering all of the above cases except for the very largest tools. The time of duty is very short. The drives are invariably by means of gearing to the operating shaft, one set of reducing gears frequently being needed to reduce the speed of the motor sufficiently. These motors should never be belted, for if the load should be thrown off, by breaking the belt, they will run up to a dangerously high speed, and may be badly damaged. Another type of auxiliary motor is shown in Fig. 15, where it is used to operate the slotting attachment of a large boring mill. Such a motor should be compound wound and the data relative to slotters are applicable for such motors.

Controllers

For use with motors on machine tools the drum-type controller is most satisfactory, as it has sufficient mechanical strength to withstand the rough usage to which it is liable to be subjected, at the same time being completely enclosed so that all current-carrying parts are fully protected from dirt and chips and from external injury. Drum controllers are built for both armature and field controlled motors as well as for combined control. They may be either reversing or non-reversing, as desired. When used with motors having a 3 to 1 speed range, obtained by field control, they will ordinarily contain about twenty speed steps. In some sizes the necessary resistance is mounted on the back of the drum, while in others it is supplied as a separate unit which is connected to the drum by wiring.

The controller should be mounted on the tool at any point to best suit the convenience of the operator. The various applications illustrated by the halftones will serve as suggestions for suitable locations. In the case of long lathes a good arrangement is to mount a handle on the lathe apron, and this, by means of gears and shafts can readily be arranged to operate the controller when mounted on the end of the lathe bed. (See Fig. 8.)

The resistance, if separate, should be mounted near the controller in order to economize in wiring, but it should be so placed as to be exposed to the air and at the same time protected from dirt and cuttings from the tool. Do not cover up the resistance or place it inside of the tool frame, but select some place above the table of the tool, away from the path of the chips. In Figs. 8 and 12 the resistances, which are in the form of iron boxes with slate tops, are shown in excellent positions.

* * *

A SPIRAL GEAR CALCULATION

By GUY H. GARDNER*

A man in the shop was given a pair of new spiral gears with orders to ascertain all dimensions necessary to enable the shop to duplicate them in the future. He was about to find the angle of spiral in the time-honored way of rolling the gear on a piece of carbon transfer paper with white paper under it, so as to be able to measure the angle of the tooth marks with an ordinary protractor and figure what fraction of the circumference a tooth advanced in the width of the gear face. A neighbor then suggested that an easier method would be applicable, as the gear was new and of standard pitch. The gear was 8 diametral pitch, 52 teeth, 8.237 inches outside diameter; hence the pitch diameter was 7.987 inches. The pitch diameter of a spur gear of 52 teeth, 8 diametral pitch, is 6.5 inches. This divided by the pitch diameter of the spiral gear ($6.5 \div 7.987 = 0.8138$) gives the cosine of the tooth angle, which is thus found to be 35 degrees, 32 minutes. The mating gear had 106 teeth, and if the previous calculations are correct, its tooth angle must be 54 degrees, 28 minutes, as the shafts are at right angles. The pitch diameter of the large gear then is $106 \div (8 \times \cos 54 \text{ deg. } 28 \text{ min.}) = 22.799$ inches, and the outside diameter 0.250 inch more, or 23.049 inches. By actual measurement, it was found that this outside diameter was 23.044 inches, so that the calculations could be assumed to be correct. To make absolutely certain, however, the calculations could be checked in accordance with the rules on page 5 of MACHINERY'S Reference Book No. 20, second edition.

* * *

The Krupp firm in Essen, Germany, has built two new guns which are larger than anything hitherto used in marine or fortification service. The largest of these is a 15-inch gun. The total length of the bore is about 66 feet and the weight of the gun proper is about 226,000 pounds. The weight of the projectile is 1650 pounds, and the gun requires a charge of 690 pounds of powder. The muzzle velocity is slightly over 3100 feet per second, and the energy at the muzzle about 122,000 foot-tons. Close to the muzzle the projectile is capable of penetrating steel plate to a thickness of 4 feet 5 inches.

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NEW PLANT OF THE GISHOLT MACHINE CO., MADISON, WIS.

The new plant of the Gisholt Machine Co., Madison, Wis., manufacturers of Gisholt turret lathes, boring mills and tool grinders, the construction of which was started last August, has just been completed. The layout of the plant is shown in Fig. 3, where the various departments are numbered, the key to this numbering being given in the illustration. As will be seen, the new building is of the regular sawtooth roof construction—tile supported on steel T-iron purlins—with trusses provided with extension gusset plates, to which hangers or other fastenings for holding shaftings, etc., can be readily attached. The area of the wire skylight glass is equal to about one-third of the floor space, which insures a good distribution of a flood of light. The building is constructed of fireproof material and every provision is made to secure the best sanitary and hygienic conditions.

Fig. 1. General View of Gisholt Machine Co.'s New Plant in Madison, Wis.

Fig. 2. View of Small Bay taken at Night, Ten Minutes Exposure, 16 Stop

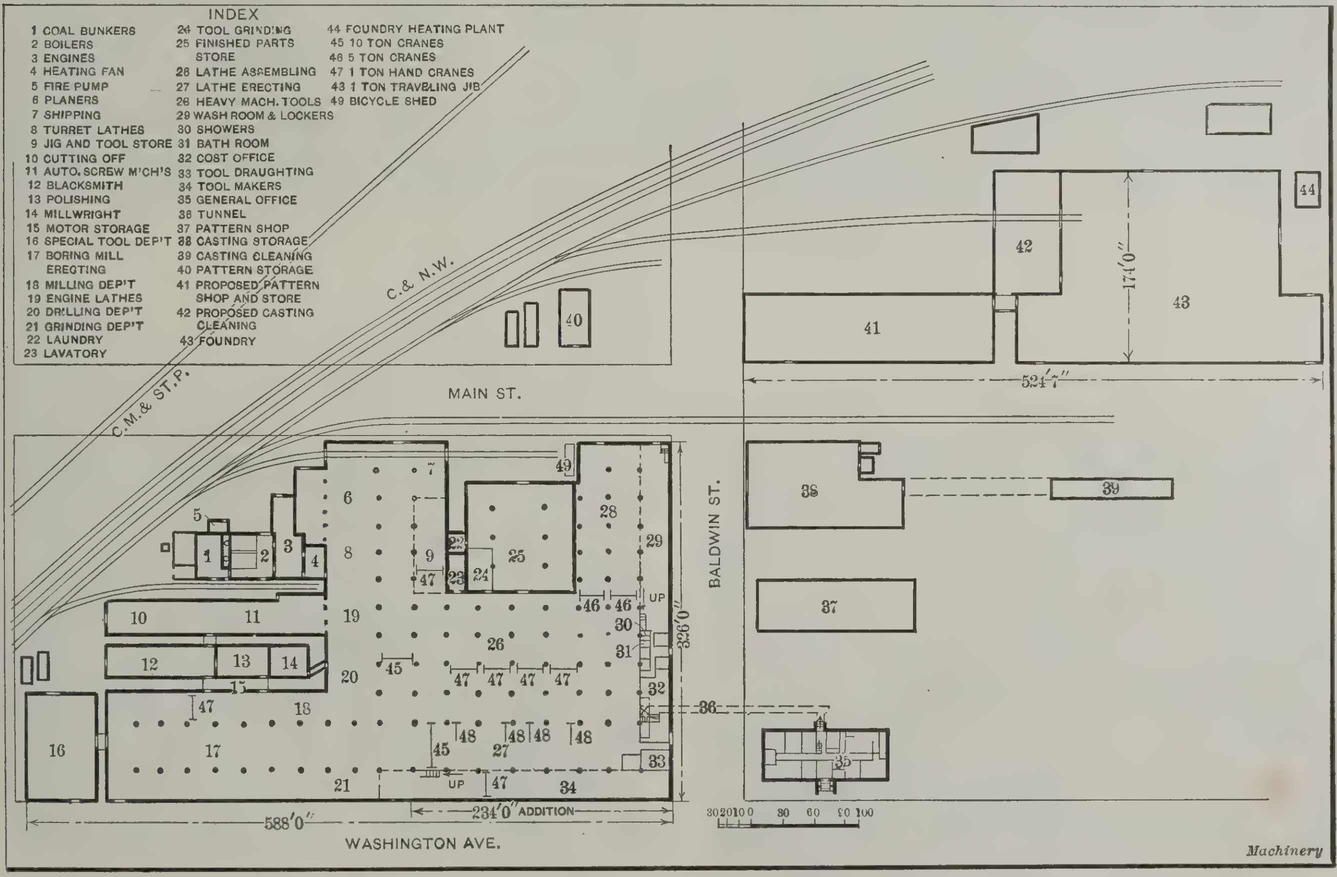


Fig. 3. Plan showing Location of the Various Departments and Buildings, Gisholt Machine Co., Madison, Wis.

Storerooms and Crane Service

The storerooms in which the finished material is held until wanted, are shown in the background in Fig. 4. The parts are brought on small trucks out to the assembling benches, shown in the foreground, where the carriages, headstocks, turrets, and feed-boxes for the turret lathes are assembled. A notable feature of the arrangement shown here, is that the trucking does not interfere with the man at the assembling bench. A good wide alley-way provides ample room for the trucks to pass through. There is also considerable space left in which to place the parts to be assembled. All the various parts of the turret lathes and boring mills made by this company are assembled on the unit plan, and are finished and tested before being attached to the machine proper.

The manner in which the traveling cranes are arranged, is commendable for a plant producing heavy machinery. The beds of the turret lathes are machined in Department 28, where the large planers are located. When a lathe bed has been machined, the small five-ton traveling crane which may be seen to the left in Fig. 5, operating in the small bay, is used to convey the finished bed to the erecting floor. As can be seen by referring to this illustration, the tracks on which this crane is mounted extend out past the posts, and are located low enough so that the crane carriage will

pass under the ten-ton crane, which travels the entire length of the large bay or erecting floor. It is evident that it is a simple matter with this arrangement to transfer a bed from the small crane to the large one, and in this way avoid a second handling or resorting to trucking. The work can be carried directly from the planer or the machine used in performing the required operations to the erecting floor with comparatively little effort. The gallery, a portion of which is shown in the background in Fig. 5, extends around two sides of the building. It is 25 feet wide by about 500 feet long, and is used for erecting light machinery, such as tool grinders, countershafts, etc. In the gallery are also located the lunch room, lecture hall, and emergency hospital, which will be referred to again later. The factory is illuminated at night by overhead tungsten "Mazda" lamps, 250-watt lamps being located over all crane-ways and 100-watt lamps over the assembling benches. The heating is of the direct vacuum system, and it has been found to give very satisfactory results.

Fig. 4. Assembly Floor for Carriages, Headstocks, Turrets and Feed-boxes. Storeroom in the Background

Fig. 5. Main Bay showing the Five- and Ten-ton Cranes

The Tool-room

The tool-room, a view of which is shown in Fig. 6, is located beneath the gallery shown to the right in Fig. 5, and is equipped with milling machines, boring machines, lathes, grinders, etc. In the tool-room all the jigs and fixtures used in the manufacture of both the boring machines and turret lathes are produced. This department is about 25 feet wide by 150 feet long, and is screened off from the main portion of the erecting floor.

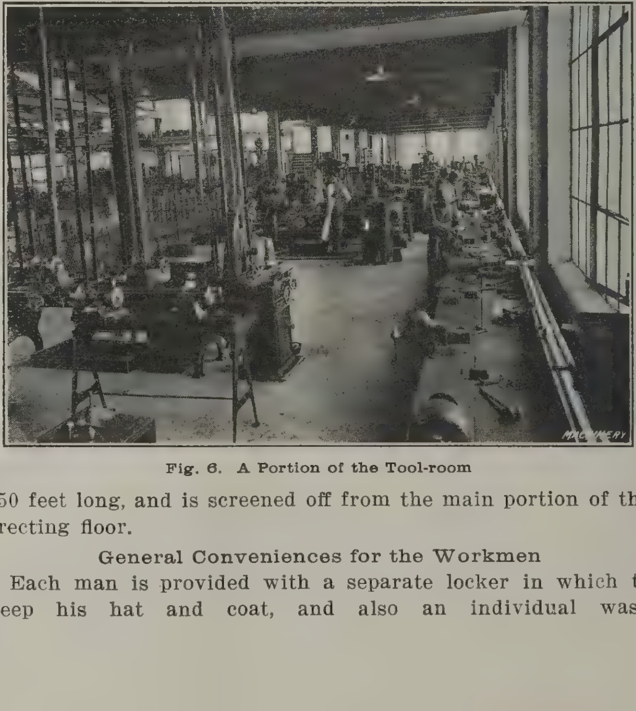


Fig. 6. A Portion of the Tool-room

General Conveniences for the Workmen

Each man is provided with a separate locker in which to keep his hat and coat, and also an individual wash

bowl. Two shower baths and a bathtub are installed to be used by the workmen, and every sanitary condition possible is provided for. Above the gallery is a lecture hall where meetings and entertainments can be held when desired. This hall has a seating capacity of about 300, and can be made still larger by throwing back the folding doors, some of which are shown thrown back in Fig. 7. The seats are in sections of three and are of the folding type. The rear portion of this hall is used as a lunch room for the workmen. Provision is made for a motion-picture machine and tne stage is equipped with scenery.

Fig. 7. Lecture Hall looking from the Stage

In this illustration the extended gusset plates of the roof construction are clearly shown.

The First Aid Room

The first aid room or emergency hospital shown in Fig. 8, is 12 feet square, and is equipped with the following: One examining table and stool, one cabinet, one instrument stand, one sterilizer, one waste receptacle, one irrigator and one hospital sink, the latter being equipped with foot pedals for opening the cold and hot water faucets. The cabinet contains a set of surgical instruments and all first aid supplies. A desk, not shown, is provided for the convenience of the surgeon in making up records of injuries. The room is painted in white throughout and is provided with a tile floor. All of the furniture is of steel construction painted white.

Offices and Engineering Departments

As shown in Fig. 3, the office building is located on the corner of Washington Ave. and Baldwin St., opposite the new

Fig. 8. The First Aid Emergency Hospital

main building, and is connected to the latter by an underground tunnel. The steam pipes and wiring for the electric lights in the office building are conveyed from the power house through this tunnel. The office building is of fireproof construction, with tile flooring, and is trimmed in quartered oak. It is 48 by 116 feet, and consists of two stories and a basement. In the basement is located a ventilating fan, which supplies the various offices with fresh air and forces the foul air out. The building is heated by direct and indirect radiation, the direct radiation being controlled by air-operated valves of the Johnson system. The fresh air being drawn from the outside, and the foul air being forced out through a ventilator in the roof mechanically, heating and ventilation are independent and separately controlled. On the ventilating fan is an automatic humidifier to keep the humidity in the offices constantly at a certain point, a very necessary provision for comfortable working conditions in offices.

All lighting in the office building is of the indirect type. Fig. 9, which shows a part of the engineering department, looking towards the vault and blueprint room, illustrates the effectiveness of this system of artificial lighting. This photograph was taken at night with the room illuminated only by the lamps. The negative was given eight minutes exposure, using a 32 stop. This system of lighting, as can be seen, eliminates all shadows and provides uniform distribution of light. Each unit is composed of four 150-watt lamps spaced at fourteen-foot centers. It requires seventeen kilowatts to illuminate the entire office building.

The system used by this company for keeping track of the workmen's time is a little out of the ordinary and worthy of note. A register called a "periodograph," is used throughout the factory to record the time. The system is worked out on the quarter hour basis, that is, the minimum time recorded is fifteen minutes. The time when the job is started is recorded by the instrument, as is also the time when it is finished. The difference between the two numerals stamped on the card shows the number of quarter hours the man has been on the job. The clocks in these periodographs are regulated by a master clock, located in the engineer's office. The data can be taken directly from the cards and added on an ordinary adding machine. As this system will be explained more

Fig. 9. A View of the Engineering Department taken at Night, Eight Minutes Exposure with a 32 Stop

fully in another article it will not be necessary to make further mention of it here.

The plant, the new part of which is briefly described in the foregoing, is one of the best in the United States, especially designed for manufacturing machine tools. It is an expression of the development of a business that has steadily grown in strength and prestige since it was founded about twenty-five years ago in Madison by Mr. John A. Johnson. Originality in design and efficiency in operation have been the characteristics of machine tools, known as "Gisholt"—the name of the boyhood home in Norway of the founder.

* * *

FIRST TELEGRAPHIC TRAIN ORDER

A bronze tablet was set in a monument May 21 at Harriman (formerly Turners), N. Y., as a memorial presented by the Erie Railroad Co., to commemorate the spot where, in 1851, the first telegraphic order was given directing a railroad train to move. The order was sent by Mr. Charles Minot, general superintendent of the Erie Railroad, a vignette of whose face appears at the top of the tablet, enclosed in a wreath. Prior to directing train movements by telegraph, the engineers and conductors ran their trains by the time-table and "judgment." The telegraph is now being displaced by the telephone and the probability is that in the not distant future the train despatcher will be in direct communication with all the trains on his division all the time, either by a wireless or sliding contact system.

WATCH MOVEMENT MANUFACTURE—2

METHOD, MACHINES AND SPECIAL TOOLS USED BY THE SOUTH BEND WATCH CO.

By DOUGLAS T. HAMILTON*

The special tools, gages, etc., used in watch movement manufacture compare favorably, from the standpoint of accuracy, with the tools used in any other line of manufacture. Accuracy is an absolute necessity in this class of work, if interchangeable manufacture is to be carried on successfully, and on a paying basis. In the following article a few of the representative gages and tools used by the South Bend Watch Co., South Bend, Ind., will be illustrated and described before the making of the various members of the watch movement is taken up.

The Transfer Chuck

The transfer chuck which is illustrated in Figs. 12 and 14 has been developed for making watch models and master plates, a group of the latter being shown in Fig. 13. The transfer chuck consists mainly of two dovetailed circular plates *A* and

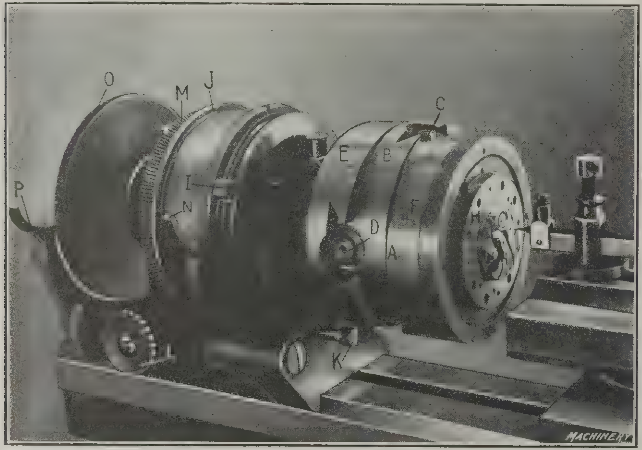


Fig. 12. Transfer Chuck used in making Master Plates and Model Watch

B, which can be adjusted at right angles to each other by screws *C* and *D*, the latter being provided with micrometer collars reading to 0.001 inch. Readings to 0.0001 inch can be easily obtained by means of the auxiliary vernier scale on the end of the slide, Fig. 14. These two adjusting circular plates *A* and *B* move in north, south, east and west directions to correspond with the geographical lines used in laying out the various holes in the watch plates, thus making it possible to drill any hole in its exact position.

The circular plate *F* is provided with a circular tongue which fits in a corresponding groove in plate *A*. The cir-

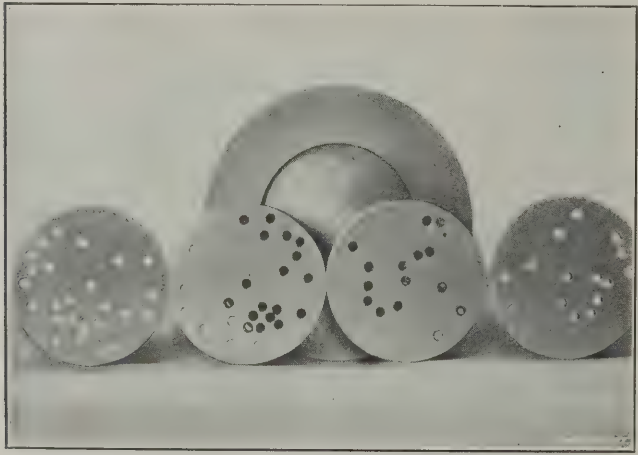


Fig. 13. A Representative Group of Master Plates

cumference of plate *F* is marked off in degrees, and the vernier scale on plate *A* makes it possible to set plate *F* to an angular position reading in minutes and fractions thereof. Plate *F*, as shown in Fig. 14, is held to plate *A* by fillister-head screws and elongated washers, which fit in a tee-slot cut in plate *A*. Fastened to the swiveling plate *F* is a brass disk *H* to which the master plate, or the various parts of the model watch to be made, are clamped. The boring of the holes and the other machining operations are completed before the master plate or model watch is removed from the brass disk. In Fig. 12, a bridged-type model watch is being worked upon.

It will be evident now, upon referring to Figs. 12 and 14, and also to the preceding description, that all dimensions north or south, east or west of the center lines can be laid out very accurately by means of these adjustable calibrated circu-

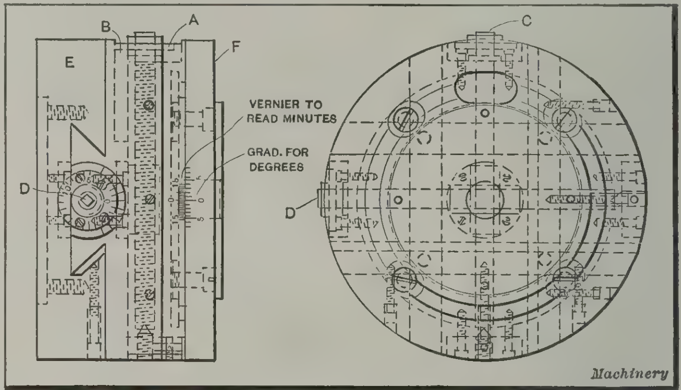


Fig. 14. Construction of the Transfer Chuck shown in Fig. 12

lar plates or slides. Also, in addition, any angular dimensions, or parts to be machined, can be accomplished by rotating the swiveling plate *F* to any desired angle.

Arcs of any length can be milled by simply setting adjustable dogs *I* in a slot in the front face of the driving pulley *J*, Fig. 12. These dogs come in contact with a pin *K*, which when pushed in acts as a stop. When small end mills are being used, and when it would be dangerous to pull the pulley *J* around by hand, a worm attached to handwheel *L* is engaged with the

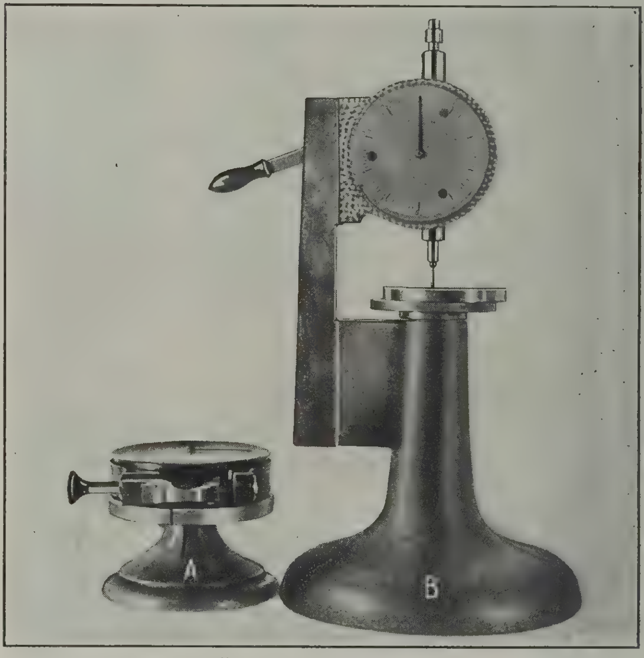


Fig. 15. Upright and "Fine" Multiplying Gages used for measuring the Various Parts of a Watch during Process of Manufacture

worm-wheel *M*. Of course the belt must be thrown off the pulley before the head can be rotated by handwheel *L*.

The head of this transfer chuck can be indexed by hand to the four positions—north, south, east and west—where it is held by a latch *N* fitting in notches cut in the front flange of the driving pulley. Other indexing disks giving a greater number of divisions are placed on the rear end of the spindle. A disk *O*, which is graduated in degrees, is located by finger *P*, as shown in Fig. 12. This transfer chuck is never taken from the model department, so that it cannot be mutilated in any way or its accuracy impaired.

Master Plates

All hole distances for the various tools are located by means of master plates, a group of which is shown in Fig. 13. These plates are all made of the same size—1.6 inches in diameter, 0.22 inch thick, while the holes are all made 0.100 inch diam-

* Associate Editor of MACHINERY.

eter, regardless of the size of the hole required to be produced in the plate of the watch. The holes in these master plates are accurately spaced in the transfer chuck and are lapped to size. All of the holes are numbered to correspond with the chart, Fig. 6 (see the May number of MACHINERY), each hole having its own particular number regardless of how many plates it may be located in.

Measuring Gages

Two types of multiplying gages are shown at *A* and *B* in Fig. 15. These are used for measuring the various parts of a watch during the process of manufacture. The gage shown at *A* is called a "fine" gage, and that shown at *B* is called an "upright" gage. The fine gage is used for measuring such parts

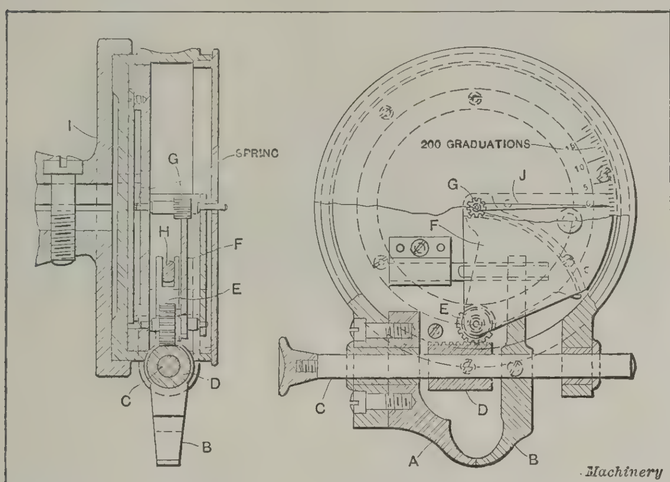


Fig. 16. Construction of "Fine" Gage shown at A in Fig. 15

as balance staffs, pinion staffs, and most of the circular work; the upright gage is used largely for measuring flat work.

The construction of the fine gage is shown in Fig. 16, to which reference should now be made. This gage is provided with a dial having 200 graduations laid off on its face. The work to be measured is placed between the jaws *A* and *B*, these jaws being separated by forcing in the rod *C*, to which jaw *B* is attached. Held on this rod by a screw, is a rack *D* which meshes with a pinion *E* having 40 teeth. Pinion *E* is connected to fan gear *F*, (the whole number of teeth in which should be 225) which meshes with pinion *G* attached to needle *J*. Jaw *B* which is held by a screw to rod *C* has a slot cut in its rear end, which fits a flattened stud *H*, thus preventing the jaw from tilting. One complete revolution of needle *J* around the dial gives a corresponding opening between the jaws *A* and *B* of 0.080 inch, so that the space between each graduation on the dial represents a movement of the jaw of 0.0004 inch. The working mechanism of the gage is enclosed in a case, which is supported on the stand *I* as shown.

The working mechanism of the upright gage is illustrated in Fig. 17. This gage is furnished with a dial having 100 graduations. The measuring spindle *A* is moved up and down by a handle *B*, which is connected to the spindle by a link *C* and a collar *D*. As spindle *A* is raised, the rack teeth cut in it mesh with a pinion *E*, which transmits motion to gear *F*, pinion *G* and needle *H*. Gear *I* is interposed to eliminate back lash in the gearing. The dial, as already mentioned, is divided into 100 equal spaces and each graduation corresponds to a movement of the measuring spindle of 0.001 inch. The capacity of this gage is ½ inch.

The table *J* is adjustable, and a plate *K* for holding the work to be measured is attached to it by screws. The stud on which table *J* is held, is screwed into a babbitt bushing *L*, the latter being clamped on the stud by the screw *M*. The babbitt was poured in through the screw hole, after the stud was put in place. The spindle *A* works in hardened and lapped bushings inserted in the case holding the measuring mechanism.

Master Thickness Gages

All measuring gages throughout the factory are kept in repair and tested from time to time by means of standard thickness gages. A remarkable illustration showing twenty-seven of these thickness gages wrung together is presented in Fig. 18. These gages are made from ½ inch diameter Sanderson drill rod, and vary in thickness from 0.025 up to and including ½ inch. The gages presented in the illustration were made twelve years ago by Mr. William R. Zessinger, foreman of the tool-room. For the benefit of those who would be interested to know how these gages are made and lapped, the following description is given.

Making and Lapping Master Gages

A piece of ½-inch diameter Sanderson drill rod is held in a chuck and is cut off, leaving sufficient material for facing, grinding and lapping. After hardening, the temper is drawn slightly—just enough to remove the strains set up in hardening. Then the block is ground, leaving 0.0002 inch on a side to be removed by lapping. The next thing to do is to prepare the cast-iron lapping block. This is planed as true as possible, using a flat tool for finishing. After the cast-iron block is planed, a hardened and ground steel block is used to rub No. 6 diamond dust into it.

Before describing the lapping of these gages it might be well to describe briefly how the No. 6 diamond dust is obtained. Splint and broken pieces of pure water diamonds are put in a mortar, and the plunger which is made of hardened steel is struck repeated blows until the broken diamond chips are crushed to powder. The powder is now removed and placed in a receptacle partly filled with watch oil. The receptacle holding the diamond dust and oil is allowed to stand for ten minutes; then the oil is poured off and the sediment which is left, is removed and labeled No. 1. The oil with the finer dust in it is then allowed to remain in the receptacle thirty minutes, after which the sediment is removed and called No. 2. The diamond dust still remaining in the oil is now allowed to settle from 4 to 6 hours, then the dregs are removed and labeled No. 3. This process is again repeated and the oil is allowed to stand for 24 hours, the sediment removed being called No. 4. The diamond dust that has not sifted through the oil is very fine, but it is still there, so that the receptacle is put away and left for two weeks. The sediment is then removed and labeled No. 5. This is the diamond dust which is used for lapping these fine thickness gages.

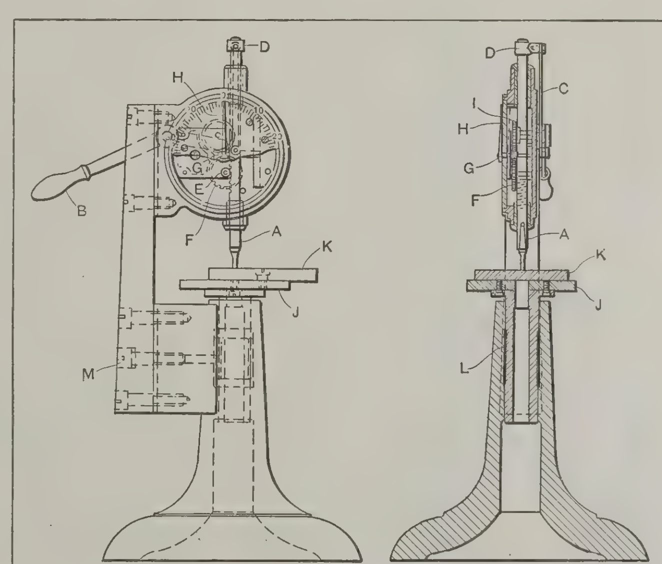


Fig. 17. Construction of Upright Gage shown at B in Fig. 15

To proceed with the lapping operation; the gages in this case have a hole in them and are held in contact with the lapping block by means of a piece of steel pointed like a lathe center, and fitting in the hole, but not passing completely through the piece. The gage to be lapped is held down firmly on the diamond charged block, and is given a rotary motion. The pressure on the gage should not be released before the lapping is stopped. After rotating the gage a few times on the block, remove all foreign matter with benzine, and repeat the lapping process until the gage is reduced to the desired thickness. Here is a point about lapping with diamond dust to be observed—never apply any more dust after the lap has once been charged, but remove the material ground from the work with

benzine when the block commences to glaze. When a lapping block commences to glaze some toolmakers apply more dust; this is wrong. The reason for the glazing, is that the material removed fills the pores of the iron and prevents the diamond dust getting at the work.

These gages, if properly lapped, can be wrung together and can be held without dropping apart as shown in Fig. 18. To wring the gages together, they should be slid back and forth on each other, and not brought together with their faces in a parallel plane, as the dust particles in the air adhere to their surfaces and prevent them coming together. It has been demonstrated that the reason that these gages adhere is because there is an extremely thin oil film on them which acts as a binding medium. Of course the more closely the surfaces approach true planes, the greater will be the power required to separate them. This work is not as difficult as it appears, but there is a slight "knack" in lapping which can only be acquired by experience. However, even a novice by following the foregoing method will be surprised at the results he will achieve.

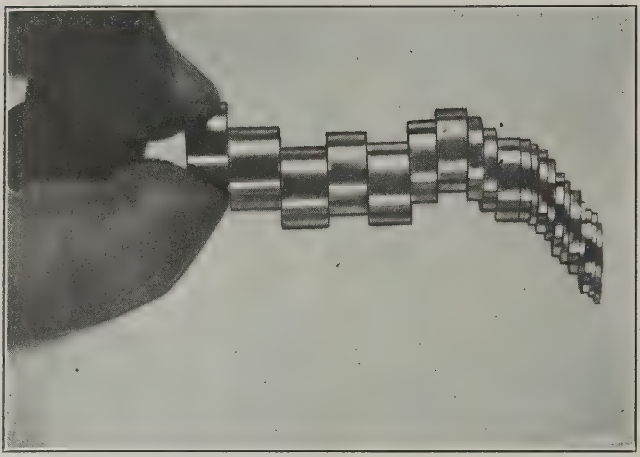


Fig. 18. A Remarkable Illustration showing Twenty-seven Standard Thickness Gages wrung together

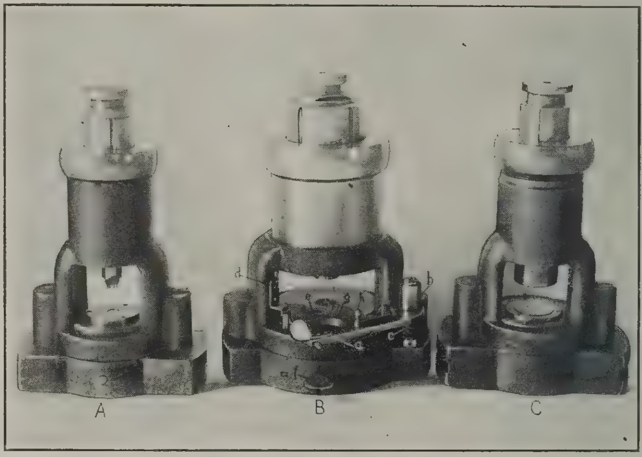


Fig. 19. Standard Sub-press Dies of the Blanking, Shaving and Burnishing Types

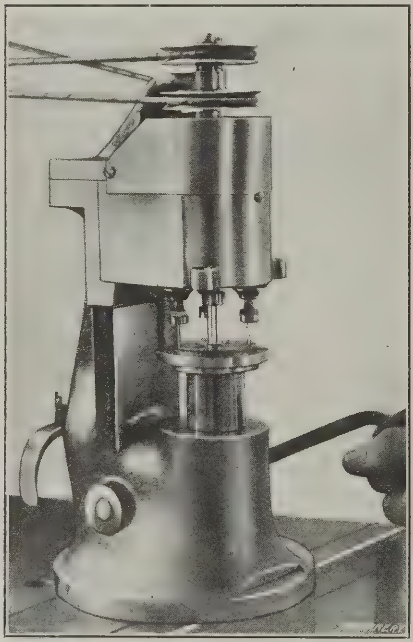


Fig. 20. Three-spindle Drill Press for Drilling Dial Foot Holes in Watch Plates

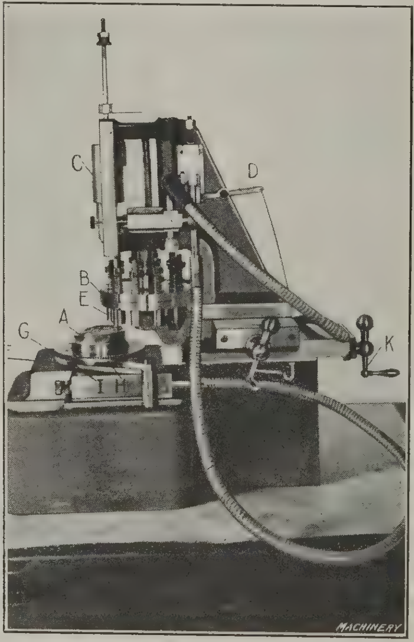


Fig. 21. Numbering Machine for Watch Plates, etc.

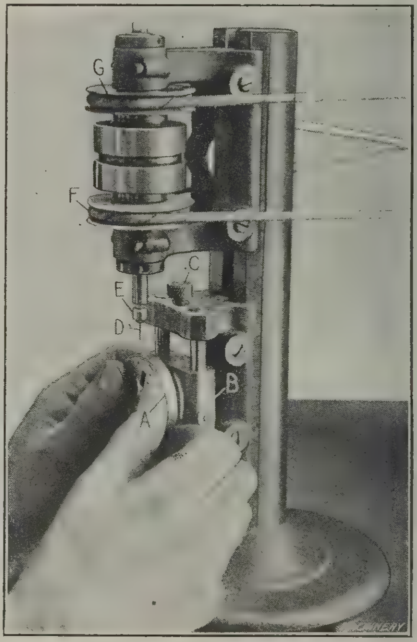


Fig. 22. Friction Tapping Machine for Dial Foot Screw Holes

Sub-press Dies

The sub-press type of punch and die is used almost exclusively in watch movement manufacture, because of the accuracy which can be obtained by its use. Three types of sub-press dies are shown in Fig. 19 where *A* is a blanking die, *B* a shaving die, and *C* a burnishing die. The general construction of these sub-press dies has previously been described in MACHINERY. The device shown attached to the shaving die at *B* in the illustration, however, is novel and worthy of description.

The particular sub-press die shown at *B*, Fig. 19, is used for shaving wheels, after they have been blanked, and is provided with a shaving locator. This consists of a nest *a*, hinged at *b*, and kept out by a coil spring *c*. The blank is placed in the nest, and the latter forced in by the thumb piece until the setscrew touches stop *d*. In this position, the blank is located over the ejector *e*.

Now supposing a wheel has just been shaved, the nest is pulled back until the front hole is in line with the ejector; then the lever *f* is depressed, which operates the ejector and places the blank in the nest. A blank is now placed in the hole *g*, in the nest, the latter being pushed in to the stop and latch *h* operated. This series of actions puts a blank in position to be shaved, and at the same time locates a blank in the "chuck" of the ejector ready for the next operation. This eliminates the necessity of the operator putting his fingers near the punch, and also allows the press to run continuously.

The burnishing die shown at *C* is a type of die which is used to a large extent in the manufacture of the steel parts of a watch movement. The use of this die obviates the necessity of polishing, as a nicely finished and accurate surface can be obtained with very little trouble. Of course it requires good work on the part of the toolmaker who must produce the die without scratches or other imperfections. The work is forced by the punch entirely through the die, which is made with straight and polished sides.

Making Watch Plates

The mechanism of a watch is retained between plates and bridges, holes being drilled and jewels inserted to act as bearings for the shafts on which the various pinions and wheels are mounted. In the South Bend watches, all plates and

bridges are made from nickel alloy and are blanked out in the punch press. The lower plate is then drilled, reamed, faced, tapped, and recessed for the various wheels, barrels, etc. The bridges are punched, shaved, faced, stoned, drilled, counterbored, recessed and pinned. After all the machine work is completed, these parts are nickel-plated.

Drilling Dial Foot Holes

The three holes in the lower plate of a watch are used for holding the dial by the pins riveted into the latter, and they

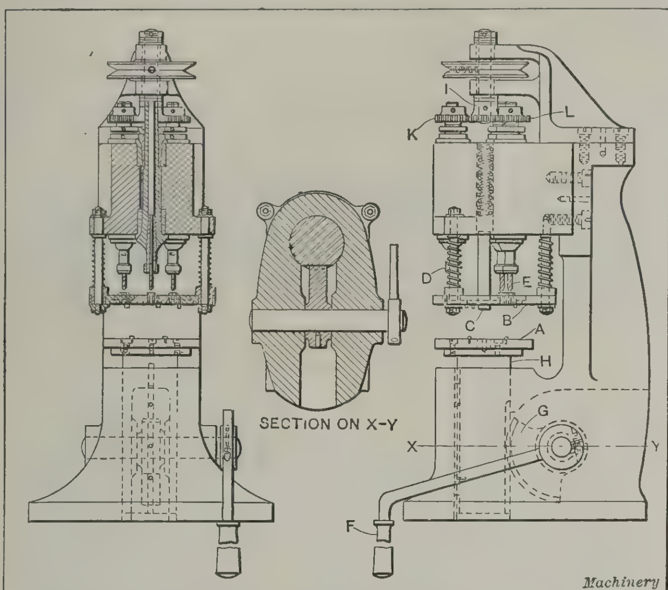


Fig. 23. Construction of Three-spindle Drilling Machine shown in Fig. 20

also serve as locating points in all the subsequent turning and counterboring operations. It is evident, therefore, that these holes must be accurately located, drilled and reamed.

The three-spindle drilling machine used for this purpose, is shown in Figs. 20 and 23. The watch plate, when being drilled, is held between two circular plates *A* and *B*; the work, however, does not come in contact with the plates, but rests on small contact points in them, thus making it impossible for dirt to get between the plates and prevent the holes in the plates from being dead in line. The work is also held down tightly by a spring plunger *C*. The upper plate *B*, which is held down by coil springs *D*, carries the drill bushings. The lower plate with the work on it is raised to the drills *E* by means of a handle *F* fastened to a shaft on which a fan gear *G*

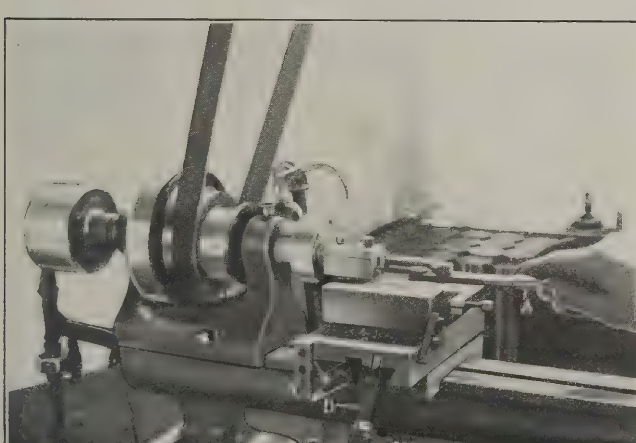


Fig. 24. Lathe equipped with Air-chuck for facing Plates

is retained. This fan gear meshes with a rack in stud *H*, on which the table is held. The top plate acts as a shedder for the drills, and at the same time by means of bushings guides the drills. The three drilling spindles are driven from the overhead works by grooved pulleys and spur gears. Intermediate gear *I* is held on the same shaft as the grooved pulley, and meshes with spur gears *K* and *L* which are fastened to the other two drilling spindles. The drills are 0.052 inch in diameter.

It is of vital importance that the dial foot holes are accurately located as to relative position and absolutely uniform as to size. This is secured by a subsequent operation performed in the same machine which does the drilling. This operation is done by means of accurately sized reamers.

Lathe for Facing Watch Plates

The lower plate after the dial foot holes and some of the other smaller holes have been drilled and reamed is faced off in the lathe shown in Fig. 24, which is provided with an automatic air chuck for holding the work. This air chuck is operated by a foot treadle which, when pressed, opens a valve, admitting air behind the piston connected to the outer sleeve of the chuck; this action holds the plate tightly against the hardened and ground stationary points in the chuck. The chuck is split and is provided with six bearing points so that the plate is always made the same thickness. The facing is accomplished by a turning tool held on the slide-rest. This tool is brought into contact with the work and fed to the desired depth by handle *A*, while handle *B*, having a gear that meshes in a rack under the slide, traverses the tool across the work.

Numbering Machine for Watch Plates

The bridges of a watch are numbered and lettering is stamped on the various parts of the watch, such as the number of jewels and other information of similar character. The

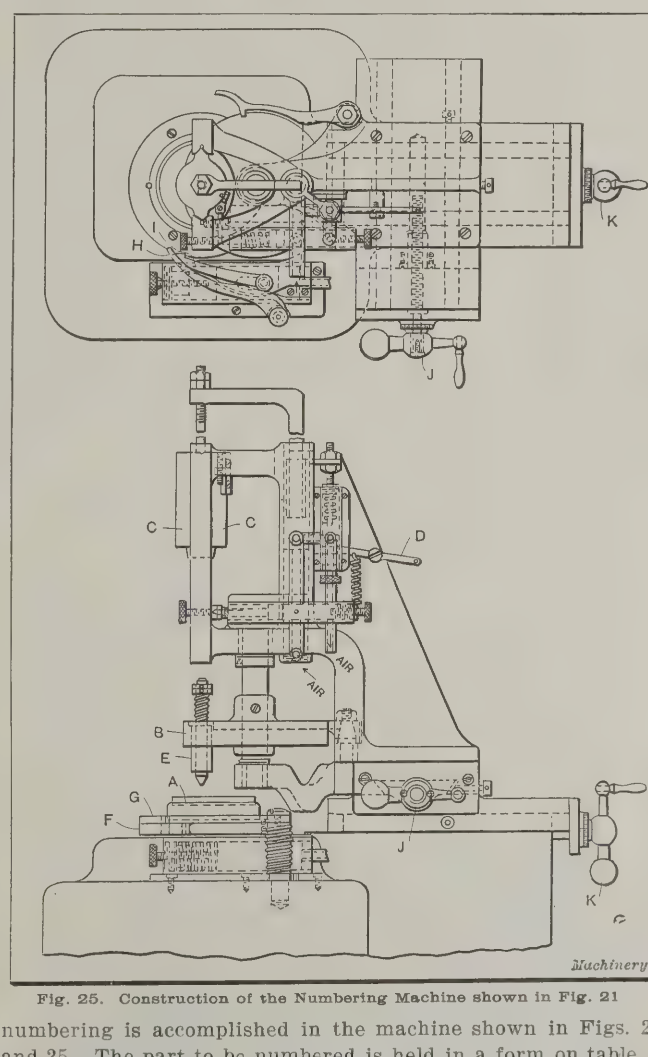


Fig. 25. Construction of the Numbering Machine shown in Fig. 21

numbering is accomplished in the machine shown in Figs. 21 and 25. The part to be numbered is held in a form on table *A* by a spring finger, and the head *B* carrying the letters or stamps, is indexed by hand, indexing slots and a latch being provided for this purpose. The hammer *C*, which gives a blow to the stamp to sink it into the work, is released by a compressed air device which is operated by tripping lever *D*, connected by a string to a foot-treadle. By a system of valves and air pipe connections, the hammer is returned to its "up" position after the blow has been delivered. The spindles *E* carrying the stamps, are forced down by the hammer against the tension of open wound springs. These springs are made of various tensions, so that the stamps will receive just sufficient pressure to force them in to the required depth. It is

evident that figure "8" will require a considerably greater blow than figure "1".

The table A is indexed by means of two ratchet dials F and G, operated by compressed air, one of which is used for indexing, and the order for locking, or holding the table when the stamping is being done. Finger H does the indexing, while finger I retains the table in position. Stops on top of the indexing dial are used as locating points, so that the stamp can be started in any desired position. The number of teeth that the dial is indexed can be changed to compensate for the diameter of the circle on which the letters are to be stamped. Of course a small circle will require a larger spacing than a large circle. The head carrying the letters is provided with adjustable slides which are operated by handles J and K, so that the stamping can be done in any desired position on the work.

Friction Tapping Machine

The pins which hold the dial to the lower plate, and which pass through the dial foot holes, are held in place by screws. Clearance holes are drilled in the pins that are fastened to the dial, so that the screws instead of being tapped into the pins, are threaded into the plate. The tapping size holes are drilled in an index drilling fixture. The tapping is accomplished in the machine shown in Fig. 22. The plate A to be tapped is held in a small fixture B, recessed to fit it, which is pushed up and down by the operator. The depth to which the tap extends into the work is governed by stop-screw C, which retards the fixture at any desired point in its travel. The tap D is not fluted, but is filed three cornered with flat sides and is held in a split chuck E. The spindle carrying the tap is provided with two cone clutches tapered to an angle of 8 degrees. These cones fit in corresponding cones which form integral parts of the two pulleys F and G, driven in opposite directions.

In operation, when the fixture holding the work is pushed up, the tap travels in to the correct depth. Stop-screw C then comes in contact with the fixture holding the work, and in so doing withdraws the cone from pulley G. Now as the fixture is pulled down, the cone comes in contact with pulley F, running in the opposite direction, and backs the tap out of the work. The tap is 0.047 inch in diameter and 110 pitch, and the fixture works so successfully that no taps are broken, or threads stripped in the work.

* * *

BORING LATHE PARTS IN RADIAL DRILLING MACHINE

The jigs and tool equipment used in the shops of the American Tool Works Co., for machining quick-change gear boxes and aprons of lathes, are shown in Figs. 1 and 2. These two

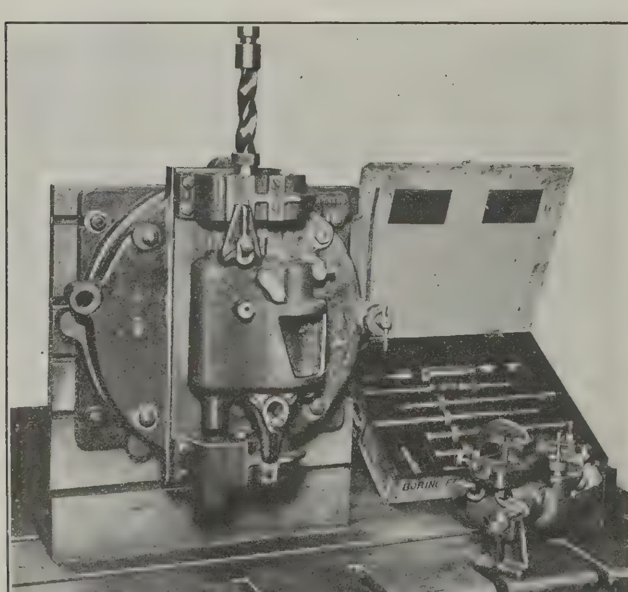


Fig. 1. Jig and Tools for Machining Change-gear Boxes with Radial Drill

views also illustrate how a radial drill is now used for machining these parts, instead of a horizontal boring machine, which was the type of tool formerly employed.

Fig. 1 shows the jig used for the quick-change gear-boxes and also the tool equipment required for this particular job. All of the necessary tools are kept in the box seen to the right, so that no time is lost while hunting for boring tools or drills. The convenience of a radial machine and the rigidity and power of a modern design, makes it possible to perform operations of this class very efficiently. When a horizontal machine was used for this work, 216 hours was required for machining thirty-six castings. The same number of parts are now done in a 6-foot radial drill (by means of a suitable jig) in 45 hours, thus effecting a saving of 171 hours for every thirty-six parts machined.

Fig. 2 shows the jig and tool equipment for machining a 24-inch lathe apron on the radial drill. These aprons were formerly bored on a horizontal machine in lots of twelve, each lot requiring 72 hours. A similar number of aprons of the

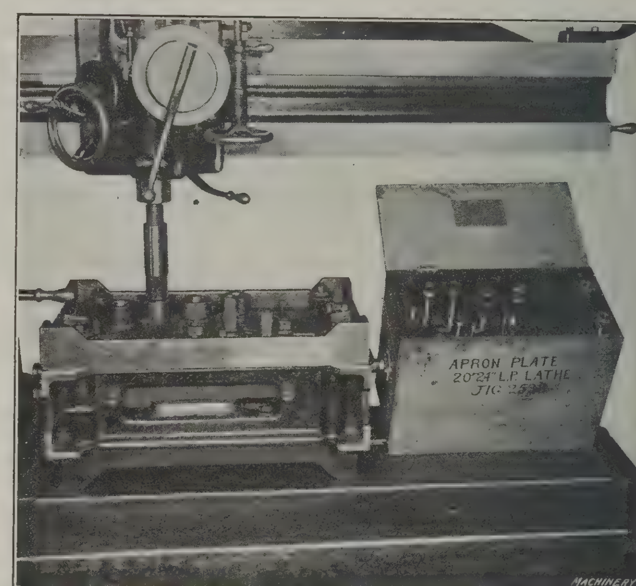


Fig. 2. Tool Equipment for Drilling and Boring Lathe Aprons

same design are now being done on the radial machine (by means of a jig), in 24 hours, thus effecting a saving in time of 48 hours. All of the tools required for the aprons are also kept in a wooden box which is marked with the name of the part, the size of the lathe, and the number of the jig, as the illustration shows.

* * *

SPECIFIC GRAVITY OF SOLIDS SUBMERGED TO GREAT DEPTHS IN WATER

Some "scientific" contributors to the daily papers have worried about the fact that "scientists have failed to agree" as to whether the *Titanic* actually sank to the bottom of the sea, the estimated depth at the part of the ocean where she foundered being some 10,000 feet. They have argued as a reason for this uncertainty that the great pressure of the water at these immense depths would prevent the vessel from sinking. The fallacy of this reasoning is, of course, obvious to anyone who has the least idea of the meaning of specific gravity; in fact, the deeper the vessel sank the more certain did it become that it would sink to the bottom; for while the specific gravity of water is practically the same at all depths, increasing only one per cent under a pressure of 3000 pounds per square inch, that of solid substances immersed in water may be greater the deeper they are immersed, on account of the fact that these substances can be compressed. In many cases the specific gravity is apparently raised because the water, on account of its pressure, fills minute cavities between the fibers of various substances. Wood offers a familiar example of this. Some woods can absorb water until their specific gravity becomes almost as great or even greater than water. Cork offers another interesting example. Cork is one of the most buoyant of substances, but if it is sunk to a depth of 200 feet in water it will not rise to the surface, being compressed to such an extent by the pressure of the water at this depth that it sinks instead of rising.

THE BALOPTICON—AN INSTRUMENT FOR PROJECTING LARGE OPAQUE OBJECTS

A new field for optical projection has been opened up by the "balopticon," an instrument by means of which pictures and objects can be reflected in their natural colors on a large screen. The accompanying illustrations show a large instrument of this type recently constructed by the Bausch & Lomb Optical Co., Rochester, N. Y., the special feature of which is that it projects an image of objects much larger than has ever before been attempted, and, hence, presents new possibilities for this method of showing, before a large audience, illustrations of objects which otherwise could not be properly exhibited.

The original model of the device shown was designed as an experiment in response to a request from the National Cash Register Co. for an instrument of sufficient size to project an entire section of a cash register on the screen. The instrument made proved entirely satisfactory. The general features of its design are indicated in Figs. 1 and 2. The device has an opening for objects measuring 20 inches square, having any thickness up to 9 inches. In order to cover this wide area with sufficient illumination to the very edges, it was necessary to use two large 90-degree arc lamps in the light-tight houses at *A*, as shown in Fig. 2. These lamps are placed at a suitable angle so that the object on the table is covered with the light. The lamps are also placed near enough to the object being projected to avoid the use of condensers, thus avoiding the loss due to absorption of light. Two adjustable rheostats regulating the electric current are mounted one on each side of the base. Good results are obtained with a current of 25 amperes to each lamp.

The next problem to be met after having obtained the maximum amount of illumination for the area to be covered was

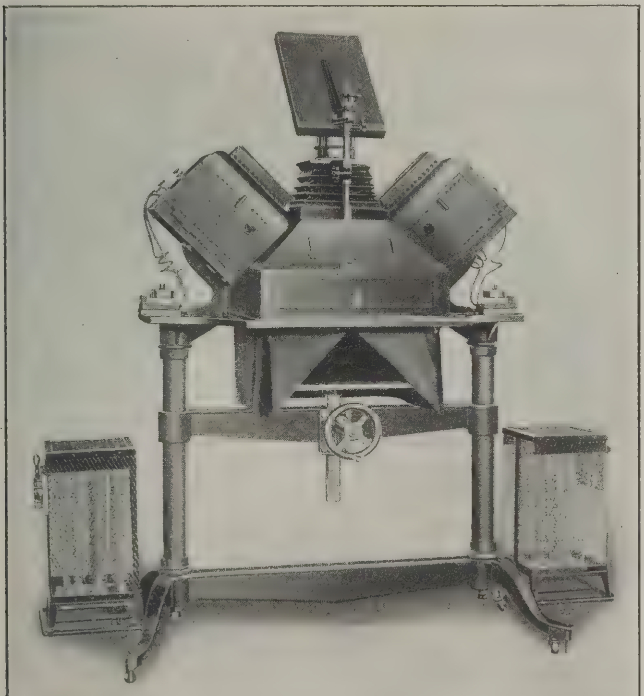


Fig. 1. The Balopticon for the Projection of Large Opaque Objects, made by Bausch & Lomb Optical Co., Rochester, N. Y.

to utilize this light so as to obtain an effective image. For this purpose a high-grade photographic anastigmat lens—a Bausch & Lomb-Zeiss Tessar Ic of 19 3/4-inch focus, 4 7/16 inches in diameter—was employed. A mirror *B* is used above the projection lens to direct the image toward the screen, this being necessary because the objects to be projected are held in a horizontal position on account of their size and weight. This mirror also serves the important purpose of reversing the view so that objects and printed matter are shown on the screen in their true positions. The mirror is silvered on the front surface, thus reducing the amount of light absorption practically to a negligible quantity.

The focusing is accomplished by bringing the object into the range of the lens by adjusting the large object table *C* vertically by means of handwheel *D*. A dark velvet curtain surrounds the table and prevents the light from escaping when the carrier is lowered. The corners of the curtain are draped up in Fig. 1 to show the table.

The instrument is of unusually large proportions for a projection lantern, the base being 54 by 24 inches, and the height of the stand to the top of the mirror being approximately 80 inches. The dark chamber is 23 inches square and is provided with a large door and an observation window of smoked glass, covered by light-tight doors, so that the object can be placed in position without lowering the carrying table.

An instrument of this kind, in addition to its commercial uses, can be used to advantage in projecting large illustrations and photographs of any size up to 20 inches square. This

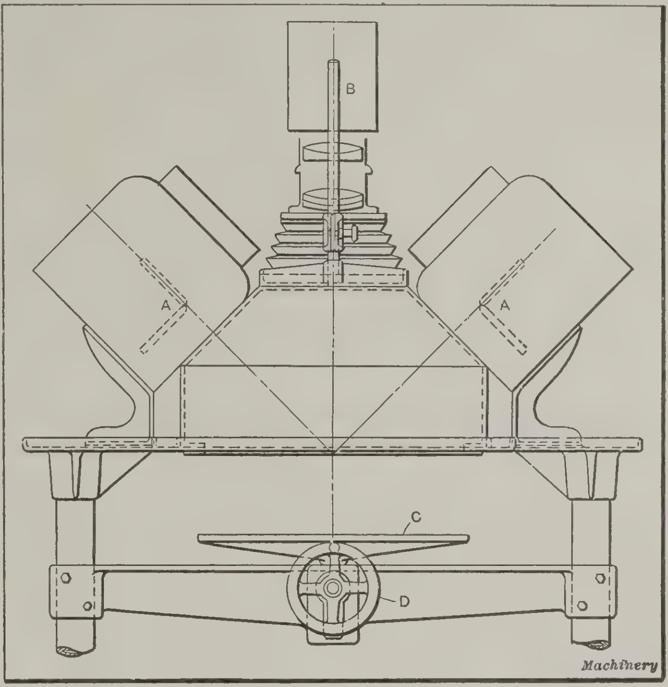


Fig. 2. General Design of the Balopticon

instrument, like a moving picture machine, undoubtedly would have considerable value in educational work, as small specimens and pictures could be shown to a large class simultaneously, and on such an enlarged scale as to make explanation of details easy and interesting.

* * *

Thomas A. Edison is an enthusiast on the value of moving pictures as an educational means. He proposes to revolutionize the present school system by teaching children through their eyes in the natural manner rather than by making them learn to read, and from reading gain knowledge of the world and its ways. He proposes to make 4000 films, costing $3,000,000, and requiring years to prepare, which will cover the subjects of the greatest importance in a general educational scheme. These films will be supplied to public and other schools to be used by the teachers as an easy and agreeable means of inculcating knowledge at an early age of sciences many of which are ordinarily taught only when pupils are approaching maturity. Take, for example, a course in physics. This can be presented by moving pictures so clearly and simply that children five or six years old will comprehend principles clearly. The pumping of water, for example, is shown, glass pumps having been constructed in which the action of water, lifting and closing of the valves, movement of the plunger, etc., can be clearly seen. Geography, botany, history, discovery, agriculture, industrial pursuits, the army, the navy and hundreds of other sciences and activities can be graphically, rapidly and effectively presented to all classes at low cost.

* * *

The designs of the two new White Star liners, now being built at Belfast, are being changed with regard to the arrangement of the bulkheads. The change provides for lateral bulkheads in addition to the transverse watertight compartments, so as to minimize the risk of disaster in case several compartments are torn open, as in the case of the *Titanic*.

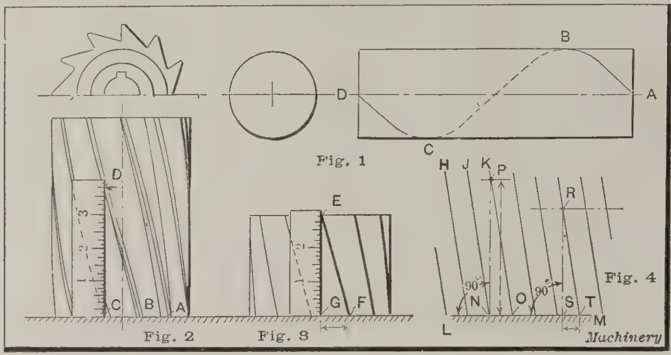
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

DETERMINATION OF MILLING-CUTTER SPIRALS FOR RECUTTING

Frequently a toolmaker is called upon to recut a spiral-toothed milling cutter. One of the first things he has to determine is the pitch of the spiral. If it is not stamped on the cutter this pitch must be calculated by methods such as those given in the following, or else guessed at; and guessing is very apt to involve several settings of the change-gears.

In order to understand the methods of calculation given herein it is necessary first to have a clear conception of what is meant by the *pitch* of a spiral. Referring to Fig. 1, the



Figs. 1 to 4. Different Methods of Obtaining Spirals of Milling Cutter Teeth for Recutting

spiral *ABCD* has a pitch equal in length to the axial distance *AD*, because this is the distance measured along an element of the cylinder from the point where a spiral crosses it, to the point where the same spiral crosses it again. Hence when cutting the spiral-tooth, the table will be fed forward a distance equal to the pitch, while the cutter-blank makes exactly one turn about its axis.

Cutters are seldom or never so long that one tooth makes a complete spiral. If such were the case, however, the spiral could be measured directly. Usually the cutter will conform to either Fig. 2 or 3.

First Method.—Set the cutter on end on a flat plate as shown in Fig. 2. The points *A*, *B*, and *C* represent the corners of the cutting edges. Now, set a square ended scale, as shown, so that its corner coincides with the cutting corner *C*. Measure the distance *CD* along the scale to where the next cutting edge crosses the edge of the scale. The pitch will be as many times this distance *CD*, as there are teeth in the cutter.

Second Method.—When the cutter is so short that the first method cannot be employed, set the cutter up on a flat plate as shown in Fig. 3. Lay the scale up against it so that its edge touches the cutting corner *E*. Now, measure the distances *EG* and *FG*, the latter being the distance from the lower cutting corner *F* of the same cutting edge to the base of the scale. Find the circumference of the cutter-blank by multiplying its diameter by 3.1416. Divide this by the distance *FG*, and then multiply this result by the distance *EG*. This final result will be the pitch of the spiral.

Third Method.—Roll the cutter on a piece of paper or wrap a piece of paper about it and rub the paper so as to get an impression of the teeth including the same ends of several teeth, as shown in Fig. 4. Here the inclined lines *H*, *J* and *K* represent the cutting edges. Draw the line *LM* through the ends of the inclined lines. From the end *N* of the line *JN* erect *NP* perpendicular to *LM*. If it cuts the next inclined line *OK* at some point *P*, the distance *NP* multiplied by the number of teeth in the cutter, gives the required pitch. If, however, the point *P* lies outside of the line *OK* it may be found by producing *OK* until it crosses *NP*.

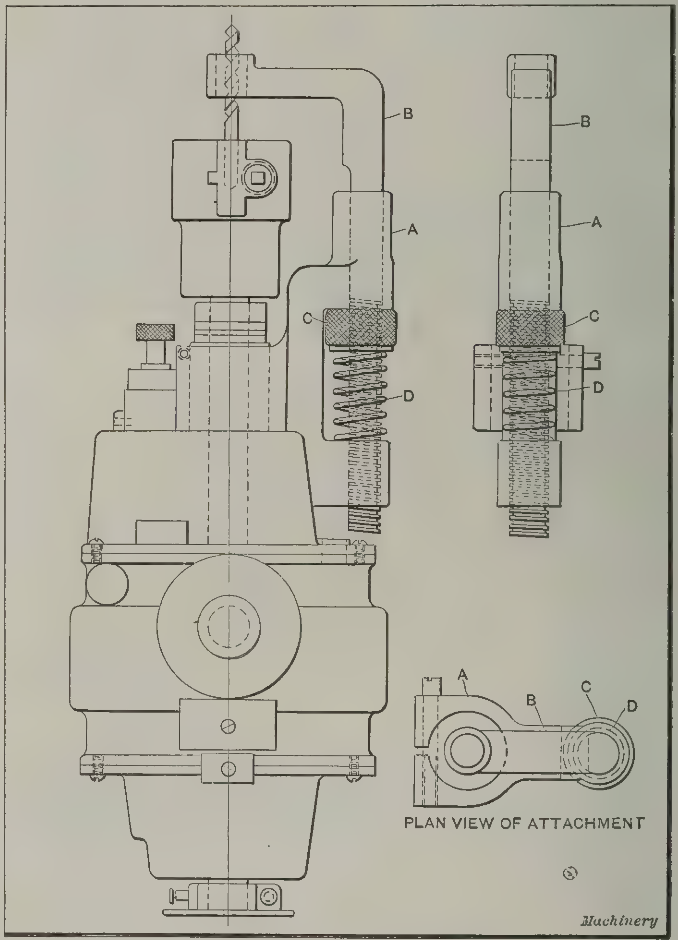
An alternative, when the cutter is narrow as shown by *SR*, is to draw from the upper edge and corner *R* a line *RS* perpendicular to *LM*. Measure the distance *ST* from the base of this perpendicular to the lower corner *T* of the cutting edge *RT*. Then the pitch will be found by multiplying the distance *RS* by the number of times that *ST* goes into the circumference of the cutter. Precaution should be taken when rolling a narrow cutter to be sure that it tracks straight, so that the points *N*, *O*, *T*, etc., will lie on a straight line.

South Bethlehem, Pa. H. A. S. HOWARTH

SAFETY STOP FOR ELECTRIC OR PNEUMATIC DRILLS

The accompanying illustration shows a safety stop for an electric or pneumatic drill. The breakage of drills used in these devices, especially in the electric drills, is very high. There are two main causes for this. In the first place, the device cannot be held very steadily, thus causing cramping of the drill in the hole. The second cause, and the more important of the two, is due to the drill's "breaking through" too suddenly after having passed through the work. This causes by far the greatest damage to drills. If the drill is large the driving device will come to a dead stop, causing damage to the mechanism itself.

Having the above difficulties in mind, the writer designed a stop which is shown applied to an electric drill in the accompanying engraving. At *A* is shown a stop bracket fastened to the frame of the drill; *B* is the stop proper fitted into *A* and bent so as to come in front of the drill chuck at the end. The hole in the end of *B* is made large enough so that the largest drill used can pass through it. The shank of the stop is threaded to receive knurled nut *C*, and spring *D* is inserted between nut *C* and the lower part of bracket *A*. The shank of stop *B* is milled flat on one side and the hole in *A* made to suit it, so that the shank of *B* cannot revolve. When using this stop the end or eye through which the drill passes is so adjusted by means of knurled nut *C* that the length of drill projecting outside of stop *B* is equal to the thickness of the work to be drilled. Then when the drill begins to break through, the stop will come against the work and a slight extra pressure



Safety Stop Device for Portable Drills

on the drill will be required to force it through the work, this extra pressure compressing the spring *D*. In this way, all danger of breaking through too suddenly and causing injury to the drill or tool is avoided. The writer has used this stop for over a year and it has given good results. T. C.

A GRINDING OR LATHE DOG WITH A CAM GRIP

The accompanying illustrations show a grinding or lathe dog made by the apprentice department of the West Lynn works of the General Electric Co. Fig. 1 shows the way in

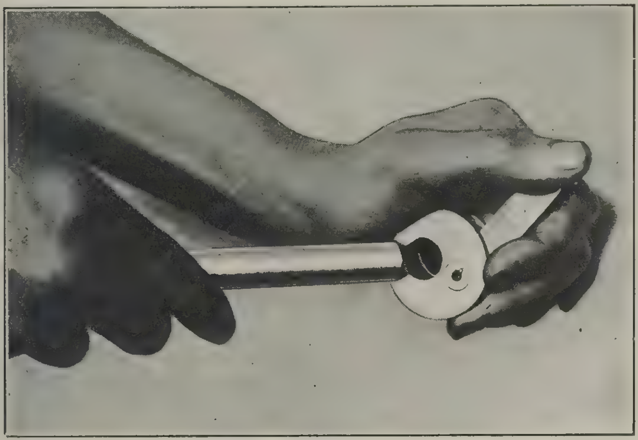


Fig. 1. Inserting the Work in the Dog

which the work is inserted. The lever is pushed back, putting under tension a spring which returns the lever as soon as it is released. The lever is provided with a cam face which

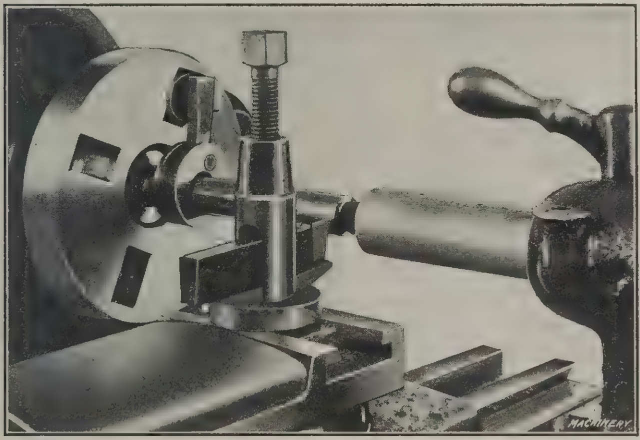


Fig. 2. Dog in use driv'ng Work in the Lathe

comes in contact with the work holding it securely. Fig. 3 shows more clearly the construction of this dog.

In Fig. 2 the dog is shown in use holding a piece in the

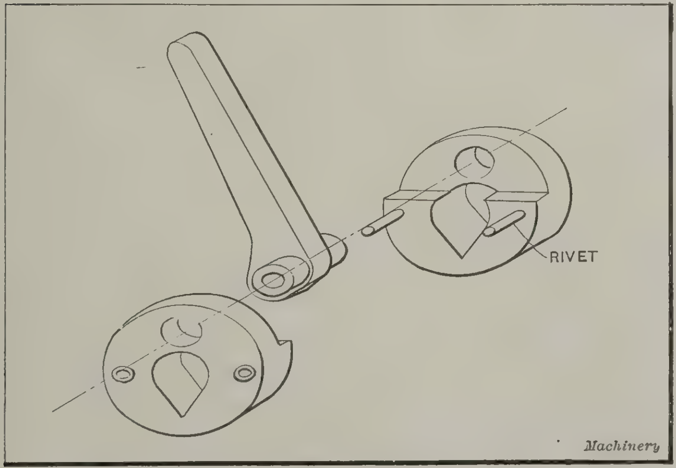


Fig. 3. Construction of Lathe Dog with Cam Grip

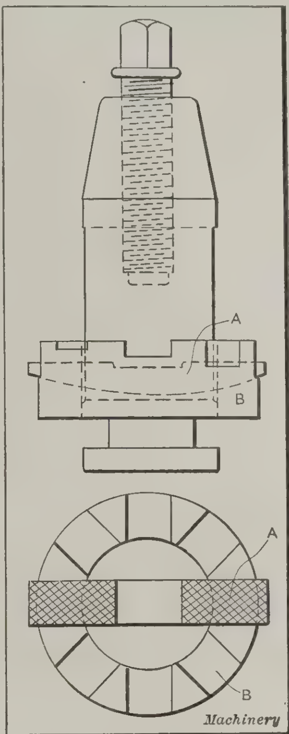
lathe. It has been found that in the lathe, the lever will break before the work will slip in the dog. The ¼-inch dog will take a variation in stock of 1/16 inch, and the 1-inch dog, a variation of 1/8 inch—this is the capacity of the cam. One advantage of this dog is that there are no set-screws or clamps to tighten, and it does not mark the shaft as a set-screw or clamp does, which is usually tightened more than is necessary.

West Lynn, Mass. CHARLES K. TRIPP

IMPROVED LATHE TOOLPOST

The accompanying illustration shows a lathe toolpost which the writer believes will prove of interest to the readers of MACHINERY. This design of toolpost was made long ago, but to the writer's knowledge it has never been published in the technical press.

It will be seen in the illustration that this toolpost has decided advantages over the ordinary types, in that a greater variation in adjustment is possible. This will be appreciated by lathe operators who know what a difficult thing it is to pack properly under a boring tool, for instance, in order to bring the tool to the center so that there may be plenty of clearance when boring small holes.



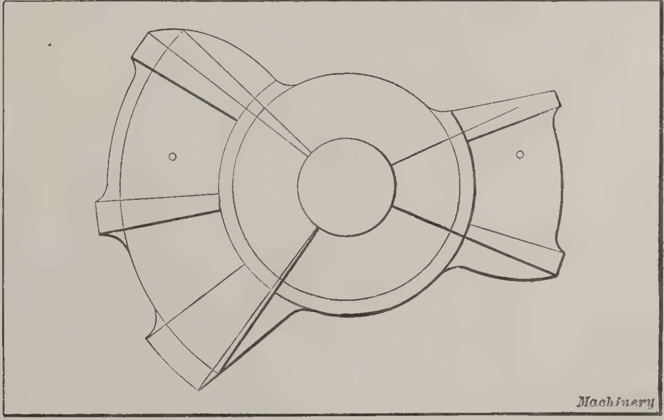
Type of Toolpost permitting of Great Range of Adjustment

One of the great advantages of this design is that it is comparatively easy to convert the toolposts now in use to this new type. In this way, toolposts with small adjustments can be changed into devices permitting a great range of adjustment and providing a simple method of setting the tool to the proper height. The only thing necessary is to cut four slots or grooves through the collar *B*. These grooves should fit the wedge *A*, as indicated.

Wickatunk, N. J. O. G. SIMMONS

TEMPLET FOR DRAWING RISES AND DROPS ON B. & S. SCREW MACHINE CAMS

The accompanying illustration shows a templet made by the writer, both in steel and celluloid, for drawing the rises and drops on No. 00 Brown & Sharpe automatic screw machine



Templet for Drawing Rises and Drops on Screw Machine Cams

cams. This device has been found more convenient than the templet regularly supplied by the Brown & Sharpe Mfg. Co. As will be noted, there is room enough around the two outer portions for three forms suitable for laying out the cut-away places between the lobes on the lead cam where the turret is revolved. The forms on this templet were so designed that one side of the templet can be used for the 4½-inch cam blanks and the other for the 5-inch cam blanks.

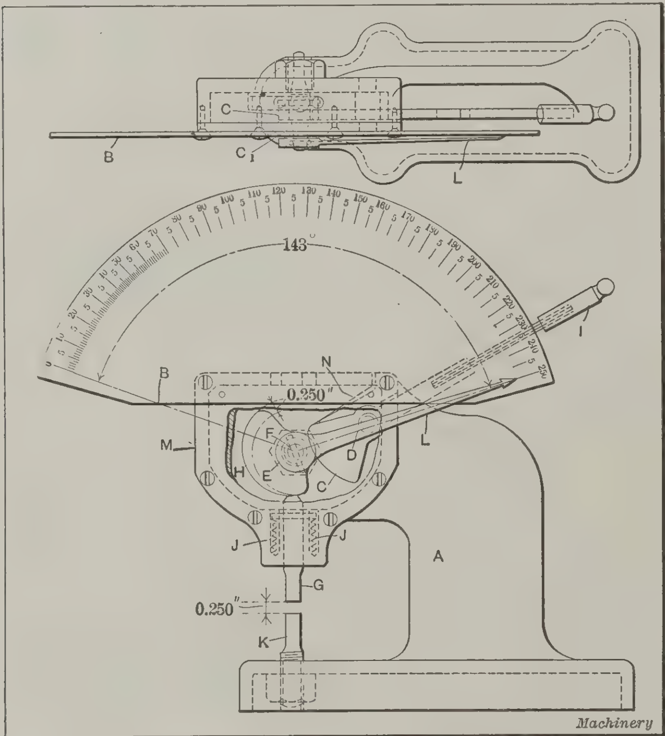
The writer finds it convenient to have the radial lines where the rises and drops meet the outside circumference of the cam, scratched on the templet. For the celluloid templet, the 1-inch center circle is simply scratched on it, but for the steel templet, the hole is machined and made to fit a 1-inch plug; this plug serves to locate the templet in the proper position on the cam blank. J. T. George

Providence, R. I.

[Templets can be used for laying out the rises and drops on the cross-slide and lead cams for the No. 00 Brown & Sharpe automatic screw machine with satisfaction, as the rise from the lowest to the highest point on the circumference of the cam is slight. However, the use of templets, constructed on this principle—drawing a line tangent to a circle for the drop or laying a line off from a circle for the rise—is not advisable on cams for the Nos. 0 and 2 machines. The reason for this is, especially on the lead cam, that the lobes are not all of the same height; consequently, when a rise for example, is laid out from a circle, it requires the same amount of cam circumference to rise a short distance as it does to rise to the full height of the cam. This adds to the time required for idle movements aand consequently reduces the production. The correct method of laying out the rises and drops for Brown & Sharpe automatic screw machine cams was described in the August, 1910, number of Machinery, engineering edition, in an article entitled, "Designing Screw Machine Tools and Cams."—Editor.]

A MEASURING DEVICE

The accompanying illustration shows a measuring device which has been used satisfactorily for measuring the thickness of mica for a number of years in our factory. For this class of work the regular micrometer is too slow, and would also show wear in a very short time. Of course, this device can be used for measuring paper, cardboard, sheet brass, sheet steel, etc. It consists of a cast-iron stand *A* to which a dial



A Measuring Device for Mica, Sheet Steel, etc.

B is attached by screws as shown. The graduations on this dial are laid off to read to 0.001 of an inch in a space of 143 degrees.

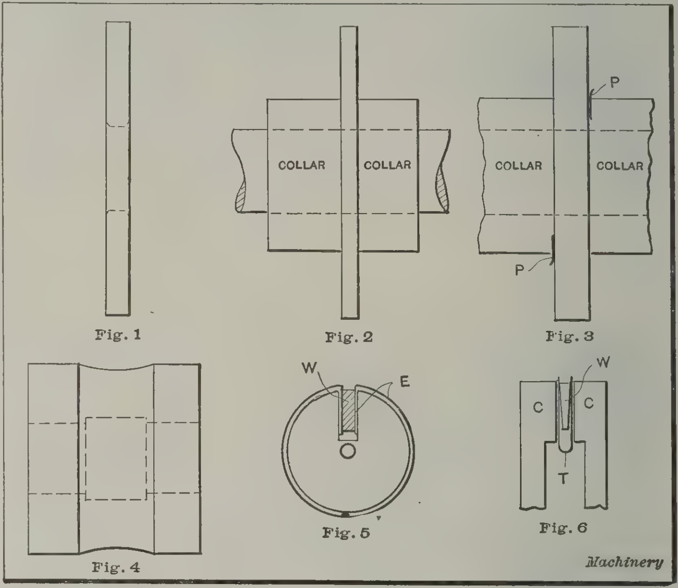
The working mechanism of this device consists of a segment gear *C*, 20 pitch (50 teeth) which is held on a shaft *D*, and is in mesh with a pinion *E* having 15 teeth, and keyed on shaft *F*. The measuring spindle *G* is operated by a cam *H* having a uniform rise of 0.250 inch in 143 degrees. This cam is fastened to the shaft *F*, and is rotated by means of the handle *I* through the segment gear *C* and pinion *E*.

The measuring spindle *G* is kept in contact with the cam *H* by two springs *J* which bear against a pin driven into the spindle. The anvil *K* is adjustable, and is held when set in the desired position by means of a nut as shown. The needle or pointer *L*, which indicates the movement of the spindle *G* is also pinned to the shaft *F*. The steel plate *M*, which is fastened to the casting *A* by screws acts as a cover for the mechanism, and also as a bearing for shafts *D* and *F*. The shaft *F* has hardened tapered journals and bearings, the rear bearing being adjustable in this case to provide for lost motion, this being accomplished by means of a lock-nut. The flat steel spring *N* keeps the spindle *G* as well as the handle *I* in the upward position. J. E. U.

SOME MILLING CUTTER SUGGESTIONS

Though improved management has greatly perfected manufacturing methods, set rules for odd jobs can hardly be formulated. This is true of jobbing and experimental work, some tool- and die-making, and of work in the smaller shops.

Milling cutters play an important part in shop practice. Saws and most other thin cutters frequently fit too tight on



Figs. 1 to 6. Various Suggestions relating to the Use of Milling Cutters

the arbors. By rounding the edges of the hole as in Fig. 1, much of this trouble will disappear. Another way of making a thin cutter work smoothly on the arbor is to use a collar of some width on each side of it when sliding the cutter on or off, as in Fig. 2, where the collars keep the cutter square with the arbor. In slotting, a cutter of the right width is not always to be found, nor is it always profitable to reduce the width of a wider one for the purpose. Lack of truth in arbor and collars will make a cutter leave a slot wider than itself, and it can be made to do likewise by inserting slips of paper between collars and cutter, on opposite sides, as shown at *P*, Fig. 3. It is not to be understood that this will produce an absolutely perfect job, but nine times out of ten it will do well enough.

A cutter used on a special milling machine for a certain manufacturing operation is shown in Fig. 4. A dozen were purchased for the machine, and in due time were ground to the limit. The shop undertook to re-cut them and put them back in service. The job was done, and, in hardening, the cutters contracted most decidedly. As no internal grinder was at hand, nor any lap of that particular size one had to be made. A piece of a shaft, 1/16 inch smaller in diameter than the hole, was procured, and a slot 2 inches long was milled in one end, as shown in Fig. 5, after which a strip of No. 0 emery cloth was wound about the shaft and the lap brought into the slot and held by a wedge; *E* is the cloth and *W* the wedge. Placed on the centers of the speed lathe, it made a cheap lap for the purpose, and was easily and quickly renewed.

To lap out the cutters, they were slipped on the shaft and the lathe started. Then by grasping a stick of soft wood in the hands and using it in the same manner as a file, the cutters were revolved two or three times for every stroke, and

with the pressure exerted, the revolving lap within soon corrected them to size. Kerosene was used as a lubricant.

Taking off a gang of cutters to put in a paper washer at the far end is expensive and uncertain. Expansion collars have done much to remedy this, but there are a few cases where an expansion collar cannot be used—between the halves of an interlocking cutter, for example. There is a way of making the cut larger without dismantling a gang. This way is shown in Fig. 6, which represents the halves of an interlocking side milling cutter. The little steel wedge *W* is driven between the parts *C*, spreading them the required amount; *T* is a strip of tin, the soft metal layers increasing the "staying-in" properties of the wedge. DONALD A. HAMPSON

Middletown, N. Y.

A SUGGESTION FOR THE DESIGN OF CHAIN BLOCKS

The writer believes that inventors and designers of chain blocks have overlooked an opportunity in not having designed a type especially for the use of erectors and small shops or power plants not provided with cranes. For such uses, it is necessary to frequently shift a chain block from one point to another in order to place it over the piece to be lifted. In doing this, the principal difficulty lies in getting the block down from one place and up in another. Much time is lost, because it is the heaviest part of the block which must be lifted and placed at the top, while the light part, the hook end, stays on the floor. It would seem that it would be possible to change this so that the light part, which one man could easily carry, would be placed at the top, and the heavy part of the block would be at the lower end. The only objection seems to be that in handling a load where there would not be sufficient head room to hang it far enough below the block, and where it extended too far horizontally, one might not be able to work the hand chain, but such cases would occur so rarely that they would hardly need to be considered.

It is also frequently a great convenience to be able to use a chain block for horizontal pulling, but the chain guides on the blocks generally made are not adapted for this purpose. It would be easy, however, to shape some hand chain guides so that they would take care of that chain, and a lug to peel the load chain from the slack side of its sheave would be sufficient for that chain.

A new device for chain blocks in such a building as a power house is to stretch a wire rope permanently as high under the roof trusses as possible and across the building. On this wire is put a light trolley with a grooved wheel about 6 inches in diameter, and from the bottom of the trolley is hung a chain block. The small wheel rolls freely enough so that the trolley can be moved on the rope, but not so freely that it will run away on a down grade. Some sag, of course, is required in the rope; otherwise, it woud be placed under too high a stress initially, and there would be nothing left for the handling of the load. The installation the writer has in mind is in a building 40 by 105 feet, having a height of 22 feet under the trusses. Three ¾-inch ropes are stretched lengthwise so as to have four feet of sag. With them, one man handles anything in the building weighing less than a ton. Four or five men were often required for the same pieces, before the ropes were put up. F. D. BUFFUM

Ellsworth, Pa.

CHAIN CASES FOR AUTOMOBILE TRUCKS

The remarks made by Mr. W. F. Schaphorst and C. P. W., in the April issue of MACHINERY lead me to further defend the practice of uncovered chains. I would not dispute that, theoretically, cases are an advantage, but there are some things which are theoretically correct that are not adopted commercially, because the advantages gained do not outweigh the disadvantages. I believe this to be true of chain cases.

The recent exhibitions of commercial cars seem to bear out this statement. Only a small number of models exhibited were equipped with chain cases. The *Power Wagon*, a Chicago automobile periodical, recently published a review of the mechanical features of 381 models. Of this number, only twenty-three had chain cases and seventy-seven were shaft-driven, which means that only about fifteen per cent of chain-driven cars are equipped with chain cases. Mr. Chester S. Ricker says in the *Horseless Age* in an article entitled "A Review of the Recent Automobile Shows": "On most trucks the chains are exposed, but upon several they are enclosed, as on the Sampson and on the Lozier." Mr. A. C. Woodbury, in the same journal of January 31, states: "A year ago one of the things that looked most promising was what seemed to be a general movement toward enclosed chains for the rear wheels of the larger trucks. The movement seems to have fallen flat, for although the Lozier is fitted with a sheet steel case and the Sampson has retained it, there is, on the whole, a smaller proportion of chain cases than last year."

An instance where chain cases would have proved a disadvantage was forcibly called to my attention after my first article was written. I was sent out to supervise the replacing of a rear axle that after years of service had broken on the road. The truck was jacked up, the axle replaced, and all the adjustments made on the road. If the truck had been provided with chain cases they would have had to be strong enough to support a seven-ton load or they would have been crushed.

In regard to the skill of drivers, it may not be out of the way to refer to the transcontinental trip made by the Saurer and Packard trucks. In this case the drivers were competent to negotiate roads of every description, without any appreciable injury to their chains. Yet, how many chain cases would have been broken on this trip if the trucks had been provided with them? I do not think it logical to compare sprocket chains and gears. A small obstruction will prevent a gear from turning, whereas, a sprocket will turn even with rather severe obstacles in the way.

I believe that a campaign of advertising the proper methods of mounting chains would lead to a more general use of chain cases. It is apparent that, at the present time, the campaign for chain cases is not being carried on by the chain manufacturers so much as by the salesmen of internal gear drives, worm drives, and other enclosed forms of drives, who are calling the attention of the public to the theoretical advantage of chain cases.

Brooklyn, N. Y. JOHN F. WINCHESTER

ESTIMATED COST OF MAKING MECHANICAL DRAWINGS

The following method may be used for determining the average cost of producing mechanical drawings. Assume that

A = average number of drawings of a given size produced in one year by one man,
B = number of square inches per drawing,
C = number of working days in the year,
D = draftsmen's rate of wage per hour,
E = working hours per day.

Then the labor cost per square inch of drawing equals $\frac{CDE}{AB}$.

In the same way the average cost per square inch of tracing and checking is determined. The cost of drawing paper and tracing cloth per square inch is also calculated. The total cost of the completed tracing per square inch equals the sum of the unit drafting, tracing, checking and paper costs. From this the average cost of any tracing of a given size can easily be determined.

In a drafting-room where the work consisted of assembly and detail drawings of punches and dies, jigs and fixtures, and tools in general, it was found that one draftsman could complete 262 drawings in 306 eight-hour working days. The draftsman's rate was fifty cents an hour. The size of the drawings was 16 by 23 inches. Hence the cost per square inch of the drawings was found as follows:

$$\frac{306 \times 8 \times 0.50}{262 \times 16 \times 23} = 0.0127 \text{ dollar.}$$

The cost per square inch of the tracing work was found in the same way to be $0.0054, and for checking $0.004. The cost

per square inch of drawing paper and tracing cloth was found to be \$0.0005. Hence the total cost per square inch of the completed tracing will be:

$$0.0127 + 0.0054 + 0.004 + 0.0005 = 0.0226 \text{ dollar,}$$

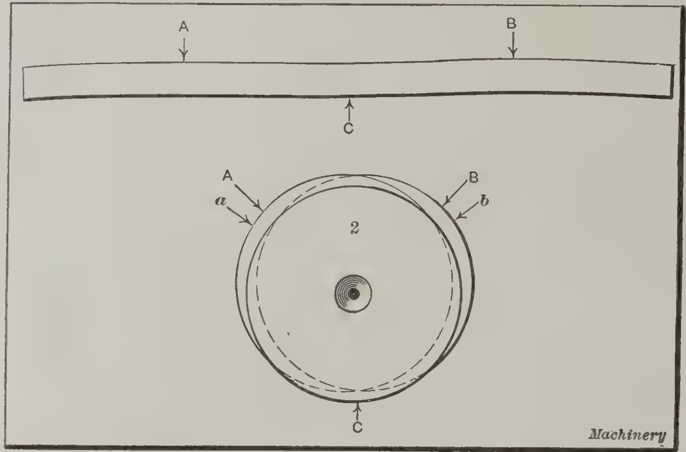
or the total cost of producing a drawing 16 by 23 inches within its borders would be: $16 \times 23 \times 0.0226 = 8.32$ dollars.

The cost of blueprints can, of course, be easily determined, and is quite independent of the cost of drawing, depending upon the number of blueprints required from each drawing. To all of these costs must be added a certain percentage for "overhead expense," if the absolute cost of the drawing is to be determined.

Cicero, Ill. E. A. Peterson

STRAIGHTENING SHAFTING

In the March, 1912, number of Machinery, an interesting article on straightening shafting, by Mr. J. W. Brandle, was published. Having had some fifty years' experience, the writer would like to say a few words on this subject. The accompanying engraving shows a two-inch rough shaft, 10 feet long, which is bent at two places about 2 feet 6 inches from each end. There is also a bend in the middle. After having "chalked" the shaft, it is found that the chalk marks are located as at A, B, and C. The beginner usually has trouble



Indicating Method of Straightening Shafting bent in Three Places

in straightening a shaft of this kind. He applies pressure at the points indicated by the chalk marks, the result being that the shaft is bent too much toward the opposite side. The proper method is to shift the marks a trifle as to a and b as indicated in the engraving, the shifting being perhaps about ten degrees. Pressure is then applied first at a and then at b. This throws the three bends into one direction, so to speak—that of the bend at C. Pressure is then applied at this place and the shaft will soon be found straight enough to clean up.

Birmingham, Ala. W. B. Odell

METHOD OF DIMENSIONING DRAWINGS

The Taft-Peirce Mfg. Co., of Woonsocket, R. I., issues the following rules for its draftsmen.

"If a limit can be permitted above and below the dimension, specify the limit thus: ±, giving the amount of limit tolerated. If a limit can be permitted below the dimension only, specify it thus: —, giving the amount of limit tolerated. If a limit can be permitted above the dimension only, specify it thus: +, giving the amount of limit tolerated.

"Fractions: Unless limits are specified, common fractions are capable, in the main, of a wide variation of limitation. For the purpose of fixing a standard, however, it shall always be understood that if a fraction is not accompanied by a limit, a minimum limit of ± 0.010 inch is permissible.

"Fractions that must be held closer than this must be accompanied by a specified amount of limit."

In order to make it unnecessary to give limits in all instances on the drawings, it is understood that two-place decimals have no limits added in case a tolerance of ± 0.005 inch is permissible. A three- or four-place decimal should be used only when absolutely necessary. If the tolerance is not added, a limit of ± 0.0015 inch is permissible. Dimensions to be accurate to three or four decimal places should be marked "exact."

Worcester, Mass. H. P. Fairfield

A MULTIPLYING ATTACHMENT FOR AN INDICATOR

In Fig. 1 is shown a multiplying attachment which the writer has used with an indicator of the type shown in Fig. 2. The principles employed might be interesting to the readers of Machinery. The device needs very little explanation. It will be sufficient to say that the area of the large plunger A, which is applied to the work, is ten times the area of the small plunger B, which, when the instrument is attached to the indicator proper, bears against the working anvil of the indicator. The cavity between these plungers is filled with heavy oil or grease of the best quality. The movements of the plungers

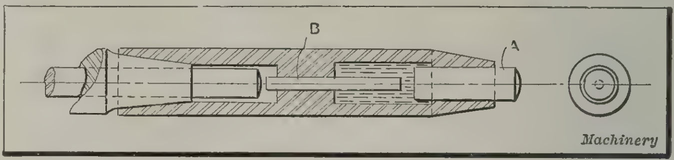


Fig. 1. A Multiplying Attachment for the Indicator shown in Fig. 2

are in inverse proportion to their displacement areas, and, therefore, any movement of the large plunger is transmitted to the indicator proper, multiplied ten times.

It was the writer's practice to true up work such as buttons, etc., as accurately as possible with the indicator minus the attachment, which would be within 0.001 inch. Then by attaching the multiplier this error would read on the dial of the indicator as 0.01 inch. Thus when this error was again corrected to read 0.001 or 0.002 inch, the writer knew the work to be accurate within 0.0001 or 0.0002 inch. Needless to say such accuracy can only be obtained with the use of a machine having very true bearings, and set on a very solid foundation.

The writer cannot forebear mentioning that he has had considerable amusement owing to the fact that he did not at once disclose the secret of the innermost mechanism of the device. The unique and learned explanations of the complicated mechanism it was supposed to contain, and the compliments to a mechanic capable of arranging so much mechanism of a com-

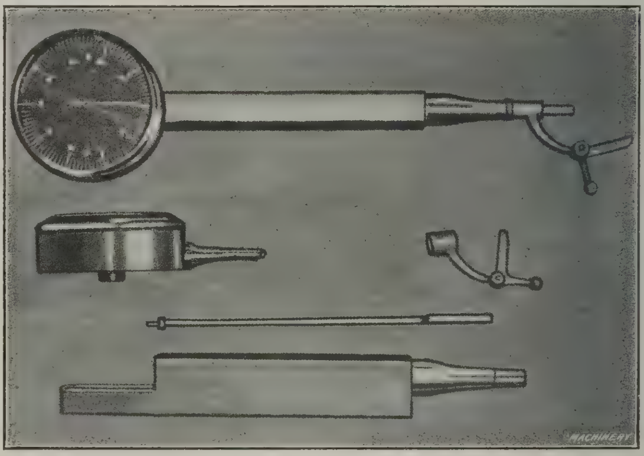


Fig. 2. Indicator to which the Device in Fig. 1 was attached

plicated, delicate nature in so small a space, were very entertaining indeed.

In making one of these attachments, considerable care should be taken to have the plungers fit properly. If they are too loose, the oil leaks out and destroys the accuracy, and if too tight, they will not work properly. T. Covey

LEAD HAMMERS FOR SHOP USE

The lead hammer is an indispensable tool in the modern machine shop. Before the advent of finely finished jigs and fixtures, when the tools for interchangeable manufacturing consisted of some old straps and boiler plate taken from the scrap heap, the machinist generally pounded the work on and pounded it off again. This process became a habit, and even yet, we frequently see some drill press hand raising the lid of a nice jig with a machinist's hammer. Some shops still build jigs without any regard to looks or finish, but the

majority of them recognize the fact that a nice looking tool will be more carefully handled and last longer than one that is not given a good finish.

Fig. 1 shows the detail of a lead hammer we make for our own use, which has saved our jigs from being all battered

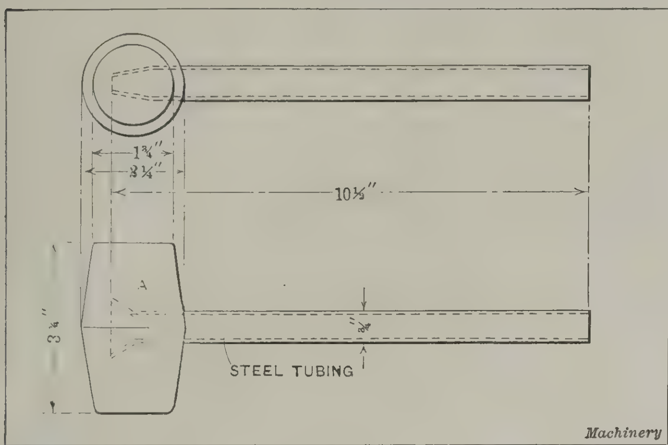


Fig. 1. Details and Proportions of Lead Hammers

up, besides giving the men something to hammer with when a steel hammer would not do. The handle is made of ¾-inch steel tubing, flattened at the end as shown at *A* to keep the mallet part from slipping off. The mallet part is made of 60 parts lead, 30 parts tin and 10 parts antimony. This makes a good general-purpose hammer, but should a softer one be

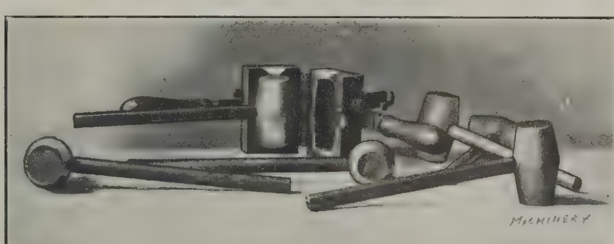


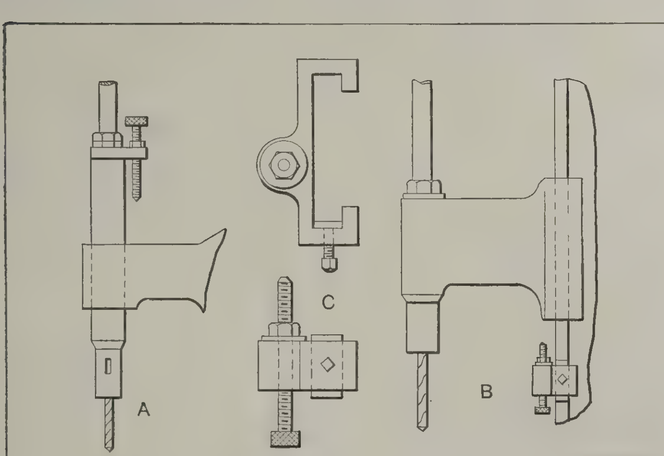
Fig. 2. The Molds for Casting the Mallet Part of the Hammers—Some Mallets fitted with Handles

required, add a little more lead. The molds for producing the mallet part of the hammer are illustrated in Fig. 2, where some completed hammers are also shown. G. W. LINN

Indianapolis, Ind.

STOPS FOR DRILLING MACHINE SPINDLES AND HEADS

It seems strange that none of the new drilling machines possesses a drilling stop. I have noticed in a large machine shop from 10 to 20 drilling machines in daily use and not one



Adjustable Stops for Drilling Machine Spindles and Heads

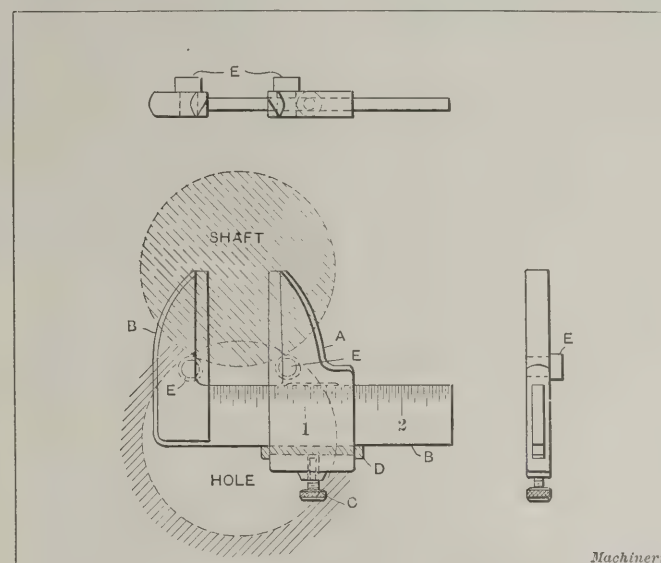
of them has even a respectable stop. The accompanying illustration shows stops for the spindle and also for the head. At *A* is shown a stop which can be applied to the spindle of a sensitive drill, while at *B* is a stop for a movable head, located on the column. An enlarged view of the stop at *B* is shown at *C*. To gage a hole for depth, set the point of the set-screw to a sizing block when the point of the drill is in the same plane as the top face of the work.

Brighton, Mass. F. RATTEK

MARKING-OFF GAGE FOR KEYWAYS

The accompanying illustration shows a handy gage for marking off keyways in hubs of pulleys, gears, etc., and at the ends of shafts. The illustration shows the gage applied to both a hub and a shaft.

The jaw *A* which moves along the bar *B* is set to the required width of keyway by means of the graduated scale on the bar, and locked by tightening the screw *C* on the gib



A Marking-off Gage for Keyways in Hubs and Shafts

D. The gage is then applied to the hub or shaft as shown, the hardened pins *E* being held against the sides of the hole, or shaft, while the keyway is being marked off. The gage has a capacity for shafts up to 6 inches in diameter.

J. M. L.

MAKING PISTON RINGS—A CRITICISM

The writer takes exception to some of the methods described in the article: "Making Piston Rings" in the April, 1912, number of MACHINERY. It is stated that the rings are turned eccentric, and then a parting or cut-off tool is used and the first ring is cut off within 1/64 inch. This must mean that 1/64 inch thickness of metal is left at the thin side, but how much stock would then be left at the other side? Again, does it produce good results to use a cut-off which generally chatters and take a finishing cut at the same time? Do not the rings give trouble by breaking off before they are cut way through?

Some firms scrap their rings if they are 0.0015 inch out of parallel. Do the rings made by the method described come as close as that? The writer does not like the milling practice mentioned. It is said that clamps are not required because of the snug fit. In that case it seems that it would be difficult to put them on quickly. It is also mentioned that they can be held with the fingers, but that seems to be a rather dangerous practice. The question of safety is being agitated at the present time so much that one can not indorse any practice that tends to lead away from the safest possible methods.

Milwaukee, Wis. W. BUTZLAFF

STATING PROPORTIONS

In a contemporary I see recommended a mixture of "55 parts tin, 45 parts zinc and 1 ounce of bismuth." Does the author mean 55 ounces of tin, or 55 pounds?

Very often we see mixtures or alloys recommended, in which every figure given is a factor of 5 or some other prime number. Why say "25 to 35" when "5 to 7" is more simple? Everyone speaks of an "8 to 1 gun-metal"; that is much more readily kept in the head than "16 to 2" or "40 to 5." Why not in all other cases use the most simple factors?

Dresden, Germany. ROBERT GRIMSHAW

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

MIXING BEESWAX WITH ALUMINUM SOLDER

C. E. L.—A formula for aluminum solder was published in the January, 1912, number which I have tried with very unsatisfactory results. In attempting to mix the beeswax with molten tin and zinc I came near causing a bad fire. The beeswax was apparently entirely consumed, and just what benefit it is to the mixture, I cannot understand.

A.—The contributor of the receipt assures us that the formula is quite correct, being exactly as given to him by the originator, and as such has been used for a number of years. Care must, of course, be taken to prevent the beeswax from taking fire by keeping the heat of the mixture as low as possible, consistent with its remaining in the molten state. Should the heat become too great, the ladle can be lifted from the fire, and in fact it is advisable to remove it from the fire when adding the beeswax, which should be inserted in small pieces, one at a time. If, however, the mixture does take fire it is an easy matter to put a cover over the pot and smother out the flame. It might be thought that the pine stick mentioned would catch on fire, but if the metal is kept at the proper heat, neither the stick nor the wax will be fired. The originator of the formula particularly recommended the use of the pine stick.

FROSTED OR CORRUGATED GLASS FOR FACTORIES

E. H. B.—I am a constant and appreciative reader of MACHINERY and admire the way it handles mechanical topics. I would be glad to see a discussion of the merits of frosted glass in the windows of factories employing skilled labor.

A.—The advisability of the use of frosted glass in the windows of factories employing skilled labor is a question of general interest. We are not in favor of frosted or corrugated glass for small floors. The effect is depressing, having a tendency, we believe, to cause eye strain. In large factories, however, the conditions are different. The dimensions of floors are great enough to allow the workers to change the focus of their eyes by looking at distant objects and the mental stimulus of the outside world is not required so much in the large shops, as there is a variety of action within to be seen. Corrugated or frosted glass can be used advantageously with clear glass in small shops, placing the corrugated glass on the sunny sides and the clear glass on the shady sides. The light from the sunny side is diffused by the glass and that coming from the shady side is diffused by reflection. To obtain a large flood of diffused light should be the object of the plant designer. The use of frosted glass to prevent men from looking out, does not appeal to us. If the shop conditions are right little time should be wasted by men staring out of the windows. Discussion is invited.

SEASONING CAST IRON FOR MACHINES

R. L. S.—Is there any practicable method or process for "seasoning" cast iron which does not require taking roughing cuts and then allowing the castings to stand for several weeks or months to prevent warping after finishing? Our system is to bore or plane castings in the rough and let them stand for some time to take whatever shape they will. They are then put back on the machines and finished. This method is costly, and during the busy season is too slow, and besides it is not entirely satisfactory as we often find that the parts change shape after finishing even though seasoned several weeks.

A.—The change of shape of castings after machining is due to readjustment of internal stresses thrown out of balance by the removal of the surfaces. These forces set up by irregular cooling of the metal in the foundry may be partially eliminated by reheating. Tumbling, rapping and repeated dippings in hot water have an accelerating tendency, but so far as we know the cheapest and most effective method is that commonly pursued by the machine tool builders, *i. e.*, taking roughing cuts off the parts to be finished and then letting the castings stand for several weeks or months to season. Then little change takes place, as the internal stresses have been largely neutralized by the effect of alternate heating and cooling due to variations in temperature. Any suggestions from readers as to ways and means of cheaply accelerating the seasoning process will be appreciated.

CONDUCTIVITY OF WROUGHT-IRON PIPE

F. C. P.—In connection with the design of a cooling apparatus for oil, in which the oil is cooled from a temperature of 100 degrees F. to 60 degrees F. by circulating through a coil placed in a water bath, it is required to find the approximate number of British thermal units (B. T. U.) that will pass through the walls of a 1¼-inch iron pipe, per hour, per square inch of radiating surface, for each degree difference of temperature of the liquid inside and outside of the pipe.

A.—The coefficient of conductivity of iron, that is, the quantity of heat in therms (252 therms = 1 B. T. U.) that will pass through one square centimeter of surface, one centimeter thick, in one second, per each centigrade degree difference in temperature, is (for temperatures here dealt with) on an average 0.165. Transforming this to English units, the quantity of heat in B. T. U. that will pass through one square inch of surface, one inch thick, in one second, for each degree F. difference in temperature is

$$\frac{0.165 \times 2.54 \times 2.54 \times 5}{252 \times 2.54 \times 9} = 0.00092 \text{ B.T.U.}$$

As 1¼-inch wrought-iron pipe has a thickness of 0.140 inch, the quantity of heat that will pass through its walls per square inch of surface per hour for each degree F, difference in temperature equals:

$$\frac{0.00092 \times 60 \times 60}{0.14} = 23.6 \text{ B.T.U.}$$

LOCATION OF VALVES IN PIPES

R. J.—Should valves be placed with the pressure on top or underneath the valve in main steam lines or in boiler feed pipes? What practice is followed in the United States Navy? The writer was somewhat surprised upon consulting two engineers engaged in power plant construction to hear directly conflicting opinions on the positioning of valves in these pipes.

A.—The engineer-in-chief of the Bureau of Steam Engineering, Navy Department, states that the requirements of the machinery specifications on locating valves in main steam and boiler feed pipes with reference to whether the pressure is above or below the valve are as follows: "All high-pressure steam valves over six inches diameter, except boiler stop valve, will have flat faced seats, with the pressure on the back of the valves, and will be so designed that the stuffing-box may be packed while under pressure. High-pressure steam valves six inches diameter, and below are installed to close against the pressure, in order that the valve stem may be packed when the valve is closed. In the feed system there is a feed check valve and stop valve on each boiler. These two valves are in the same casing, the stop valve being between the check valve and the boiler, opening against the boiler pressure and so fitted that the stuffing-box may be packed when pressure is on the boiler. The remaining valves in the feed system are gate valves, except the suction and discharge valves at pumps, which are stop valves, except where the connections are such that water may run to the bilge in case valves are left open, under which conditions stop lift check valves, so arranged that they may be kept off their seats when desired, are fitted."

METAL PAINT TO WITHSTAND ALCOHOL

Replying to the question by S. J. B., in the April number of MACHINERY, for a paint for brass vessels which will successfully withstand the action of diluted alcohol, the writer wishes to say that years ago, during his apprenticeship as a nautical instrument maker, a paint made of white zinc and pure turpentine was used, two coats of which was applied. White japan was also used, the objects afterward being baked in an oven. This, however, was more expensive. The instruments so painted were liquid ship compasses, and the liquid consisted of rectified spirits of wine reduced 50 per cent with distilled water.

Denver, Colo. ROBERT NEILL

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE MELLING-NORTHRUP DIE-SINKING MACHINE*

The superiority of drop forging over casting for certain classes of work is well known, but the cost of making dies of intricate shape has impeded the progress of this art to a considerable extent. It has been necessary in connection with a great deal of die work, to rough out certain impressions with a chisel by hand, and then scrape and "type" the impression to a finish. When the impression is deep and narrow, this work of chipping, scraping and typing will be found to be slow and difficult. Many devices and attachments for both the milling machine and the ordinary die-sinking machine, have been devised to eliminate chipping and the difficult hand work. Some of these attachments are very

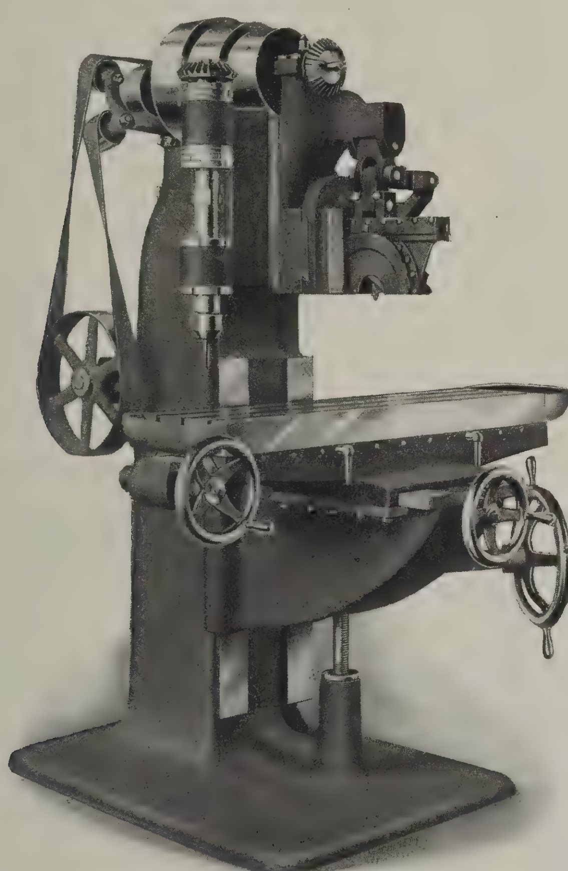


Fig. 1. Die-sinking Machine manufactured by Melling-Northrup Co.

ingenious and have been of inestimable value to the die-sinker. When not more than two types have to be sunk in a die, it is the usual practice for the die-sinker to use a chisel and type, because the work can be accomplished much cheaper and quicker in this manner, as it takes considerable time to set up a cherrying attachment. Having worked as a die-sinker for about ten years and experienced the need of an improved device for this work, Mr. Herman Melling of Melling-Northrup Co., Jackson, Mich., set about to design a machine which would meet all the existing requirements of drop-forge die-sinking. After considerable experimenting with different attachments and devices for this work, he conceived the idea of building a machine which would be suitable both for routing and cherrying.

The machine, which is shown in Figs. 1 and 2, does away with the necessity of typing most dies, so that the impression can be completed without resorting to any chipping or typing. The machine is of the column-and-knee construction, and the aim has been to make it heavy and rigid enough to eliminate chatter. The knee has a vertical adjustment on the column, which is effected by hand-wheel *A*. The table is long and wide, and is traversed by hand-wheel *B*. Lateral adjustment of the table on the knee is obtained by hand-wheel *C*. All movements of the saddle and table are effected by hand, no automatic feeds being employed to confuse the workman and make the machine more difficult to operate. These hand-wheels are all in convenient reach of the operator, and the table, saddle and knee are equipped with lock levers.

This machine is so arranged that it can be used for cherrying out an impression in a die, and also as a vertical milling or routing attachment, and both devices can be brought into operation without resetting the work. The vertical milling head *D* carrying the routing cutter *E*, is hinged at *F*, and is held to the column, when in the working position, by two bolts *G*. This vertical milling head can be swung out of the way by simply removing the bolts *G*, when it is necessary to use the cherrying cutter. The vertical milling spindle is driven from the cone pulley *H* through miter gears *I*, and it runs in solid, taper, phosphor-bronze bearings. The thrust, instead of being taken on the lower journal, is transferred to the upper journal, in order to equalize the friction on both bearings and, consequently, prevent them from heating excessively under heavy cutting action. The spindle can be locked by a spring-actuated wrench, which fits over a flattened portion of the spindle, when it is desired to hold the latter rigidly to remove the routing cutter.

Construction and Operation of the Cherrying Head

We now come to the most interesting part of this machine, namely, the cherrying device. This consists essentially of a segment head *K*, which carries a cherrying cutter *L* having teeth on half of its periphery and sides, the latter being beveled at an angle of 7 degrees, which takes care of the draft necessary in the dies. The axis of the die-sinking cutter *L*, is located in line with the axis of the segment head *K*, the latter being oscillated by a rack *M* which, in turn, is operated by a lever *N* and crank arm *O* (see also Fig. 3). This arm is free to slide in a bronze box *P*, which is fastened to the cam-wheel *Q*. The cam-wheel *Q* is rotated by a pulley *R* (Fig. 3), which, when it is desired to use the cherrying attachment, is pinned to a collar fastened on the main driving shaft by a spring-plunger *S*. The belt runs over idler pulleys *T* and onto a lower pulley *U* which drives the cam-shaft and cam-wheel.

The cherrying cutter *L* cuts into the impression when the rack *M* (see Fig. 5) is on the return stroke. Owing to the eccentric location of bronze box *P* on cam-wheel *Q*, a quick-return movement for the cutter is obtained, the cutting being done on the slow movement of the eccentric, or, in other words, when box *P* is at the bottom and farthest from the rockshaft *V*, Fig. 3. As shown in Fig. 1, the cherrying head slides in another slide which, in turn, is mounted on the face of the column and can be moved in a lateral direction. Connected with the cherrying head by a toggle joint, is a link *Y* (Fig. 4), which, in turn, is fastened to a bellcrank A_1, shaft B_1 and cam-lever C_1. Located on the lower end of cam lever C_1, is a roll which runs in a groove cut in cam-wheel *Q*. This cam transmits an oscillating movement to the cam lever, which operates the toggle, thus raising and lowering the cherrying head. This action, as can be seen, will remove the cherrying cutter from the impression on the back stroke, owing to the relative positions of the eccentric crank *P* and the operating portion of the groove in the cam-wheel.

When the cherrying cutter is to be sunk down into the die to produce an impression the exact duplicate of its own shape, it is not necessary that it be relieved on the sides, but when it is necessary to make an impression much longer

* For information previously published in MACHINERY on drop-forge die-sinking, see "Drop-Forge Die-Sinking," July, August and September, 1911, and articles there referred to; "Making Duplicate Drop Forging Dies" and "Compound Trimming Die," July, 1911, engineering edition; "Tempering Drop Forging Dies," January, 1908, engineering edition. See also MACHINERY'S Reference Series, No. 45.

than the width of the cherrying cutter, the cutter on being returned for the next stroke must be relieved or else it would be dulled very quickly and would not produce a good finish. This relief is accomplished in a very interesting manner. As can be seen in Fig. 4, bell-crank A_1 is formed into a yoke in which a stud D is held. Sliding on this stud and also on

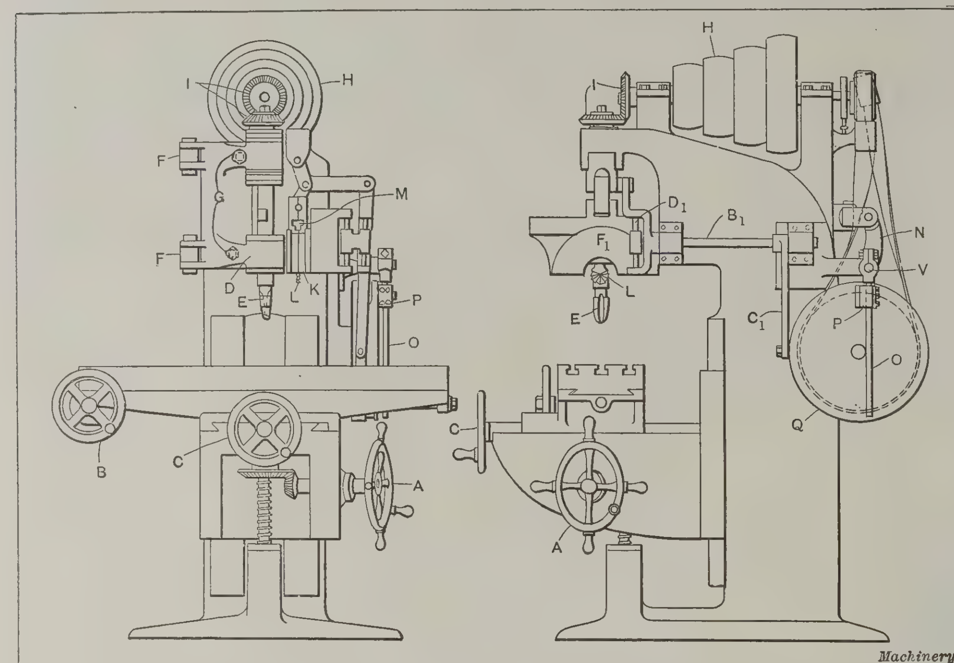


Fig. 2. Front and Side Elevations of the Melling-Northrup Die-sinking Machine

a second stud E_1, held in lugs cast integral with the slide in which the cherrying head is mounted, is a yoke F_1. This yoke is provided with a lug in which a spring plunger is held, the latter fitting in a series of drilled holes in the cherrying head slide. Now by changing the position of this yoke relative to the center of the cam-shaft B_1, the desired movement of the

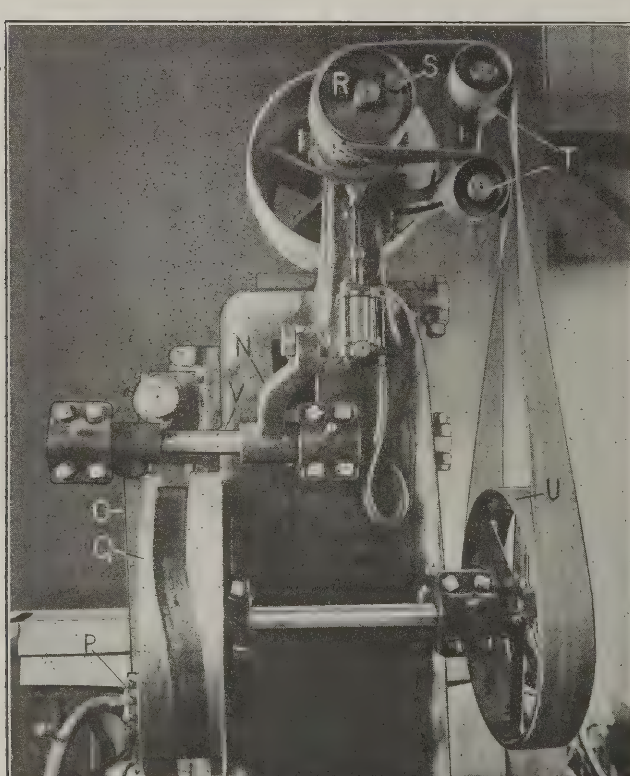


Fig. 3. Rear View showing Drive for Cam-wheel and Compressed Air Pump

cherrying head slide can be obtained. When the plunger is in direct line with the center of the shaft B_1 no movement at all will be transmitted to the slide, and when the plunger is shifted to a position above or below the center, a corresponding movement is given to the slide, so that the cutter is relieved to allow it to return free and without roughing up the work.

The action transmitted to the cherrying head by means of this toggle-joint motion and sliding yoke, is clearly indicated in Figs. 6 and 7. In Fig. 6 the toggle joint is shown in the position it occupies after being operated by cam Q; hence the cutter L has been raised and relieved from the bottom of the impression. The spring plunger G_1, as can be seen, is located above the center of the cam-shaft, and, consequently, has relieved or drawn the cutter away from that portion of the die in which it was working. In Fig. 7 the toggle joint is shown straightened out, in which position the cutter would be at work. Of course, while the toggle joint is straight, no side relieving movement is given to the cherrying cutter L.

A little device that will be appreciated by most die-sinkers is a small air pump which is operated from the cone-pulley driving shaft by an eccentric, as shown in Fig. 3. The compressed air is carried to the front of the machine through flexible tubing. This tube passes through holes drilled in the frame of the machine and is held, when not in use, in a spring socket H_1 as shown in Fig. 4. With this simple little device, it is possible for the die-sinker to always keep his work free from chips and dirt.

The Cherrying Cutters

In Fig. 8 is shown a representative group of die-sinking and routing cutters. The routing cutters A, as is the usual practice, are made with but two cutting edges. They are relieved on the sides, ground on the ends, and are somewhat similar

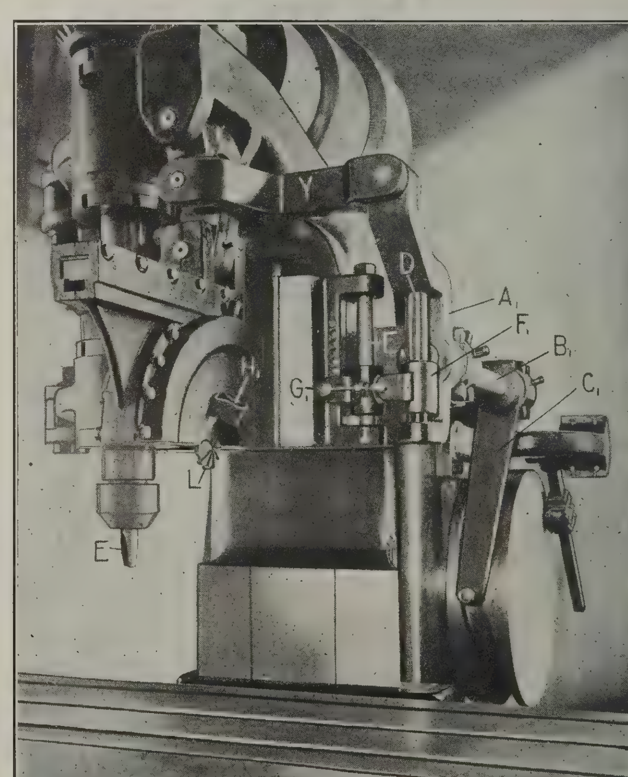


Fig. 4. Front View showing Relieving Mechanism for the Die-sinking Cutter

in shape to twist drills. Of course, this type of cutter would only be used for roughing purposes. When any special shape is to be reproduced, a cutter would be made to that shape. The cherrying cutter shown at B has six teeth and cutting edges on the sides that extend to the center or axis. The

teeth, as has been previously mentioned, are backed off on the periphery and sides, and are also tapered on each side to an angle of 7 degrees, this being the angle of draft usually allowed in drop-forge dies.

It has been found from actual experience that, irrespective of the diameter, six teeth will give the best satisfaction. These cutters are made from drop forgings, and are milled on a special fixture, which is an exact duplicate, as far as the

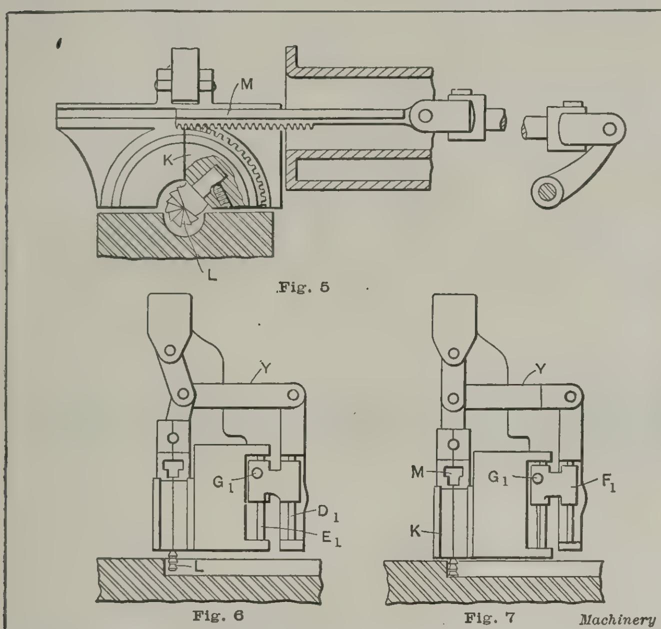


Fig. 5. Section of Cherrying Head showing how it is operated. Fig. 6. The Cutter in the Relieved Position. Fig. 7. The Cutter at Work

radius is concerned, of the segment head in the cherrying attachment. Owing to the construction of this die-sinking tool, and the attachment in which it is used, it is possible to cut in to the center and completely mill an impression without doing any chipping or typing. Cutters have been made ranging in diameter from ¼ inch to 3 inches.

Work Done by Melling-Northrup Die-sinking Machine

In Fig. 9 is shown a die block which has been used for testing the machine. The rapidity with which the majority

Fig. 8. A Representative Group of Routing and Cherrying Cutters

of these impressions have been sunk is marvelous, considering the time that it takes a man to do this work by hand. The impression *A* is 1½ inch in diameter and ¾ inch deep, and the width of the impression is 5/16 inch. This impression was sunk in 7½ minutes, without previous roughing operations. The smaller hole *B*, which is 1 inch in diameter, was formed in 3 minutes. This test block is made of the regular crucible steel used for drop-forge dies and contains from 0.40 to 0.50 carbon.

The small block shown to the right, has an impression *C* sunk in it which is 3 inches in diameter, and the width of the narrowest part is only 5/16 inch. This impression was made in 45 minutes, which includes roughing with the routing attachment. A die-sinker would certainly have difficulty in producing a similar impression with a chisel or by any other means, on account of the great depth and small space in which he would have to work. If this hole had been sunk with an ordinary cherrying cutter, it would still be necessary to do a little hand work, as the ordinary cherrying cutter does not cut clear to the center, and, consequently, does not finish the impression. On holes much larger than 1½ inch in diameter,

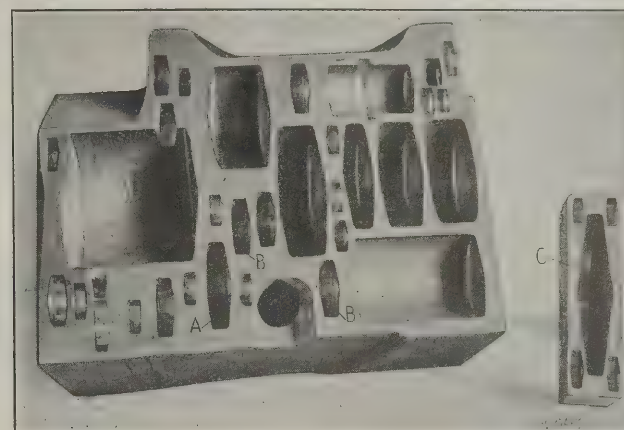


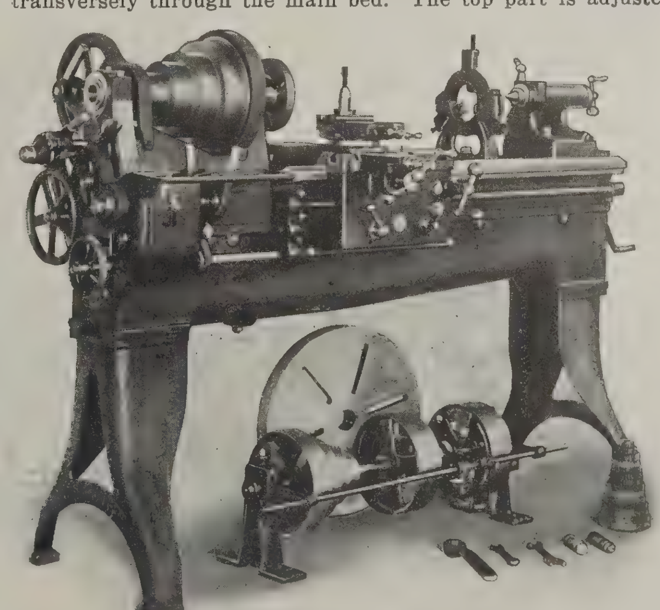
Fig. 9. A Drop-forge Die-block used in Testing the Capacity of the Machine for Sinking Holes quickly

it is always best to rough out the impression with the routing cutter, as this will relieve the cherrying cutter of considerable hard work.

The first machine built by the Melling-Northrup Co. was sold to the Baker Drop-Forge Co., Jackson, Mich. Other machines with some changes are now in process of manufacture.

BARNES EXTENSION-BED GAP-LATHE

The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now building a 14–24-inch gap-lathe which embodies a number of improved features. The feed changes are effected by quick change gear boxes giving six variations ranging from 0.007 to 0.049 inch. The bed is of a broad, deep pattern and well braced. The top and main beds are fitted together by a dovetailed construction which permits the top section to be firmly held in any position by means of clamp bolts which extend transversely through the main bed. The top part is adjusted



Barnes 14-24-inch Extension-bed Gap-lathe

for varying the width of the gap by a screw and crank at the tailstock end.

The headstock is of a heavy design, and the spindle has a diameter of 2 15/16 inches in the front bearing. A 1 9/16 inch hole extends through the spindle so that 1½ inch stock can be

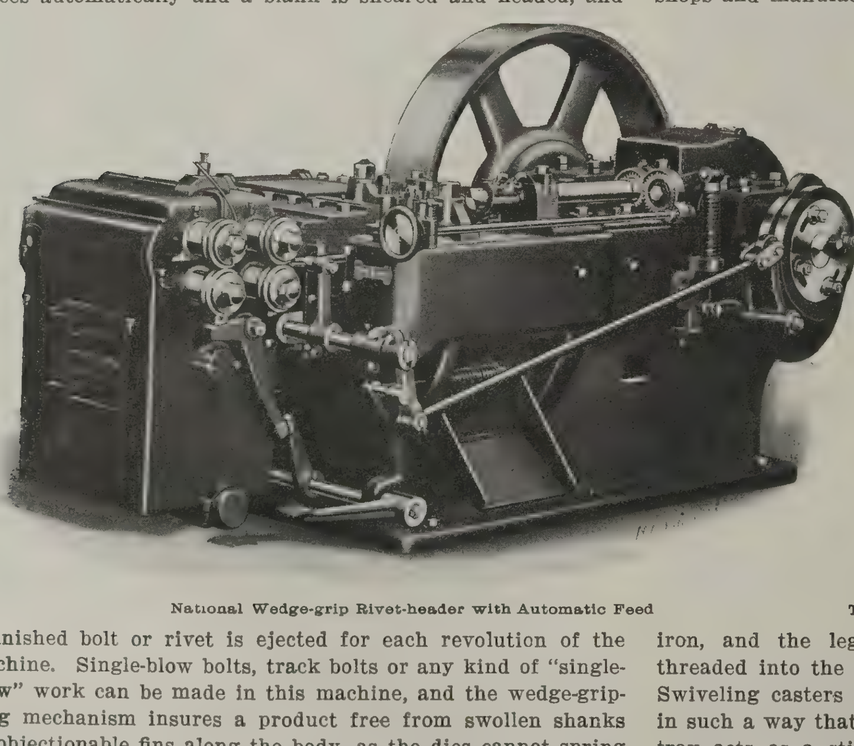
inserted. The spindle runs in split bronze bearings which are carefully scraped and fitted. The cone pulley has four steps, the diameters of which are 4, 6, 8 and 10 inches, and the width 2⅛ inches. By means of the back-gears which have a ratio of 11 to 1, eight spindle speeds are obtained. The cone can be quickly locked and unlocked for direct or indirect driving, by means of a push-pin and without the use of a wrench. The tailstock is of the offset type.

The carriage is extended in front to provide a firm support for the tool when turning large diameters. The carriage has a long bearing on the front V and a flat bearing at the rear. It is fed by a splined screw and can quickly be clamped to the bed for cross-feed work. A taper attachment is secured to the back of the carriage and turns any taper up to 2¾ inches per foot.

This lathe has a swing over the bed of 14½ inches, a swing over the carriage of 10 inches, and a swing through the gap of 24 inches. The sizes of the front and rear bearings are 2 15/16 by 3 7/16 inches and 2 1/4 by 2 3/4 inches, respectively. The diameter of the tailstock spindle is 1 13/16 inch. The feed-screw is one inch in diameter and has eight threads per inch, Acme standard. The maximum distances between the centers with 5½ and 7½ foot beds, when the gap is closed, are 36 and 60 inches, respectively. When the bed is extended the maximum distances between the centers are 54 and 96 inches, respectively. This lathe can be equipped with a motor-drive, if desired.

NATIONAL RIVET-HEADER WITH AUTOMATIC FEED

The National Machinery Co., Tiffin, Ohio, is manufacturing a wedge-grip, rivet-header equipped with a new design of automatic feed. In the operation of this machine, long rods in mill lengths are taken from the finishing rolls while on the initial heat (or they are re-heated in special long furnaces) and when the rod is started into the feed rolls by the workman, it advances automatically and a blank is sheared and headed, and a finished bolt or rivet is ejected for each revolution of the machine. Single-blow bolts, track bolts or any kind of "single-blow" work can be made in this machine, and the wedge-gripping mechanism insures a product free from swollen shanks or objectionable fins along the body, as the dies cannot spring or give during the upsetting operation.

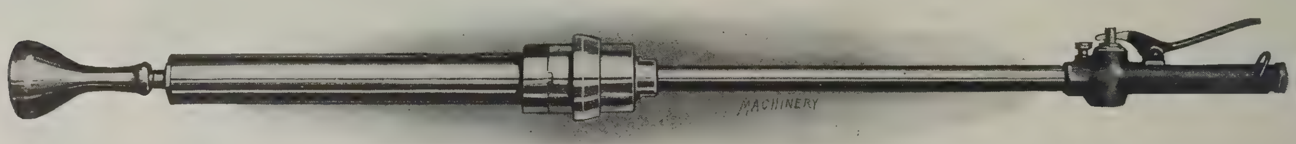


National Wedge-grip Rivet-header with Automatic Feed

The feed rolls are made of chilled castings and they are water-jacketed, in order to maintain an even temperature and insure a minimum wear on the feeding surfaces, so that a positive and uniform feeding movement is obtained. A new type of stock gage is employed which is designed not only to allow rapid and minute adjustments while the machine is in operation, but also to eliminate "spring" and thus secure uniformity in the work produced. The output of this type of header is said to be from 50 to 100 per cent larger than is obtainable on the hand-feed machine, and, owing to the accuracy and uniformity in feeding, a better quality of work is secured on the automatic-feed header. This machine is built in 1-, 1¼- and 1½-inch sizes.

CLEVELAND SAND RAMMER

The Cleveland Pneumatic Tool Co., Cleveland, O., has brought out a new molders' sand rammer. This rammer, which is illustrated herewith, is pneumatically operated and is made in different styles and sizes, adapted for general foundry work or for bench or core ramming. All sizes are equipped with either a round or grooved rod, as preferred, and with a butt and pein. The use of the groove is to prevent the rod from turning when the rammer is in operation, except at the will of the operator.



Pneumatically operated Sand Rammer manufactured by the Cleveland Pneumatic Tool Co.

These rammers are light in weight, operate at high speed and with practically no vibration. The piston-rods are packed with a special design of packing which prevents dirt from getting into the piston chamber and cutting the working parts. The floor rammer, which is the type shown in the illustration, has an exhaust deflector which prevents the exhaust air from blowing onto the operator, as well as on others who might be working with him.

THE BADGER TOOL RACK

The tool rack illustrated herewith is designed for machine shops and manufacturing plants. The trays are made of cast iron, and the legs, which are of 1-inch round steel, are threaded into the top tray and pass through the lower trays. Swiveling casters with 4-inch wheels are fastened to the legs in such a way that they will not become detached. The lower tray acts as a stiffener for the legs and, when the rack is assembled, it is strong and serviceable. Any number of trays

Tool Rack for Machine Shops and Manufacturing Plants

can be furnished, and drawers can be supplied if desired. The standard racks are made with 20- by 25-inch trays and have a total height of 36 inches. If a stationary rack is wanted, ¾-inch pipe legs with floor flanges are furnished.

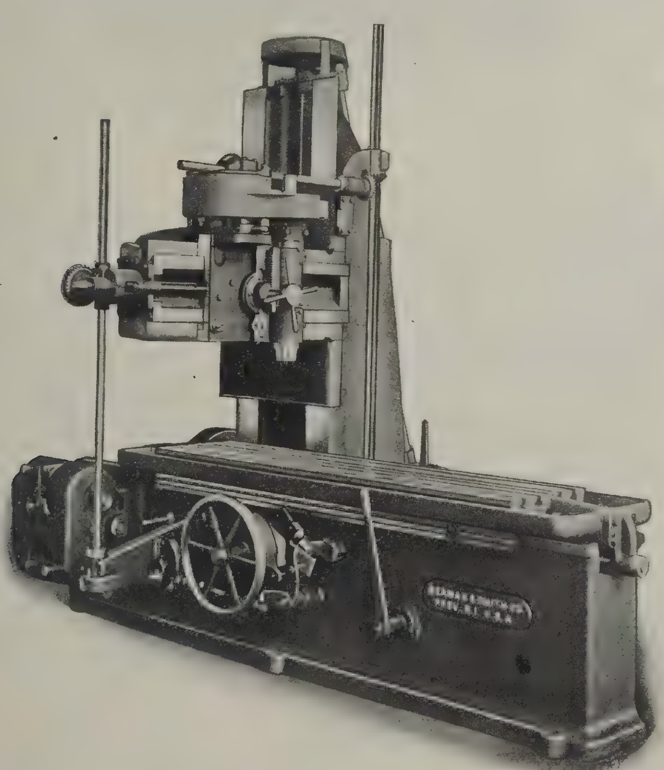
These racks are especially adapted for use in connection with machine tools, as they can readily be moved about. They can also be used in place of "tote" trucks for conveying products from one tool to another and from one department to another. The weight of a crated rack is approximately two hundred pounds. These racks are manufactured by the Wisconsin Foundry & Machine Co., 623 E. Main St., Madison, Wis.

BEAMAN & SMITH MILLING MACHINE

The vertical-spindle milling machine shown in the accompanying engraving is a recent design built by the Beaman & Smith Co., Providence, R. I. This machine is of the open-side construction, and is capable of handling a large variety of work. The horizontal bed of the machine has attached to it an upright that carries an overhanging arm or cross-rail. The spindle is carried by a saddle which, in turn, is mounted on the overhanging arm and has a horizontal feeding movement. The work table is provided with a rapid power movement, available in either direction and varying from 9 to 26½ feet per minute. The table is operated by a screw which engages a revolving bronze nut, and the thrust is taken by ball bearings.

The feed for the table is positive and operates in either direction. The required changes are obtained by a geared feed-box which is conveniently located at the left end of the bed, as the illustration shows. There are nine changes of feed, ranging from 1 inch to 8½ inches per minute, and the arrangement is such that the feed can be varied independently of the spindle speed. The table is equipped with an automatic stop for disengaging the feed at any predetermined point.

This machine is driven by a 4-inch belt which operates on a four-step cone pulley. Eight spindle speeds are available, varying from 14½ to 140 revolutions per minute. The spindle is of crucible steel and runs in boxes of hard bronze. It has a



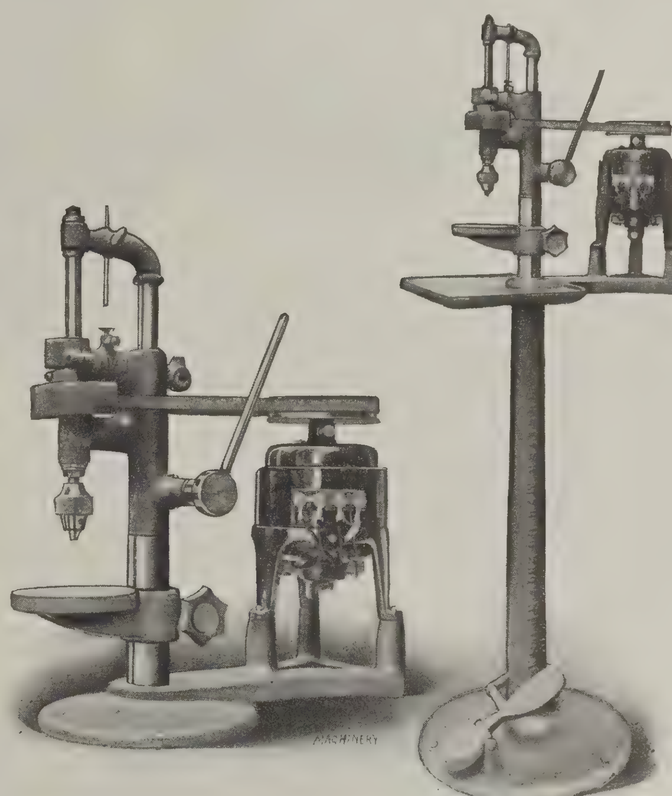
Beaman & Smith Open-side Vertical-spindle Milling Machine

tapered end 3 inches in diameter, for attaching face milling cutters, and also a No. 11 Brown & Sharpe taper hole for receiving cutter shanks and arbors. The spindle has a 6-inch independent vertical adjustment and a horizontal movement of 22 inches on the overhanging arm. There is a hole through the center of the spindle for a retaining bolt. The respective diameters of the two spindle bearings are 3 1/4 and 2 9/16 inches, and the length, in each case, is 4½ inches.

The cross-rail or overhanging arm is very substantial and proportioned to best resist the strains to which it is subjected. It has a vertical power movement for adjustment on the upright, varying from 11 to 32 inches per minute. The work table is 18 inches wide, 6 feet long, and has a feed and rapid power movement of 6 feet 9 inches. The distance from the end of the spindle to the top of the table can be varied from 0 to 36 inches. The weight of the machine is approximately 13,000 pounds.

LANGELIER MOTOR-DRIVEN SENSITIVE DRILLS

The Langelier Mfg. Co. of Providence, R. I., has recently designed a new line of motor-driven drilling machines of the sensitive type. These are made in two sizes and for either bench or floor use, as shown by the accompanying illustration.



Langelier Sensitive Drilling Machines of Bench and Floor Types

The smaller size has a capacity for drills up to 7/32 inch, and the capacity of the larger size is for drills up to ⅜ inch in diameter. The machine shown to the left in the illustration is the No. 1 bench type, and the machine to the right is the No. 1 stand or floor drill. These machines are driven by ⅛ horsepower motors, and they can be obtained either with or without the motor.

The motor drives the drill spindle by an endless belt at a speed of about 2000 revolutions per minute. The spindle "floats" inside of a sleeve which is continuous through the two spindle bearings, and the driving pulley is keyed to this sleeve and not to the spindle. This feature gives great sensitiveness and adapts the machine for precision work. This form of drive also obviates any jerking of the spindle, no matter how tight the driving belt may be, and spindle wear is practically eliminated. A belt guard is placed over the spindle pulley to prevent the belt from hitting the operator in case of breakage.

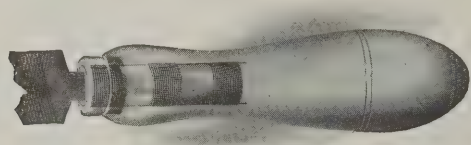
The feeding of the spindle of either a bench or stand drill can be effected by a hand-lever at the side of the column or by a foot-treadle connecting with a rod passing inside of the column. The drill table has a vertical adjustment of 4⅝ inches and it can be swung to one side, if desired. Each of these machines is equipped with a depth gage, which is a valuable feature when drilling duplicate parts, especially if the holes must be drilled accurately to a given depth. This gage

consists of a vertical rod which passes through the spindle frame and can be locked in any position by a winged nut. The lower end of the rod strikes a hardened, fine-pitch knurled screw, by means of which very minute adjustments can be made. A binding screw at the side locks the vertical screw after it is set to the required height.

All of the running parts of these machines are designed for taking up wear and for replacement, if necessary. The weight of the No. 1 bench drill with a motor attached is 50 pounds, and the bench space is 20 by 12 inches. The weight of the No. 1 stand drill with a motor is 100 pounds, and the floor space 20 by 16 inches.

OSGOOD FILE AND TOOL HANDLES

The J. L. Osgood Tool Co., 121 Erie County Bank Bldg., Buffalo, N. Y., has added to its line of indestructible file and tool handles, the type shown herewith. This handle has a steel-bound inner core to prevent splitting, and it is made in six different sizes, having lengths varying from 4 to 5⅝ inches. The smallest size is intended for files from 2 to 4 inches in length, and the largest size, for files from 14 to 20 inches in length. This company has also brought out a line of screw-driver and toolmakers' handles. The latter have a a tough wood core reinforced by a steel tube, and the grip is made of soft, flexible cork.



Osgood File Handle with Steel-bound Center Core

ROBERTSON POWER HACK SAW

The power hack-saw machine shown herewith, is a recent design being manufactured by the W. Robertson Machine & Foundry Co., 32 Greenwood Pl., Buffalo, N. Y. The general construction of this saw is clearly shown by the illustration. The surfaces of the bed are milled true, and the base of the head is machined to fit into housings formed on the bed, which gives a solid construction. The frame is supported on a finished steel arm and has a long bearing provided with ample lubrication.

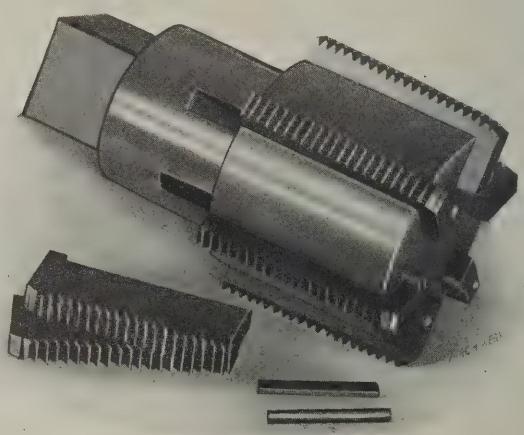
Power Hack-saw made by W. Robertson Machine & Foundry Co.

The frame is mounted and driven so as to insure a true cut and it takes either 10-, 12- or 14-inch blades. The saw cuts on the draw stroke, and there is a mechanical release on the return stroke. The machine is equipped with an automatic stop. The vise is strongly constructed and all surfaces are milled true. It is secured to the bed by two bolts and can be swiveled to 45 degrees. The position of the vise is indicated by degree graduations. This machine has a capacity of 6 by 6 inches, and the net weight is 250 pounds.

WINTER BROS. INSERTED-CHASER TAPS

Winter Bros. Co., of Wrentham, Mass., in developing a line of high-speed taps, found, that for sizes above 2 inches diameter, the cost of the steel increased to such a point that it more than offset the increased production obtained as the result of the superior qualities of high-speed steel. The inserted-chaser style of tap was developed to solve the cost problem. After numerous trials in different shops, the simple style of inserted-chaser tap which was first designed proved both economical and satisfactory.

This tap, one size of which is shown herewith, has a body made of machinery steel, or, in the case of very large sizes, of cast iron, and the chasers are held in slots, the sides of which are parallel. Before these slots are milled in the body, holes (which ordinarily have a diameter of 3/16 inch) are drilled in such a location that the inner sides are flush with the bottom of the slots, and the centers are 1/32 inch ahead of the sides of the slots. When the latter are milled, two-thirds of each hole is left, and into these holes the chaser binding pins are inserted.



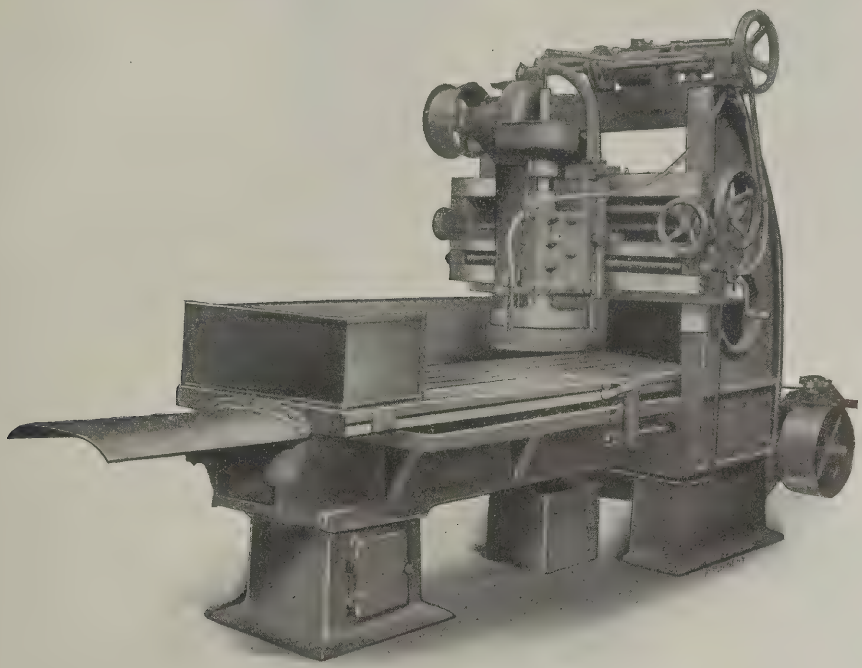
Tap having Inserted Chasers or Blades

The chasers are made of flat stock with parallel sides, and the bottom is milled off, thus leaving a shoulder about ⅛ inch high near the front end, as shown in the illustration. In assembling the tap, this shoulder is set against the end, thus locating each chaser accurately. Near the bottom of the front or cutting side of each chaser, a surface is milled, having an angle of 16 degrees to the rest of the face. The binding pins have one side flattened, and when they are driven in place, this flat side bears against the angular surface, which holds the chasers firmly against the ends and bottoms of the slots. The pins are made of straight pieces of drill rod or screw stock and they are an easy fit in the round hole, but a driving fit when the chasers are in place. It is not necessary to drive the pins very hard or insert them for any great distance. The chasers are removed by driving them out endwise, which also removes the pins.

The cost of a new set of high-speed steel chasers is less than that of a carbon steel tap for sizes above 2 inches diameter. For sizes as large as 4 inches diameter the cost of a complete inserted-chaser tap with high-speed steel blades is less than that of a carbon steel tap, and a new set of chasers costs only about one-third as much as a solid tap of carbon steel. When the same number of threads per inch is used for different diameters, the chasers are said to be interchangeable for diameters varying as much as 6 inches. Special pipe taps have also been made which work satisfactorily with duplicate chasers, for all sizes from 2½ inches up to 12 inches.

VERTICAL GRINDING PLANER WITH MOVABLE HEAD

The vertical planer-type grinder illustrated herewith is designed for grinding a large variety of work. The wheel-head on this machine is mounted on a heavy and substantial cross-rail, and has a cross movement of 36 inches. It is traversed back and forth by a screw and the crank handle seen at the right-hand end of the cross-rail. The wheel spindle has a quick hand motion, vertically by means of the large handwheel shown, and a slow or feeding motion is effected by the smaller handwheel at the front of the cross-rail, which operates through a worm and worm-gear that can easily be disengaged.



Vertical Grinder of the Planer Type

The wheel-head travels on the modern narrow guides, and has bearings of generous proportions. The wheel-head proper is of the same general design and size as that used on the Springfield-Brandes vertical grinding planer, which was illustrated in the department of New Machinery and Tools for December, 1910. The wheel is 16 inches in diameter and is driven by an accurately planed pair of bevel gears, one being of cast iron and the other of rawhide. All the high-speed bearings are either of the self-oiling or sight-feed type. The end thrust bearings are all provided with ball bearings.

The drive for traversing the table is something like a planer drive, except that the motion is transmitted through a worm and worm-gear and a large coarse-pitch screw operating in a nut 15 inches long. The machine is equipped with a pump and all necessary attachments, and lubricant can be applied either through the spindle or from the outside of the wheel. It is also equipped with a large water guard which surrounds the table to confine the spray. This guard is made in two sections. The front section is shown removed, and it can readily be taken out and put back, by sliding it in from the top and clamping with thumb-nuts.

This machine has a capacity for grinding widths up to 30 inches and lengths up to 7 feet. The weight is 13,450 pounds. It is built by the Springfield Mfg. Co., Bridgeport, Conn.

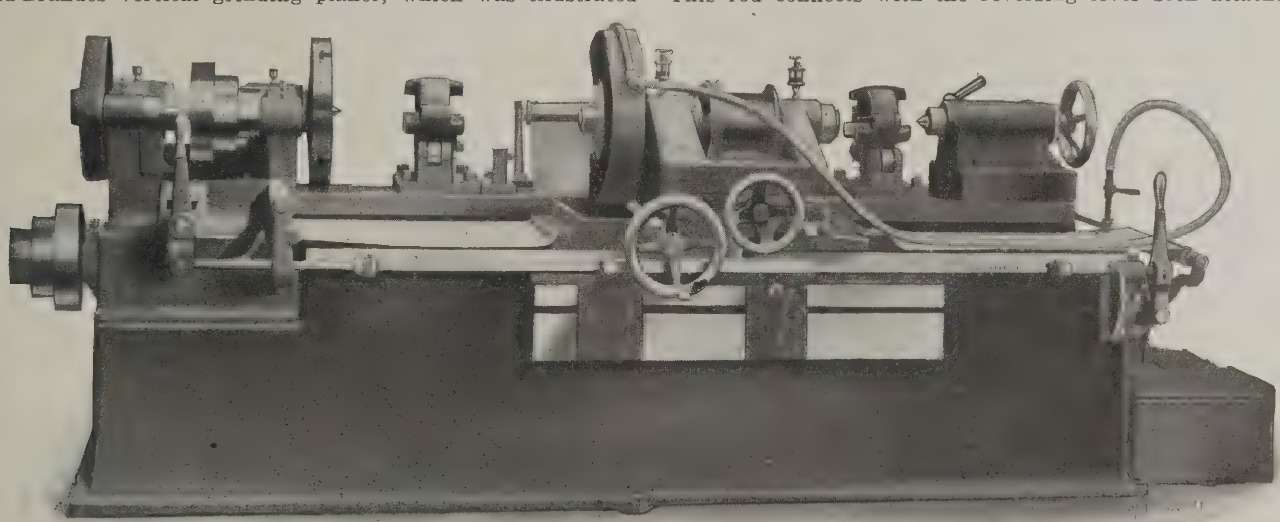
SPRINGFIELD SPECIAL ROLL GRINDER

The Springfield Mfg. Co., Bridgeport, Conn., has designed a special grinder for grinding concave rolls by means of a former. This former is located directly under the handwheels at the front of the machine, as will be seen by referring to the accompanying illustration. It is somewhat similar in construction to a lathe taper attachment and is provided with an adjustment.

In operation, the intermediate slide on which the wheel-head is mounted is forced against the former by a heavy spring. The operation of grinding is practically automatic, although the grinding wheel is fed by means of a small handwheel. The wheel face is curved slightly, as this is necessary in order to reproduce the curve of the former. The two rests seen on each side of the wheel-head are to permit revolving the rolls on their own journals. These rests are adjustable.

The machine is also designed to do internal grinding. The internal attachment is shown in place, directly beyond the wheel. It is driven by a belt which runs over a pulley that forms part of the main driving pulley for the grinding wheel. This internal attachment is removed when the machine is to be used for either straight or curved grinding.

The wheel carriage is reversed automatically by ordinary trip-dogs, which are mounted on a rod at the front, as shown. This rod connects with the reversing lever seen attached to the speed-box at the left. When this lever is in a neutral position and the smaller lever seen to the right is set against the retaining drum, the mechanism remains idle and the wheel-head can be traversed by hand, the movement being transmitted by a revolving nut operating on a stationary screw.



Special Machine designed for Grinding Concave Rolls

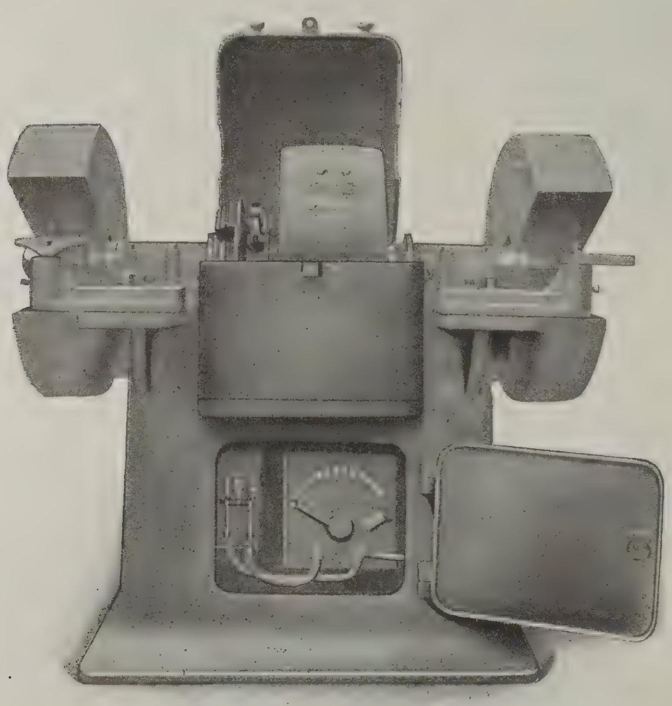
This machine has a capacity for grinding rolls 12 inches in diameter and 4½ feet long. It is equipped with a pump and water attachment for wet grinding, and the matter of lubrication and protection of exposed parts has received careful at-

tention. The wheel-head ways, as will be seen, have covers which are attached to automatic rollers that wind and unwind as the wheel-head traverses back and forth. The weight of this machine is 7250 pounds.

SPRINGFIELD MOTOR-DRIVEN GRINDER

The direct-connected motor-driven dry grinder shown in the illustration has been designed by the Springfield Mfg. Co., Bridgeport, Conn., as a standard for direct-current motors. The aim has been to adapt it, as far as possible, to standard motors, and the only thing that is special, as far as the motor is concerned, is the shaft. The motor is mounted on a rigid base and it is enclosed with a dust-tight case. The upper half of this case is hinged so that it can easily be thrown back to the position shown, either for inspection, adjustment or cleaning, and it is held in the closed position by a bolt. The case is bored out to fit finished projections on each of the boxes, and, as the joint is ground, the case is practically dust-proof.

The grinder is designed to take two hoods, as shown. These are made so as to enclose practically the entire wheel, with the exception of the portion which must be left exposed



Direct-connected Motor-driven Dry Grinder

at the front. The hoods have an outer plate which can readily be removed when it is desired to change the wheels. These hoods can also be connected with an exhaust system, which is desirable where such a system is installed. The starting controller is mounted on a slab inside of the base and is as close to the front as possible, for convenience in operating. The spindle bearings are of generous proportions and are of the self-oiling type. At present, these machines are made in three sizes suitable for wheels having diameters and widths of 12 by 2 inches; 18 by 2 or 3 inches and 24 by 3 or 4 inches.

GARDNER POLISHING STAND

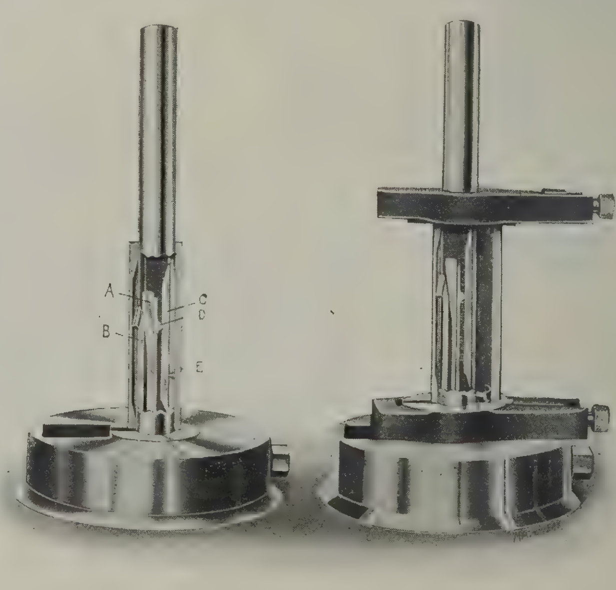
A ball-bearing polishing stand has been put on the market by the Gardner Machine Co., Beloit, Wis. This machine, which is shown herewith, is fitted throughout with ball bearings. The diameter of the spindle at the bearings is 2 inches and it tapers down to a diameter of 1¾ inch. The arbor is 1¼ inch in diameter and forms a shoulder for the 4½-inch wheel collars. The spindle extends 15 inches on each side of the base and is 39 inches from the floor. The spindle pulley is 5 inches in diameter and has a 4½-inch face. The two radial ball bearings are encased so as to be completely protected from dust or grit, and they are lubricated by a light grease contained in compression grease cups. Spacing collars are furnished when wheels of various widths are required. The countershaft hangers have ball bearings. The tight-and-loose pulleys are 8 inches in diameter and have 5½-inch faces. The loose pulley is fitted with two radial ball bearings. The

Gardner Ball-bearing Polishing Stand

driving pulley is 18 inches in diameter, and when it runs at 750 revolutions per minute, the machine is driven at a speed of 2700 revolutions per minute. This polishing stand is known as the No. 3 size. Its weight, complete with the countershaft, is 600 pounds.

KEYSEATER ATTACHMENT FOR CUTTING OIL GROOVES

Mitts & Merrill, 843 Water St., Saginaw, Mich., have brought out an attachment for cutting oil grooves, which can be applied to the keyseaters built by this company. The accompanying sectional views show the working parts of this device and how it is operated. Referring to the left-hand view, part *A* is the feed wedge, *B* is the cutter, and *C* is the pattern of the oil groove to be cut. This pattern is fastened to the back of the groove in the post which forms a support for the work. Part *D* is a follower-bar having a knob or projection on the



Sectional Views of Mitts & Merrill Keyseater Attachment for Cutting Oil Grooves

rear side, which follows the pattern and guides the cutter, thus forming an oil groove corresponding in shape and length to the pattern. The bushing *E* represents the work, and the form of the completed oil groove, as well as the way it is reproduced from the pattern, is clearly shown.

When the attachment is in operation, the cutter *B* and the follower-bar *D* travel together in a line parallel to the pattern.

The feed wedge *A* is operated in the usual manner for feeding the cutter into the work. The cutter has an automatic relief on the return stroke. The work is chucked by means of bushings similar to those used for keyseating. The view to the right shows the attachment equipped with expansion bushings for chucking work that varies in diameter.

With this device, as regularly furnished, oil grooves up to 3/16 inch deep can be cut. A groove 4 inches long and 1/8 inch deep can be cut in one minute, which includes the time required for chucking and removing the work. The No. 1 size will cut grooves 1/8 inch deep in holes 1 inch in diameter and larger. The No. 2 size is adapted for grooves 3/16 inch and holes 1 1/2 inch in diameter and larger.

BRYANT HOLE- AND FACE-GRINDERS

The Bryant Chucking Grinder Co., of Springfield, Vt., has designed two new chucking grinders, one of which has a single spindle and the other two spindles. These machines are being built in addition to the three-wheeled chucking grinder which was illustrated in the November, 1909, number of MACHINERY, and they are intended for chuck work which requires only one

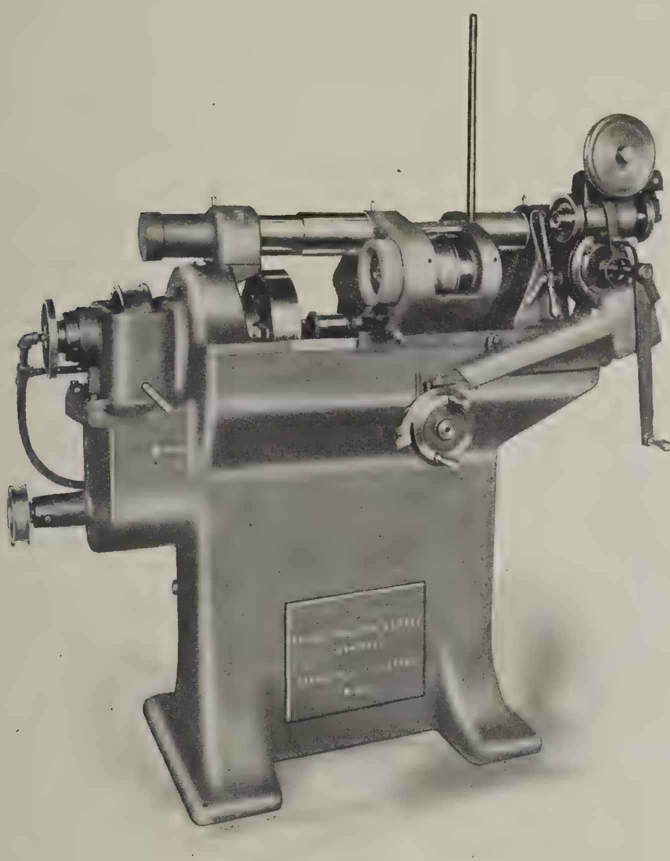


Fig. 1. Two-spindle Face- and Hole-grinder built by Bryant Chucking Grinder Co.

or two grinding operations at a single setting. A front view of the two-spindle type is shown in Fig. 1, and Fig. 2 is a rear view of the single-spindle machine. The former is especially adapted to that class of work which has to be ground internally and faced, as both operations can be performed successively and rapidly.

The design of these machines has been simplified as far as possible, in order to give a maximum output for the grinding of duplicate parts within a limited range. Provision is made only for those adjustments which are actually needed in general practice. The average machine tool is ordinarily provided with an assortment of speeds, feeds, and adjustments which are necessary to meet the conditions for work within its range, but when such machines are used on duplicate work in manufacturing, usually only one or two of the many feeds, speeds, and adjustments are needed.

These new hole- and face-grinders, as the illustrations show, are a decided departure from conventional designs, particularly in regard to the method of mounting the wheel-slide. Instead of the usual flat or V-shaped ways, the wheel-slide is held in position and traversed in hardened and ground cylindrical bearings which are located above the grinding wheels, and are further protected by brass telescoping sleeves which make them grit- and dust-proof. These bearings, the general arrangement of which is clearly shown by the longitudinal section Fig. 4, give a smooth even traverse to the wheel-slide and insure its permanent control and alignment. These bear-

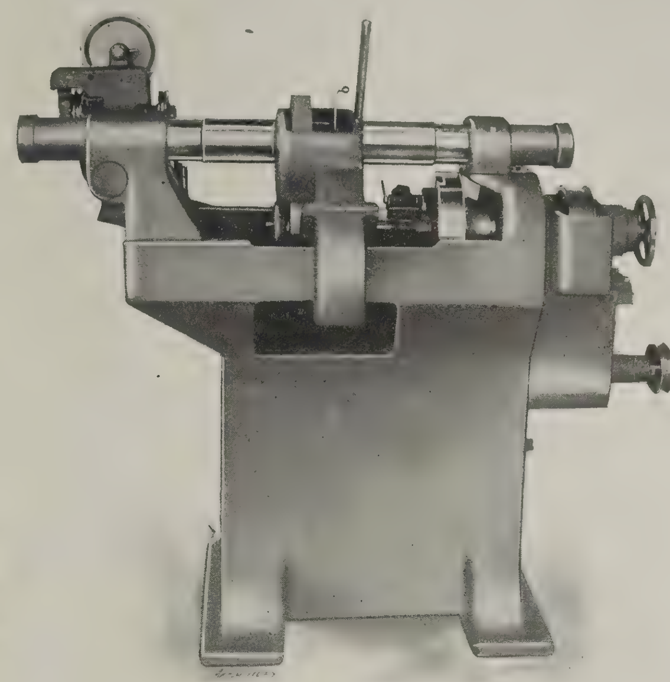


Fig. 2. Rear View of Single-spindle Internal Grinder

ings are not only used for the longitudinal traverse, but they enable the wheel-slide to be given a radial swinging motion, which furnishes the cross-feed for diameter control. This radial motion, when a grinder is equipped with two wheels (one for hole and the other for face grinding), is used for locating either spindle in the operating position; whereas, with the single-spindle grinder, this motion is employed to swing the wheel out of the working position when necessary.

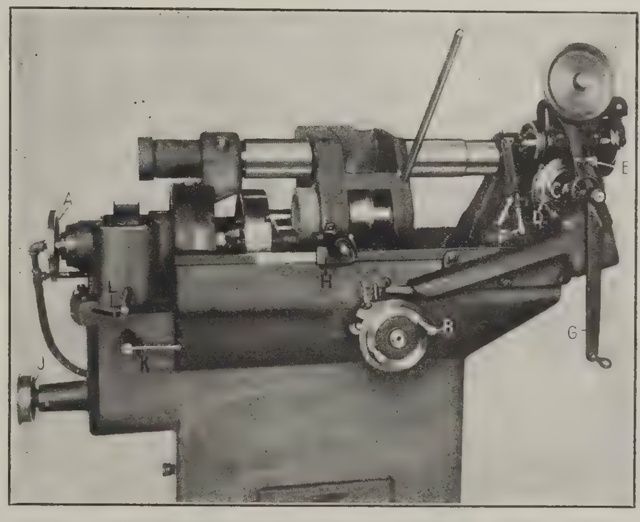


Fig. 3. Two-spindle Machine with Wheel-slide set for Face-grinding

The wheel-slide, in either case, can be moved easily and quickly.

The hand lever seen attached to the wheel-slide, is used for moving the facing wheel into position. Fig. 1 shows the wheel-slide set for hole grinding, and Fig. 3 shows the cup-wheel set for end facing. The work-holding chuck is operated by handwheel *A* (Fig. 3) at the left end of the spindle, which is connected with the chuck as shown in the sectional view Fig. 4. The handwheel *B* (Fig. 3) seen at the front of the machine, is for the diameter control, and the way this wheel imparts a radial swinging movement to the grinding wheel slide, is shown by the cross-section, Fig. 5. A circular arm *E*

is bolted to wheel-slide *S* and projects into a pocket under the water pan. The lower or inner end of this arm rests against feed-screw *F* and is held in this position simply by the arm's weight and the pull of the driving belts. There is no vibration of this arm, as it simply pushes against the feed-screw.

The wheel-slide is traversed longitudinally by a belt which passes over the three grooved pulleys seen at the right-hand end of the machine. The two smaller pulleys rotate in reverse directions and are alternately connected through a clutch mechanism with a worm engaging with worm-wheel *C*. This worm-wheel, in turn, rotates a pinion shaft and pinion meshing with a circular rack on the wheel-slide, as shown to the right in Fig. 4. On the side or front face of worm-wheel *C*, are mounted the reversing stops *D* for controlling the wheel travel. The reversal of the wheel-slide can also be effected by the hand lever *E*. Lever *F* is used for disengaging the power traverse, and the long lever *G* is for moving the slide back and forth by hand.

The cross-feed is equipped with an automatic trip mechanism having suitable adjustment. A diamond holder is located at *H* for truing the grinding wheels. The cooling water is supplied by a pump driven by pulley *J*, and the piping is so arranged that the water can be conveyed to the work either through the spindle or by a flexible pipe attached to the wheel carriage. The flow of water is controlled by lever *K*, which is within convenient reach. The work-head of this machine has an angular adjustment for grinding tapers up to 30 degrees included angle. The position of the head is shown by graduations on the segment-shaped base *L*, and the method of clamping the head is clearly shown by the illustration.

This machine has a capacity for grinding holes up to 10 inches in diameter and 6 inches in length, and the chuck will hold parts having a maximum diameter of 12 inches. There are three work speeds of 150, 225 and 300 revolutions per minute, and variations of wheel traverse of 20, 30, and 40 inches per minute. The wheel-spindle driving shafts are mounted in ball bearings of the enclosed type and require only occasional oiling. Either the single- or double-spindle machines are furnished for power or hand operation.

The equipment of the two-spindle grinder consists of a 12-inch chuck; a facing spindle with a 6-inch cupwheel; an assortment of grinding wheels to cover internal and face grinding on both hard and soft metals; a diamond holder and diamond; water pump and connections; a countershaft and suitable wrenches. The floor space occupied by the machine is 3 by 6 feet, and its approximate weight, 2000 pounds.

The principal features claimed for a grinder of this type are as follows: Better control and greater rigidity for the wheel-slide; hardened and ground wheel-slide bearings, which are grit- and dust-proof; quick and accurate operation; elimination of any vibration or error such as might result from faulty fitting and adjustment of the cross-slide; a housing that partly confines the water and spray; and uniform lubrication due to the cylindrical wheel-slide bearings.

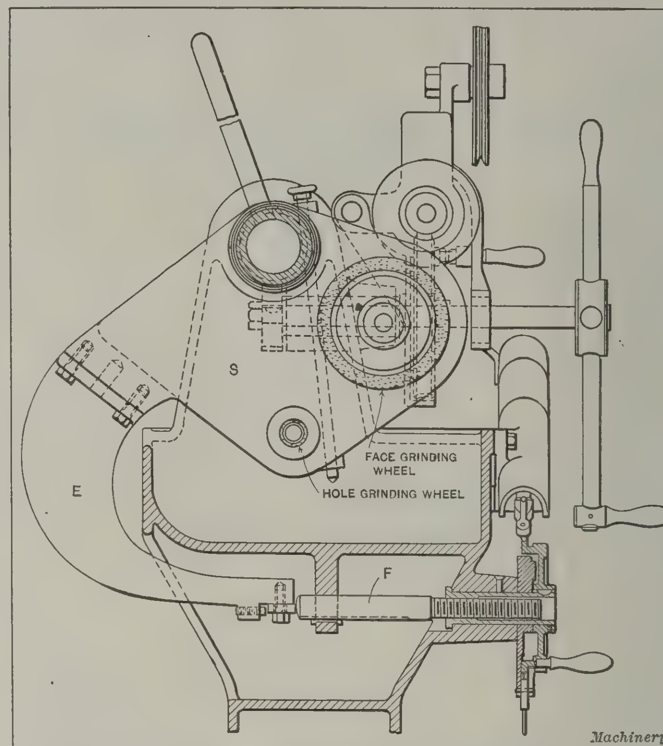


Fig. 5. Cross-section showing Cross-feed Control for Wheel-slide

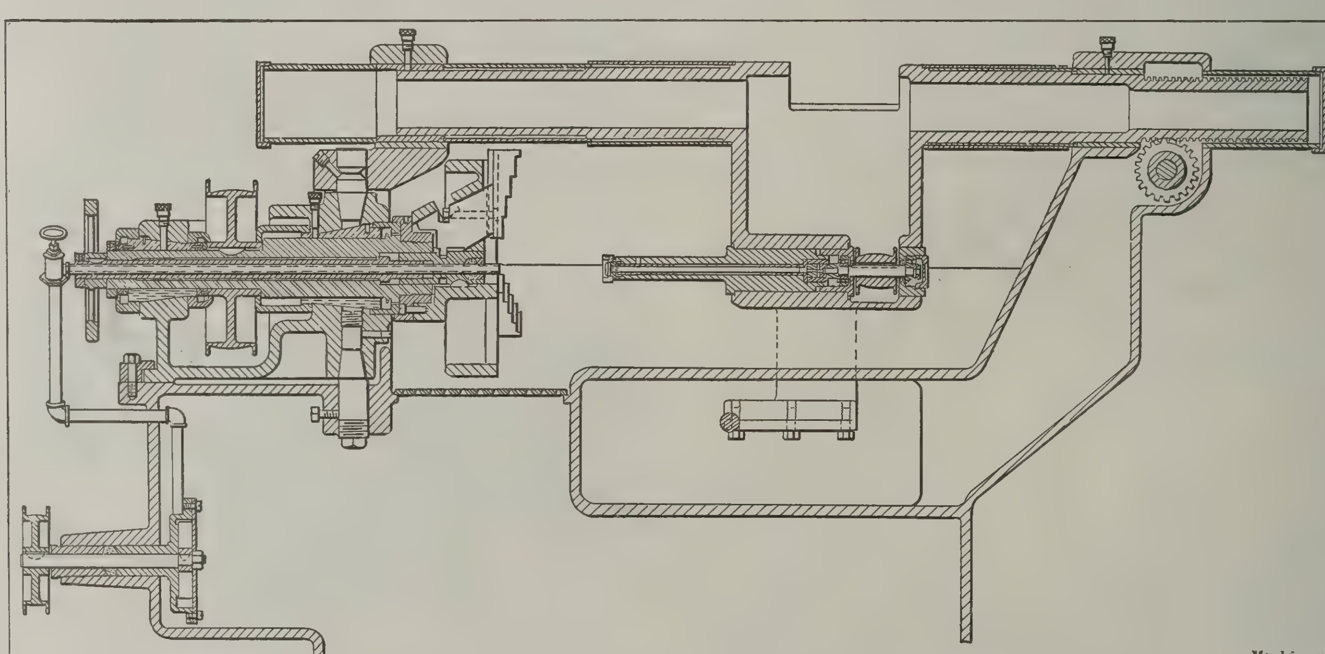


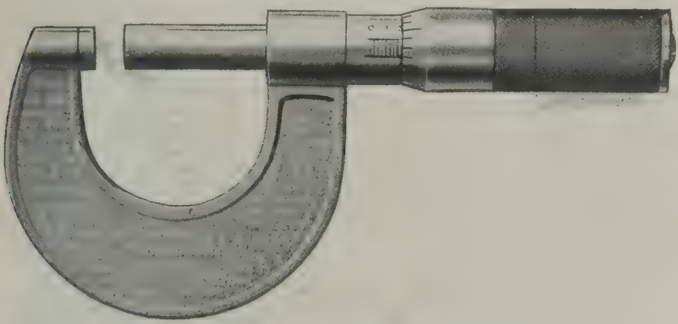
Fig. 4. Longitudinal Section of Bryant Chucking Grinder

FRICTION THIMBLE FOR SLOCOMB MICROMETER

Most mechanics are familiar with the friction or ratchet stop which is applied to some micrometers for the purpose of securing the same degree of pressure when measuring. Some machinists have what is called a "heavy feel" and others a "light feel," and when a micrometer without a ratchet or friction stop is used, variations in diameter are sometimes the result, when duplicate parts are measured by different men. This is overcome by the ratchet or friction, which slips when more than a certain amount of pressure is applied, thus preventing the measuring screw from turning farther.

The J. T. Slocomb Co., Providence, R. I., is applying a friction thimble or stop to the Slocomb micrometers (when so

ordered) which is so arranged that it can be operated by the same hand which holds the micrometer. By referring to the accompanying illustration, it will be seen that this friction thimble is the same size as the regular knurled thimble, and it extends forward to about the center of the micrometer handle. This device consists chiefly of a coiled, flat, German silver spring the inner end of which is attached to a washer clamped to the end of the thimble by a shoulder on the



Slocomb Micrometer equipped with Friction Thimble

central screw. The outer end of the spring slides around inside of a large bore in the outer revolving part, the arrangement being such that when the thimble is turned to the right, the device slides over the spring, but when turned to the left, the friction uncoils the spring, thus causing it to drive positively in this direction.

There are no parts liable to get out of order, and the spring will not wear and thus lose its tension. This stop gives a smooth forward action and a movement that is fully as positive in a reverse direction. The friction thimble can be used when the micrometer is opened to its full capacity, and the screw can, of course, be operated without using the stop, when desired.

NEW MACHINERY AND TOOLS NOTES

Knurling Tool: Edgar T. Ward & Sons Co., Boston, Mass. Knurling tool with capacity for diameters up to ¾ inch. Three knurls are applied to the work, thus giving a good support, and the holder has a hollow handle which contains an extra set of knurls.

Drilling and Tapping Machine: Taylor & Fenn Co., Hartford, Conn. Radial drilling machine having two heads. One head is for drilling and the other, which is equipped with a reversing mechanism, can be used for tapping. The speeds of each head can be varied independently, if necessary.

Metal Saw: Peter Bros. Mfg. Co., Algonquin, Ill. Abrasive metal-saw designed primarily for the tool-room, for cutting off high-speed or other tool steels. The cutting wheel is 8 inches in diameter and 1/16 inch thick. It has a capacity for square bars up to ⅞ inch, and angles, channels, tees, etc., up to 1¼ inch.

Electric Hammer: Electro-Magnetic Tool Co., Chicago, Ill. Electric hammer having a motor of the series type and brush-holders attached to the tool casing so that the motor-head can readily be removed. Ball bearings are used throughout, and the hammer is equipped with a magnet which acts as a flexible clutch to prevent transmitting the strain and jar to the gears and motor.

Knurling Tool: Alert Tool Co., 221 N. Broad St., Philadelphia, Pa. Knurling tool having three knurls, thus giving a three-point contact which prevents bending or straining the work. By means of a winged nut, the knurl-holder is adjustable for pieces varying from 0 to 1¼ inch in diameter. This holder is applicable to all types of machines, such as engine lathes, bench lathes, etc.

Lathe: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. New line of motor-driven lathes with from 13- to 30-inch swing. The headstock is designed to permit placing all the gearing at the forward end or close to the spindle nose, and the rear end is arranged for the motor, which is placed low to avoid top-heaviness. The headstock covering encloses all gears. The lathe has double back-gears which are shifted by a lever at the front.

Pipe Bender: Wallace Supply Co., 108 N. Jefferson St., Chicago, Ill. Pipe bender so designed that the wall of the pipe is supported where the bend is made, thus eliminating any distortion or flattening. A radius of 14 inches or more is recommended for pipe as large as 2 inches, but the machine has been successfully used for a radius as small as 9 inches on 2-inch pipe; 8 inches on 1½-inch pipe; 6 inches on 1¼-inch pipe, and 4 inches on 1-inch pipe.

Milling Machine: Kearney & Trecker Co., Milwaukee, Wis. Vertical milling machine known as No. 2½-B. This machine is similar in construction to the No. 1½ size illustrated and described in the February, 1912, number, but has a greater capacity. The table has a feed of 30 inches and a cross-feed of 15 inches. The vertical feed and the greatest distance from the end of the spindle to the top of the table is 20½ inches. The working surface of the table is 14 by 47 inches, and the diameter of the rotary table, 17¼ inches. There are eighteen speed changes ranging from 15 to 360 revolutions per minute, and twelve feed changes which vary from ½ to 16 inches per minute. The net weight of the machine is 5200 pounds.

Portable Drill: Cincinnati Electrical Tool Co., 652 Evans St., Cincinnati, Ohio. Two sizes of portable, universal drills for operating on either direct or alternating current. One size will drill holes up to 3/16 inch in steel or hard wood, or 3/8 inch in soft wood, and the other size has a maximum capacity for 1/4 inch holes in steel or hard wood, and 1/2 inch in soft wood. The motor armature is equipped with ball bearings. The gears are enclosed and run in grease, thus protecting the electrical parts from dust and grease. The body of these drills is made of aluminum, and the outside diameter is about 4 inches. The weights of the two sizes are 7½ and 8½ pounds, respectively. A spade handle and a straight handle are furnished.

Milling Machine: Gooley & Edlund, Syracuse, N. Y. Single-purpose milling machine designed for form and gang milling in connection with the manufacture of guns, automobiles, typewriters, sewing machines, and similar parts. The frame of the machine is a single casting having two uprights joined by an arch at the top and cast integral with the base. The inner faces of these uprights have dovetailed ways, to each of which the heavy bed is fitted. The bed can be rigidly clamped to the uprights by four ⅞-inch bolts. The front upright contains an adjustable sleeve bearing which acts as an outboard support for the cutter arbor. The table has a screw feed and a quick-return handwheel operating through a rack and pinion. Eight changes of feed are provided. The maximum distance from the center of the arbor to the surface of the table is 12 inches. The table is furnished in lengths of 32, 38 and 44 inches, as may be required, and it has a width of 10⅛ inches.

* * *

JOINT MACHINERY DEALERS' CONVENTION

The joint triple convention of the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association, and the American Supply and Machinery Manufacturers' Association was held in Norfolk, Va., at the Monticello Hotel, May 13-15. The National Supply and Machinery Dealers' Association was called to order by President W. L. Rodgers of the Pittsburg Gage & Supply Co., Pittsburg, Pa.; the Southern Supply and Machinery Dealers' Association by S. M. Price of the S. M. Price Machinery Co., Norfolk, Va.; and the American Supply and Machinery Manufacturers' Association by Willard Parker, president. The program included an address on "Workmen's Compensation," by F. C. Schwedtman; "Motion Study," by Charles S. Miller; "Accident Prevention and Relief," by F. C. Schwedtman and James A. Emery; "The Modern Machinery Supply Jobber a Necessary Adjunct to the Manufacturers," by W. T. Dodd; "Cost of Handling Small Orders in Broken Package Lots and Remedies Proposed" and "Resale Prices in Their Present Status," etc.

* * *

NEWARK INDUSTRIAL EXPOSITION

Newark Industrial Exposition, Newark, N. J., was held under the auspices of the Board of Trade of the city of Newark, May 13 to 25 in the First Regiment Armory, its object being to advertise the industries and advantages of the city. Newark has a population of 365,000 and with the immediate surrounding towns 565,000. It has a wharf frontage on the Passaic River of 10½ miles, and is served by the Pennsylvania, Lackawanna, Lehigh Valley and New Jersey Central Railroads. The exposition comprised 196 concerns who showed a great variety of machinery and products valued at over $1,000,000, produced in Newark. It was attended by thousands of interested visitors. Among the exhibitors were Gould & Eberhardt, makers of shapers and gear cutting machines; Newark Gear Cutting Machine Co., maker of gear cutting machines and cut gears; Zeh & Hahnemann, makers of screw, crank and hydraulic presses; Crocker-Wheeler Co., maker of electric generators and motors; A. & F. Brown, makers of transmission machinery; Garvin Machine Co., maker of milling machines and other machine tools.

GRINDING THIN ALUMINUM CASTINGS

The Gardner Machine Co., Beloit, Wis., recently completed a grinding test on some peculiarly shaped aluminum castings which, owing to the thinness of the sides that required grinding, presented some rather interesting difficulties owing to the distortion caused by the heat generated. These aluminum castings are used for making automobile horns, and Fig. 1 of the accompanying illustrations, shows how the flat sides were ground between two disk wheels on a No. 14 Gardner grinder.

As the sides of the casting were only about 1/16 inch thick, they could not be ground in the usual way because the thin sides were heated so quickly and bulged out to such an extent that the metal, in some cases, was ground entirely through near the center, before the other parts of the surface were finished true. In all cases, the sides were decidedly convex

Fig. 1. Grinding Thin Aluminum Castings on a Gardner Two-wheel Disk Grinder

after the metal had become cool, showing that they had expanded or bulged because of the heat, which caused an excessive amount of stock to be ground away from the center; consequently, when a casting cooled and resumed its natural shape, the sides were convex.

The idea was conceived of filling the hollow castings with cold water, and this was carried out as shown in Fig. 2. The open end or pipe was plugged with a cork of suitable size. The casting was then filled with water and placed in the hinged wooden holder shown in Fig. 2. The upper half of

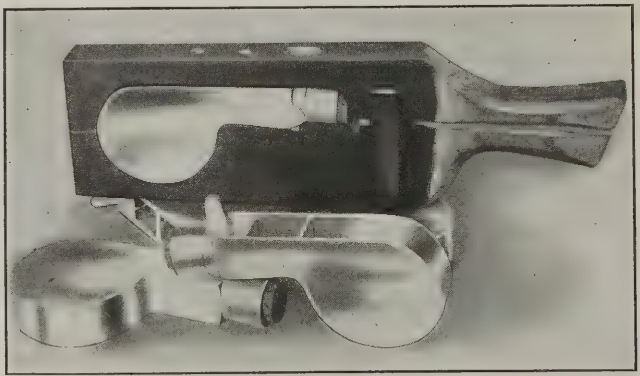


Fig. 2. Holder for Aluminum Castings

this holder was provided with a felt pad which pressed down, thus covering the rectangular opening in the casting and preventing the water from jarring out during the grinding operation. It was found that the water absorbed the heat and equalized its distribution so thoroughly that no further trouble was encountered from warping. The samples were ground to accurate dimensions, and finely finished flat surfaces were formed at the rate of 60 to 75 castings per hour.

BROACHING A CONNECTING-ROD END

The method of finishing the end of an engine connecting-rod by broaching is illustrated in Fig. 1. The hole is 2¼ inches wide by 4½ inches long, and the end of the rod is 1⅞ inch thick. This rectangular opening is finished by broaching in from four to five minutes, the time depending somewhat upon the facilities for handling the work. The end of the

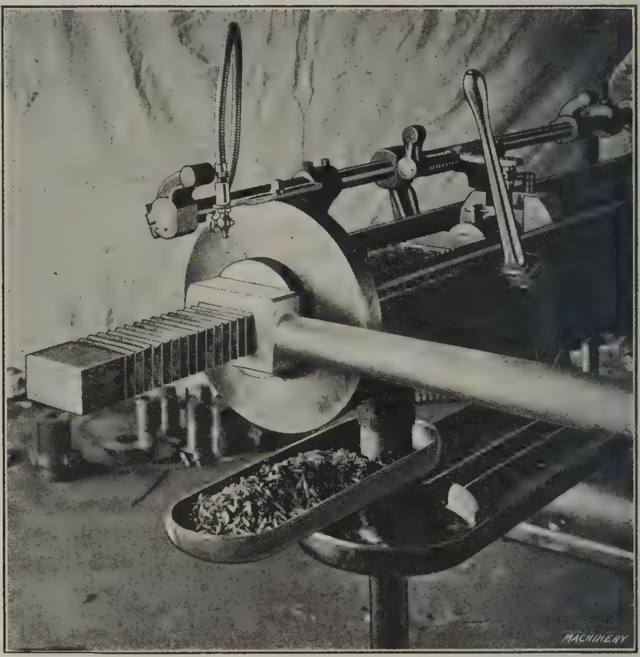


Fig. 1. Broaching Connecting-rod End in Lapointe Machine

rod prior to the broaching operation, is either blocked out by jig drilling as indicated at *A*, Fig. 2, or a rough hole is formed by forging. The full lines in these sketches show the rough surfaces in each case, and the dotted lines, the finished hole.

For broaching an opening of this size, two operations are required; one for roughing and one for finishing. The roughing broach removes the greater part of the metal and

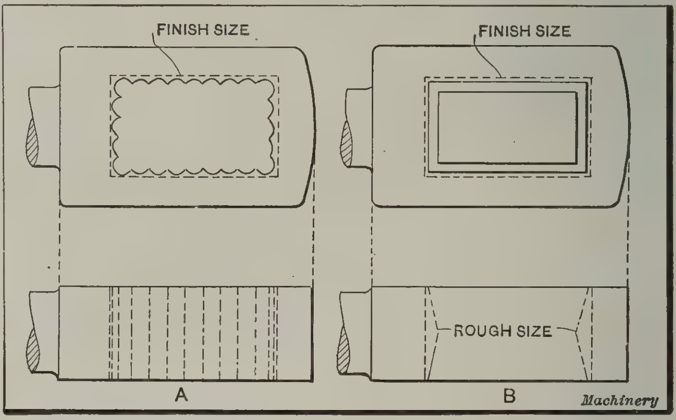


Fig. 2. (A) Rod End Blocked Out by Drilling. (B) Rod with Forged Hole

enlarges the hole to within 1/16 inch of the required size, there being 1/32 inch left on each of the four faces for finishing. The starting end of the finishing broach fits into the hole made by the roughing broach. These broaches are made of a solid piece of steel and are approximately 48 inches long.

As each of these rods weighs from three hundred to four hundred pounds, they are usually handled by means of a hoist. The end of the rod to be broached is supported by the broach itself, and the opposite end rests on a suitable stand. In this way, the work is held parallel or in position to bring the finished hole in alignment with the rod. The broach operates in a fixed position and finishes the hole according to the way the rod is set. After the support is properly located, any number of pieces can be broached without further adjustment, the holes produced being uniform in size and in alignment with the rod. The broaching machine used for this work is built by the J. N. Lapointe Co., Marlboro, Mass.

SEMI-ANNUAL CONVENTION N. M. T. B. A.

The tenth semi-annual convention of the National Machine Tool Builders' Association was held at the Hotel Chalfonte, Atlantic City, N. J., May 16-17. While the representation of the concerns having membership was only about sixty, their seeming indifference was not justified by the work the association has done this year, as was apparent from the report of the committee that worked in Washington to modify the drastic provisions of the Underwood tariff bill which, if passed, will place machine tools on the free list.

Mr. E. P. Bullard, Jr., of the Bullard Machine Tool Co., in welcoming the members as president of the association, referred to the great value of the body when an emergency, like the proposed bill, arose. The industry, through its appointed representatives, could act practically as a unit before the congressional committees and win recognition that probably would be denied to individual manufacturers seeking to protect their interests.

Mr. James H. Herron was introduced as the general manager of the association instead of permanent secretary, the name of the position originally proposed. The fact that the constitution of the association requires the secretary to be a member made the change necessary. Mr. Herron, who will devote his entire time to the work of the association, outlined his views in the paper "What can the Association do for its Members?" in which he spoke of working for the common good, revising nomenclature, the importance of standardization, the protection of gears and other dangerous parts of machine tools, the collection of statistics, keeping technical indexes for the benefit of members, and cost keeping. Reference was made to the indefiniteness of the present system of designating the nominal capacity of engine lathes and it was suggested that something be done that would show in the nominal rating what the lathe will swing over the carriage and between the centers. Other excellent suggestions were made that merit the serious attention of the members.

Mr. W. A. Viall of the Brown & Sharpe Mfg. Co., read the report of the membership committee in the absence of Mr. C. A. Hoefer, chairman. Eleven concerns were proposed for membership as follows:

A. D. Quint, Hartford, Conn.
Landis Machine Co., Waynesboro, Pa.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Grant Mfg. & Machine Co., Bridgeport, Conn.
Geometric Tool Co., New Haven, Conn.
Gooley & Edlund, Syracuse, N. Y.
Joseph T. Ryerson & Son, Chicago, Ill.
Langelier Mfg. Co., Providence, R. I.
Baird Machine Co., Bridgeport, Conn.
Armstrong-Blum Mfg. Co., Chicago, Ill.
Acme Machinery Co., Cleveland, Ohio.

The following consolidations and changes of membership names were reported:

Stoever Foundry & Mfg. Co., Myerstown, Pa., to Treadwell Engineering Co., Easton, Pa.

Grant & Wood Mfg. Co., Chelsea, Mich., to Flanders Mfg. Co., Pontiac, Mich.

Miami Valley Machine Tool Co., Dayton, Ohio, to Conover-Overkamp Machine & Tool Co., Dayton, Ohio.

Fay Machine Tool Co., Philadelphia, Pa., to Jones & Lamson Machine Co., Springfield, Vt.

F. E. Reed Co., and Prentice Bros. Co., of Worcester, to Reed-Prentice Co., Worcester, Mass.

The membership has been increased by seven, making the total 173.

Mr. D. M. Wright of the Henry & Wright Mfg. Co., reported on standardization of machine tools, and counseled that no radical moves be made without giving them very careful consideration and obtaining the opinions of every member of the association affected by the proposed changes. The matter of revising the nomenclature of the trade was discussed, particularly the term "machine tool" which the courts have decided has a much broader significance than the machine tool builders generally believe. In view of the ambiguity, Mr. Wright offered a resolution to the effect that the name of the association be changed to "American Metal Working Machinery Constructors' Association." The resolution was referred to the executive committee.

Mr. C. Wood Walter of the Cincinnati Milling Machine Co., chairman of the committee on prices charged to educational institutions, made no definite recommendations but pointed out the inconsistency of the common practice of machine tool dealers in dealing with educational institutions as compared with the practice of all other concerns, such as builders, plumbers, publishers, etc. The latter, of course, obtain full prices, and it seemed that all interests would be best served by making the rule universal and letting the individual members make their contributions to the cause of education direct instead of in the form of rebates on the prices of equipment.

Mr. Walter also reported on the fight against placing machine tools on the free list before the Senate committee, in the absence of Mr. F. A. Geier, the president of the Cincinnati Milling Machine Co. It was pointed out that although the subject is by no means settled and adverse legislation may be passed, either in the form of the Underwood bill or the Cummins bill, the machine tool builders, through their representatives, have placed on record their arguments against unjust discriminations and the prospects are reasonably bright for a tariff of twenty-five per cent as against no protection at all, as originally proposed in the Underwood bill.

The paper "How can the Mechanical Journals be made of the Most Value to their Patrons?" by Mr. Fred E. Rogers, editor of MACHINERY, was read in the second session (see engineering section of this number), following which Mr. Charles E. Hildreth of the Whitcomb-Blaisdell Machine Tool Co., presented "What has the Future in Store for Us?" accompanied by a large chart on which the fluctuations of pig iron prices for the past eighty-five years had been plotted. From this chart the prospects for the next six years can be predicted if the observed cycles in the past are reproduced. The signs of the times and known conditions existing with the railroads seem to confirm the indication of the chart that an era of heavy pig iron consumption and general prosperity is close at hand, if it has not already begun.

The third session was given up entirely to meetings of the lathe, sensitive drilling machine, boring machine, gear cutting machine, grinding machine, hand screw machine, radial drilling machine, planing machine, milling machine, shaping machine, vertical drilling machine and turret lathe committees.

In the last session Mr. Charles E. Carpenter of E. F. Houghton Co., spoke on "The Value of the House Organ as an Advertising Medium." He outlined the history of the *Houghton Line* and the principles observed in its conduct, without giving conclusive statements as to the value of house organs to manufacturing concerns generally. The fact was made plain that, to be successful, a house organ must have a good organization, including editorial writers of exceptional ability and that the circulation list must be carefully selected.

The question of admitting the makers of woodworking machinery had been submitted to letter ballot, and the vote was against their admission, the opinion being that the woodworking machinery makers have to meet so many conditions out of common with those of the machine tool industry that there would be confusion and lack of harmonious action.

The committee on standardization was made permanent. Mr. L. P. Alford, editor of the *American Machinist*, reported on the progress of the investigation being made by the Bureau of Standards at Washington into the laws governing the behavior of metals beyond the limit of proportionality up to and including rupture. It is within this zone that all metal working machines act in changing the shape of metals, but comparatively little has been done scientifically to deduce the laws of action.

* * *

HYDRAULIC PRESS—PULLEY REAMING MACHINE

The illustrations show two homemade tools in the plant of the Cleveland Planer Works, Cleveland, Ohio, the first being a portable hydraulic press and the second a pulley reaming machine. The hydraulic press consists of a wheeled base containing the ram and carrying the hand pump and two uprights with a cross-rail at the top. The ram will safely exert a pressure of 100 tons, and, of course, has sufficient capacity for assembling all ordinary press fits met with in machine tool building. It is used also for straightening shafts. Being portable, the press is taken to the work when it is more convenient than to transport the work to the press.

The pulley reaming machine consists of a low cast-iron base supporting the table and enclosing the reaming spindle which runs in an oil bath. The bevel gears and pulley shaft also are immersed in the oil bath, thus providing lubrication for all running parts from one reservoir, by a simple construction that is practically proof against leakage and drip. The table carries the pulley dogs, these being two stationary uprights on opposite sides of the spindle.

Fig. 1. Portable Hydraulic Press made and used by Cleveland Planer Works

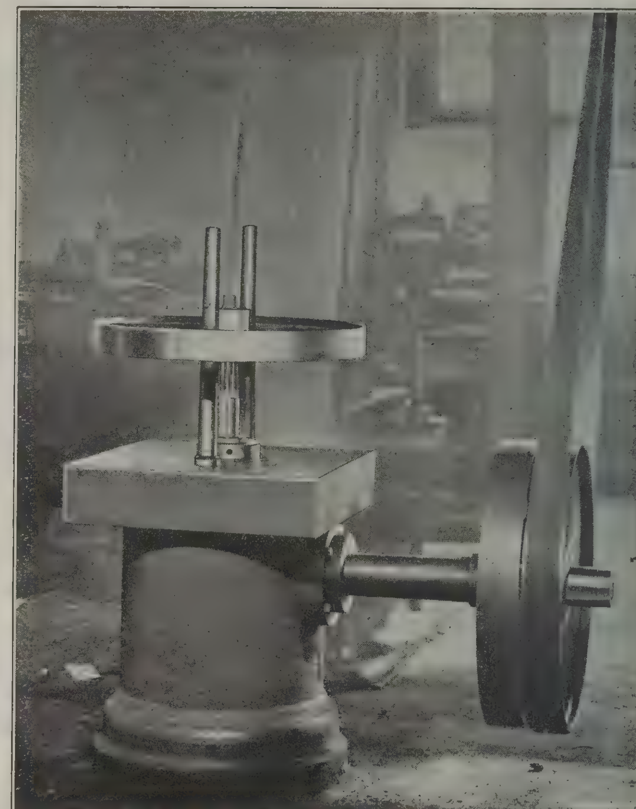
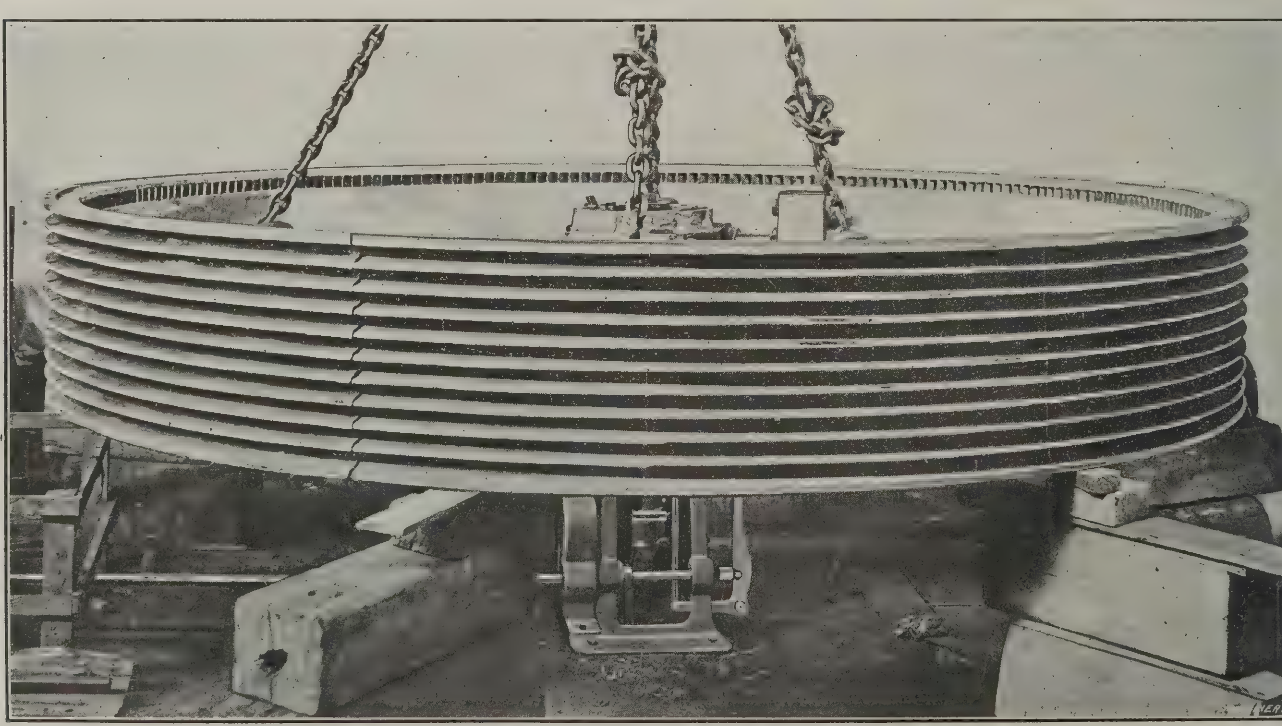


Fig. 2. Pulley Reaming Machine made and used by Cleveland Planer Works

The reamers have square shanks fitting the square socket in the vertical spindle and enter the pulley bore from the under side. The pulley is restrained from turning by the two uprights or dogs and "feeds" down by its own weight only, the pressure of the spokes against the uprights tending to keep the feed from being too rapid.

KEYSEATING LARGE PULLEY IN AN INDIAN SHOP

The keyseating job illustrated herewith is of considerable interest because of the great difference between the size of the pulley and the machine. The casting is a large rope pulley which weighs ten and one-half tons, whereas the keyseating machine weighs only about one ton. The keyway cut is 2½ inches wide, and the machine used for cutting it was built by Mitts & Merrill, 843 Water St., Saginaw, Mich. The cutting of such a large keyseat on a machine of this size, to the required degree of accuracy, is made possible by the method of supporting the work and guiding the tool. The bored hub fits over a vertical post which forms a part of the machine, and this



Cutting Keyway in Hub of 10 1/2-ton Rope Pulley

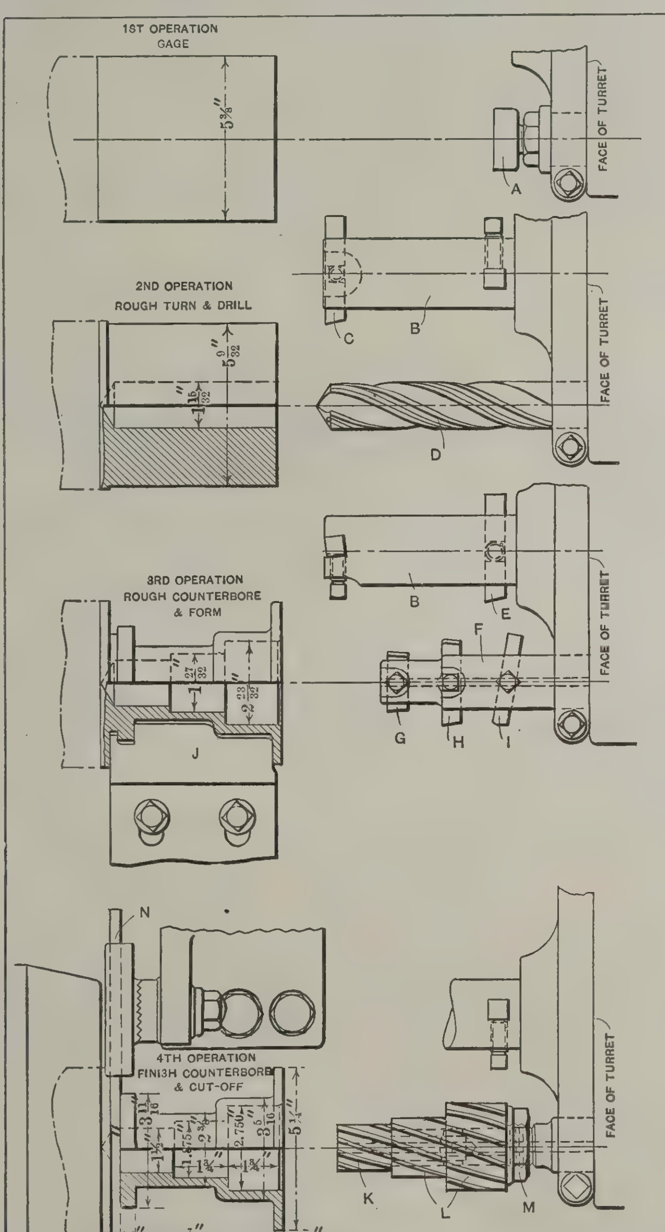
post is provided with a groove in which the cutter operates. The advantage of this construction is that the keyway is cut with reference to the bore, and the cutter has a positive and rigid support. Locating the pulley by the bore also makes it unnecessary to have the hub faced true, as far as cutting the keyway is concerned. This machine has a maximum stroke of nineteen inches and the stroke can be decreased to suit the length of the work. The cutter has a quick-return movement which is twice as fast as the cutting speed. It also has an automatic relief on the return stroke.

The photograph of this keyseating operation was received from Messrs. Burn & Co., Ltd., Bengal, India. This firm is said to be the largest engineering and shipbuilding concern in the Far East.

* * *

MACHINING CLUTCH HUBS IN A CLEVELAND AUTOMATIC

The different machining operations for producing motor car clutch hubs on a 6-inch standard model Cleveland automatic, are shown by the accompanying diagrams. These hubs are made of 14 point carbon, open-hearth steel and from rough bar



Successive Operations for Producing Motor Car Clutch Hub in Cleveland Automatic

stock. The first operation is feeding out the stock and gaging it to length by means of a stop-gage *A*, which is mounted in the No. 1 hole of the turret.

During the second operation, the entire length of the clutch hub is rough-turned by an overhanging turning attachment *B*. A central hole is also drilled with a 1 15/32-inch high-speed oil-feed drill *D*, which is carried in the No. 2 turret hole. The turning tool *C* is made from square stock, and the cutting edge is formed by simply grinding the end. The holder that carries this tool is fastened against the face of the turret and is clamped around the stems of all the other tools, which gives a very rigid support.

The third operation consists of rough-counterboring, chamfering, forming the outside, and finishing the periphery of the large flange at the outer end of the hub. The rough-counterboring is done by two tools mounted in boring-bar *F*, which is provided with an oil feed. The forward tool *G* bores a 1 27/32-inch hole and tool *H*, a 2 23/32-inch hole. The rear tool *I* chamfers the outer edge of the larger hole, as shown. The finishing tool *E*, mounted in the overhanging turning attachment *B*, takes a finishing cut over the large flange. The flat forming tool *J*, which is mounted on an adjustable toolpost on the front of the cross-slide, forms the outside of the clutch hub at the same time that the tools previously referred to, are in operation.

The fourth operation is that of finish-counterboring. The tool for this work is of a three-step form, provided with an oil feed. This counterbore is not made of one piece, but is composed of three separate tools. The advantage of this construction is that if one tool wears out before the rest, it can be replaced, whereas, if the entire tool were solid, it would be difficult to grind and expensive to reproduce. The smallest part *K* has a taper shank with a tang similar to an end-mill. The part *L* is locked by a square key and is backed up by a nut *M*; it has longitudinal adjustment to compensate for grinding the front faces.

The cutting-off operation, which comes next in order, starts before the work of the finishing counterbore is completed, and the cutting off is half finished at the time this counterbore is withdrawn; then the cutting-off tool severs the piece from the bar.

The time for each of these operations is as follows: 1. Gaging to length (takes place during the idle movement of the machine). 2. Drilling and rough-turning, 9 minutes. 3. Rough-counterboring, forming and finishing large flange, 12 minutes. 4. Finish-counterboring, 4 minutes. 5. Cutting off, 4 minutes 26 seconds. Idle movement of machine, 50 seconds. Total time for each hub, 30 minutes 16 seconds.

These clutch hubs are machined accurately to size and require very little extra work after being severed from the bar. The actual labor cost is about five dollars per hundred. The simple design of tools used for these operations is an important feature, especially in the production of pieces of this kind in large quantities. Forming tool *J* is a high-speed steel tool and both ends are the same, although the engraving only shows one end. With this arrangement, if one end is worn to such an extent that it needs replacement, after a large number of parts have been made, it is simply necessary to turn the tool around and use the opposite end. The cutting-off tool is a strong, straight blade, which can be adjusted in a few minutes after grinding, and all of the tools are rigidly mounted.

* * *

The American Society of Engineer Draftsmen held its regular monthly meeting in the Engineering Societies Bldg., May 16. A paper was read by Mr. R. E. Boehck of Evansville, Ind., on "The Development of Logging Machinery," and Mr. F. F. Nickel of the Worthington Pump Co. delivered a lecture on "Practical Applications of the Slide Rule." The meeting was especially interesting on account of the fact that Miss Marie Oberlander, student of architectural drawing at Teachers College, Columbia University, was admitted to junior membership. Miss Oberlander is the first woman to be elected as a member of the society.

* * *

Within the past decade concrete has become one of the most important of building materials, but unless properly mixed with standard materials it is hardly ever satisfactory. Mr. Leonard C. Wason, president of the Aberthaw Construction Co., states that in his opinion five per cent taken out of the proper cost of a concrete building decreases its value one-half.

SEVENTEENTH ANNUAL MEETING OF THE N. A. M.

The National Association of Manufacturers held its seventeenth annual meeting at the Waldorf-Astoria, New York City, May 20-22. At the first session the reports of the various committees, including those on consular reform, bankruptcy, merchant marine, and union labor were presented. One of the most valuable features of the convention was the exhibition of safety appliances and the special motion picture exhibit which illustrated in a clear and interesting manner the methods of accident prevention. The exhibition of safety appliances consisted of a large number of working models, and two thousand photographs lent to the society for the occasion by the Wisconsin State Industrial Commission and the U. S. Steel Corporation. A model ten feet long of an ocean liner with full lifeboat equipment was exhibited by the Hamburg-American line, and a full-sized installation of a submarine bell signaling system, with both sending and receiving apparatus, was shown.

Four films of moving pictures relating to accident prevention were shown, the first being of the general dramatic moving picture type, illustrating the disregard of safety appliances which is frequently met with among experienced workmen, and showing the fatal results. Another film showed the practical application and use of safety appliances on many machines in the plant of the Brown & Sharpe Mfg. Co., Providence, R. I. These pictures illustrated probably better than could have been done by any other means the need for, and the application of, effective guards on machine tools. Incidentally, one was impressed with the great field for moving pictures for educational purposes, not only as regards accident prevention, but as regards machine operation in general.

Another film showed methods adopted in large factories for safeguarding the employes in case of fire. Typical fire drills were exhibited showing hundreds of employes forming in line in perfect order and descending the fire-escapes from the third and fourth stories of a factory building. Since the deplorable Triangle Waist Factory fire, in New York City, fire drills have been made compulsory by law in the state of New Jersey, and these moving pictures were taken under actual working conditions at the regular fire drills. An interesting feature mentioned in connection with this exhibition of pictures was that in the case where fire drills are inaugurated, it is highly important to have an organized system for keeping the employes together and in order after they have left the building until they are ready to enter the building again, so that there may be no unnecessary loss of time. This applies to the fire drill as well as to an actual fire, which might be put out in a few minutes. In one case, it was stated that, in a factory employing eight hundred girls, the fire drill proved a success, as far as leaving the building in order was concerned, but no provision had been made for the method of re-entering the building, and it took several hours to again collect the working force! An interesting film submitted by the North German-Lloyd Steamship Co. showed a life-boat drill on board one of their liners.

There is a good reason for dwelling so long upon this exhibition of moving pictures, as it seems beyond question that accident prevention and the safeguarding of life and limb of industrial workers has become a matter to which all associations of manufacturers and engineers must give due attention. At the same time, there is probably no more effective means to illustrate to both the employers and employes the causes of accidents and the means for their prevention, than is offered by the moving picture machine. To the National Association of Manufacturers is due considerable credit for having given so much attention to this subject, and for having cooperated with the moving picture film makers in producing films of this character.

During the second day of the convention, one of the main addresses was that by Mr. John Kirby, Jr., president of the association. His address was largely devoted to a bitter and uncompromising attack directed partly against the initiative, referendum and recall, and partly against the National Civic Federation and the labor unions. Mr. Edward S. Beach read a paper on the "Influence of Patent Laws on the Development of Industries," in which he defended the present patent laws and voiced his objections to the provisions for compulsory working contained in two bills now before congress. One manufacturer, commenting upon the paper, stated that he believed that the bills containing clauses for compulsory working secured to the inventor all that was intended to be secured by the patent law, and that such provisions did not involve additional hardship to inventors. Addresses were also made by Mr. James A. Emery, on "Legislation and Business," and by Mr. Franklin H. Wentworth on "Fire Prevention."

During the afternoon session, May 21, papers were read by Mr. Frank E. Law, on "Workmen's Compensation for Accidents," and by Mr. Walter E. Edge, on "Workmen's Compensation." Mr. Henry Weismann read a paper on "Immigration, Its Value to the Country, Past, Present and Future."

During the last day of the convention, addresses were made by Mr. Irving T. Bush, on "Currency Reform"; by Mr. M. L. Stewart, on "Trade Possibilities of the Philippine Islands and the Far East"; by Mr. W. M. Benney, on "The National Association of Manufacturers and its Work for Export Trade," and by Mr. C. A. Conant, on "The Panama Canal in Relation to Commerce and Transportation." Moving pictures showing the progress on the Panama Canal were shown. A banquet was held on the evening of May 22, which marked the conclusion of the convention.

The following officers were elected for the year: President, John Kirby, Jr., Dayton, Ohio; secretary, George S. Boudinot, New York; treasurer, A. B. See, New York; assistant treasurer, J. P. Bird, New York.

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CONSOLIDATION OF THE HORTON CHUCK COMPANIES

S. E. Horton Machine Co., Windsor Locks, Conn., and E. Horton & Son Co., of the same place, manufacturers of lathe chucks, have been consolidated through the sale of stock owned by Ezra B. Bailey to interests affiliated with Stoddard Ellsworth Horton, the president and treasurer of the S. E. Horton Machine Co. Mr. Horton will be president, treasurer and general manager of the combined companies.

The E. Horton & Son Co. was started sixty-two years ago by Eli Horton, the inventor and patentee of the first geared universal chucks. Mr. Horton developed original methods of manufacture and made his product known for excellence throughout the manufacturing world. His grandson, S. E. Horton, was identified with the E. Horton & Son Co. beginning 1891 and was superintendent of the plant from 1896 to 1905. He left the company a few years ago and organized an independent company of which he was president and treasurer. The consolidation of the Horton chuck companies will make conditions favorable for a much stronger and more effective business organization.

* * *

REORGANIZATION OF THE WALTHAM WATCH TOOL CO.

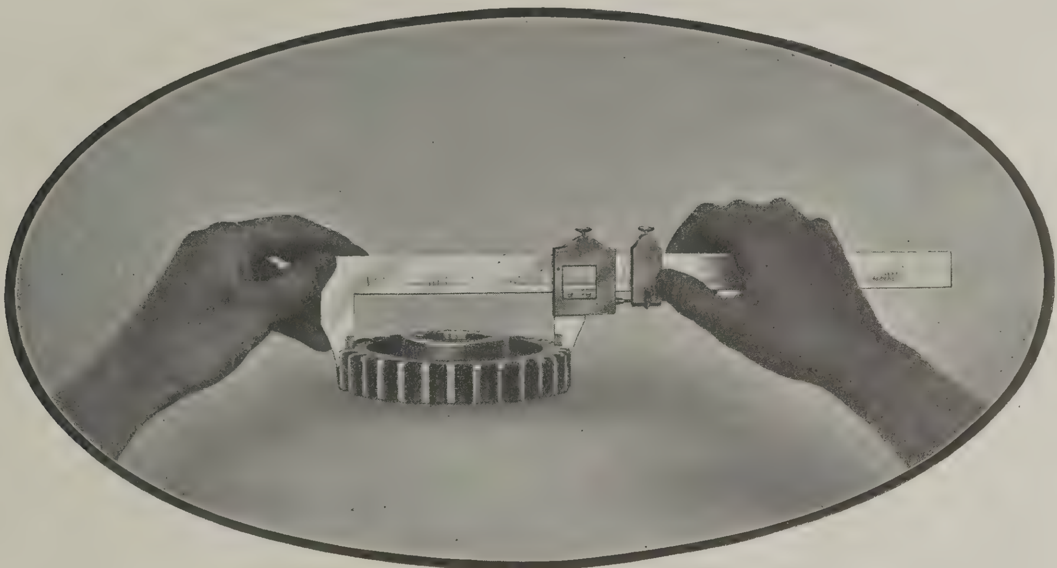
The Van Norman Machine Tool Co., Springfield, Mass., is a new corporation organized to take over the business and property of the Waltham Watch Tool Co., of that city. The authorized capital stock is $400,000, and the incorporators are: Frank H. Page, Clarence J. Wetsel, Charles E. Van Norman and Fred D. Van Norman, all of Springfield. Mr. Page, who is president of the National Equipment Co., will be president of the reorganized company; Mr. Wetsel, formerly manager of the Baush Machine Tool Co., of Springfield, will be treasurer; Charles E. Van Norman, vice-president; and Fred D. Van Norman, secretary. The Van Normans founded the Waltham Watch Tool Co. about eleven years ago, in Waltham, Mass.

The company will continue to manufacture the Van Norman milling machines, universal bench lathes, bench milling machines, internal grinding machines and other tools and accessories that have become well known during the past few years.

* * *

When springs are used for producing certain movements in quick succession, the strength of the springs should be from two to three times what would be required to produce the same movements at a slow speed.

A new adaptation of an old tool for determining accurately the depth of gear teeth



VERNIER CALIPER NO. 687

Measuring the bottom diameter of gears provides an accurate check on the cutting operation and insures the duplication of any desired standard.

This tool, therefore, is found especially valuable in the Automobile Shop for measuring automobile transmission gears, and in fact for measuring the bottom diameter of any gear where it is impossible to use our regular vernier calipers on account of the thickness of the jaws.

Outside of the measuring jaws this tool is exactly like our 12" vernier caliper, and can be used as such.

Write for further information.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

PERSONALS

George B. Pickop, formerly master mechanic of the American Hardware Co., has entered the employ of the Universal Screw Machine Co., Hartford, Conn., as general superintendent.

Henry G. Dreses, president of the Dreses Machine Tool Co., Cincinnati, Ohio, sailed for Europe May 25. Mr. Dreses will make a tour of European manufacturing countries in the interests of his concern.

C. A. Nourse has resigned as general superintendent of the American-LaFrance Fire Engine Co., Elmira, N. Y., to become superintendent of the Reed-Prentice Co., of Worcester, Mass. He assumed his new duties June 1.

George Bradshaw has been appointed general safety agent of the New York Central & Hudson River Railroad Co. He will have his headquarters at New York, reporting to the general claims attorney and to the general manager.

Douglas T. Hamilton, associate editor of MACHINERY, has been made Western editor with headquarters in the Monadnock Block, Chicago, Ill. Mr. Hamilton will travel in the machine tool building territory west of Pittsburg and Erie.

H. W. Kreuzburg, president of the Champion Tool Works Co., Cincinnati, Ohio, sailed May 25 on the *Cincinnati* for a four months' trip in Europe in the interests of his company, taking in Great Britain and the Continental manufacturing countries.

J. C. Dufresne, formerly in charge of the speed and rate setting departments of the Providence Engineering Works, Providence, R. I., has resigned to become factory engineer and mediator for the Aurora Automatic Machinery Co., Aurora, Ill.

J. E. Fries, engineer with the Cutler-Hammer Mfg. Co., Ampere, N. J., has been transferred to the San Francisco office as Pacific Coast engineer, where he will be able to render prompter service to the rapidly growing business of the company on the Pacific Coast.

Duncan H. Macdonald has resigned as general manager and superintendent of the Southern Engine & Boiler Works, Jackson, Tenn. Frank W. Milbourn has been elected to succeed Mr. Macdonald as general manager, and H. M. Harris has been appointed superintendent.

Emile A. Tordet, manager of the Italian branch of Fenwick Freres & Co., of Paris, Turin, Liege, etc., is on a two-months' business trip in the United States to visit the firms represented by his concern in Italy. His address while in the United States is care of Brown & Sharpe Mfg. Co., Providence, R. I.

W. S. Quigley has withdrawn from the Rockwell Furnace Co., New York City, of which he was vice-president and general manager since the formation of the company. Mr. Quigley has formed the Quigley Furnace & Foundry Co., 50 Church St., New York, to carry out some advanced ideas in furnace construction.

Ezra B. Bailey of Windsor Locks, Conn., who recently sold out his entire interest in E. Horton & Son Co., of Windsor Locks, had been connected with the company for thirty-two years. He became treasurer and general manager of the company in 1880 and has been in the chuck business longer, with one exception, than any other man now engaged in it.

George I. Keyes (W. P. I. '97) has retired from the management of the Reed Foundry Co., Worcester, Mass., with which he was connected since it was first established in 1901. For the present Mr. Keyes will take a much needed rest and vacation. He was formerly a member of the firm of Keyes & Woodbury, Worcester, Mass.

John Harland Nelson has been elected professor of applied mechanics by the trustees of the Worcester Polytechnic Institute, Worcester, Mass., to succeed the late Prof. Edward L. Hancock. Prof. Nelson has been at the head of the department of applied mechanics, Case School of Applied Science, Cleveland, Ohio, for the past three years, and is a graduate of the South Dakota State College.

A. Bradley Burgess (W. P. I. '01) has been appointed general manager of the Standard Plunger Elevator Co., Worcester, Mass. Mr. Burgess, upon graduation from the Worcester Polytechnic Institute, became an estimating engineer, following which he filled the positions as sales manager, local manager and now that of general manager. Since he assumed control, the main offices have been removed from 115 Broadway, New York, to Worcester. The treasurer's office of the company will remain in New York.

W. H. Sherwin, for the past ten years Northwestern representative of Joseph T. Ryerson & Son, Chicago, located at Minneapolis, has resigned his position, and will become general manager and vice-president of the Alberta-American Ornamental Iron Co., of Redcliffe, Alberta. This concern is successor to the American Ornamental Iron & Steel Co., of Minneapolis, Minn., a well-known concern that is moving its entire plant to Redcliffe where it expects to add to its already large equipment and thus put the concern in a position to handle the business of that rapidly developing country.

John W. Hill, mechanical engineer, has resigned from the Brown & Sharpe Mfg. Co., Providence, R. I., to become sales engineer with the Bantam Anti-Friction Co., Bantam, Conn. Mr. Hill has a wide experience as mechanical engineer, having been connected with the General Electric Co., Westinghouse Electric & Mfg. Co., and the American Locomotive Co., at Providence. He was also associated several years ago with Mr. W. S. Rogers, president of the Bantam Anti-Friction Co., at the Watervliet Arsenal, in the design of heavy machinery for building the big guns for coast defense purposes, and is, therefore, well equipped for the position he now holds.

* * *

OBITUARY

Hugh Addison Reed, president of the Baird Machinery Co., Pittsburg, Pa., and one of the most prominent machine tool men in the Pittsburg district, died at his home 1232 Sheffield St., N. S., April 25, aged fifty-eight years. Mr. Reed was a native of Pittsburg, having been born in the old city of Allegheny, and spent his entire life in that vicinity. Although he had not been in good health for the past year, his death came as a shock to his many friends. He was one of the first to represent the machine tool business in Pittsburg, becoming interested in it at an early age. Mr. Reed was a member of the Engineers' Society of Western Pennsylvania, and Technischer Verein, and was well known by the machine tool builders throughout the country.

* * *

COMING EVENTS

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

June 17-22.—First annual gas engine show under the auspices of the National Gas Engine Association in the Auditorium, Milwaukee, Wis. Albert Stritmatter, secretary, Cincinnati, Ohio.

June 27-29.—Summer meeting of the Society of Automobile Engineers, Detroit, Mich., Hotel Pontchartrain, headquarters. Coker F. Clarkson, secretary, 1786 Broadway, New York.

July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

NEW CATALOGUES AND CIRCULARS

RICHARD DUDGEON, Broome and Columbia Sts., New York, manufacturer of hydraulic jacks, hydraulic punches, and roller tube expanders. Booklet entitled, "Some Mathematical Recreations."

GEM MFG. Co., Pittsburg, Pa. Catalogue No. 6 of steel and brass oilers, torches, oil carriers, tallow pots, flue scrapers, foundry chaplets, loose pulley lubricators, flexible shafts, portable drills, center grinders, clamp spindles, universal joints, electric polishing machines, stop clutches, etc.

CONOVER-OVERKAMP MACHINE & TOOL Co., Dayton, Ohio (successors to Miami Valley Machine Tool Co.). Catalogue of lathes and No. 1 grinder comprising 14-inch standard lathe; 16-inch standard lathe; 16-inch lathe, double back geared; plain turning lathe; and universal cutter and tool grinder, illustrating applications to various forms of cutters.

EGBERT R. MORRISON, Sharon, Pa. Circular of the "Morrison" water-tube boiler of the type consisting of cylindrical shells connected by water-tubes, there being two shells above and two below connected by tubes and surrounded by brick work which is provided with baffle-plates insuring thorough circulation of the hot gases over the heating surface.

ROCHESTER BORING MACHINE Co., Rochester, N. Y. Sixteen-page catalogue, 8 by 10 inches, on floor type and table type boring machines. The machines are illustrated and details of construction are shown in line illustrations and halftones. Special tables and attachments are also shown.

ROCKFORD DRILLING MACHINE Co., Rockford, Ill. Booklet entitled "Jigging and Tooling." This booklet illustrates and describes how the Rockford gang drills built by this company may be used to best advantage in manufacturing work. A number of examples from practice giving detailed data of possibilities in production form the basis of the contents.

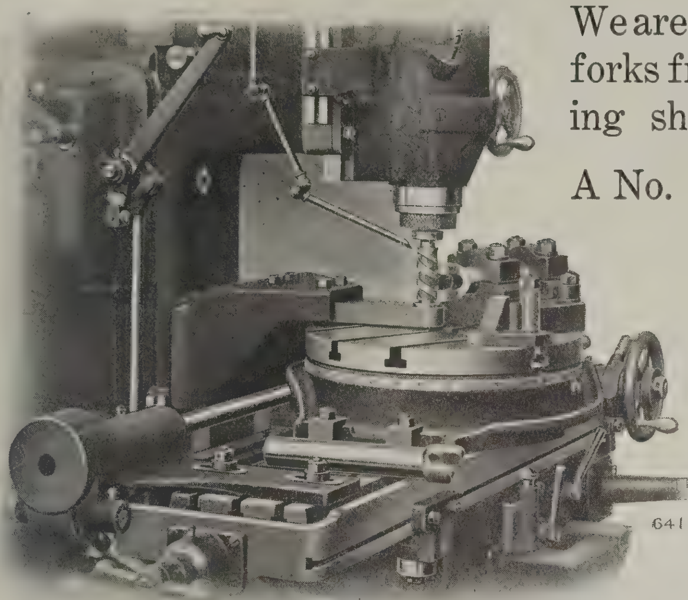
E. T. COPELAND Co., 100 William St., New York. Booklet entitled "Circulation of Water in Steam Boilers," containing a general treatise on circulating devices and especially on the Copeland patent automatic circulating system, describing its general construction, how it works, what it accomplishes, etc. The text matter of the booklet is clearly illustrated by engravings.

HESS-BRIGHT MFG. Co., 2111 Fairmount Ave., Philadelphia, Pa. Pamphlet entitled "Ball Bearings in Woodworking Machinery," illustrating a large variety of woodworking machinery to which ball bearings have been successfully applied; also showing the approved construction of ball bearing mountings adapted to the peculiar conditions in woodworking machinery.

HYATT ROLLER BEARING Co., Newark, N. J. Miniature bulletin 400 C of twenty pages on roller bearing line shafting boxes. Data of tests made by the United Shoe Machinery Co., showing a large saving in power, are included; also data on a test made by the American Can Co. A price-list is given of Hyatt standard line-shaft bearings and extra heavy main shaft bearings, and dimensions of Hyatt standard boxes, etc.

MAKUTCHAN ROLLER BEARING Co., 1541-42 McCormick Bldg., Chicago, Ill. Catalogue of roller bearings and roller bearing hangers. The principle of the Makutchan roller bearing is illustrated and described and tables of sizes and price lists of roller bearings, roller bearing hangers of various types, and thrust ball bearings are given. A number of halftone illustrations are included, showing views of installations where the Makutchan bearings are used.

Time Per Piece—7 Minutes

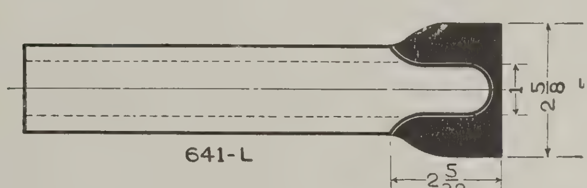


We are now cutting our universal shaft forks from solid steel bars. The drawing shows them ready for milling.

A No. 3 Vertical with a 20" Circular Attachment forms up the outside at one setting and at one cut.

This is possible because all feeds are set and controlled from the front of the knee without stopping. A combination of table, cross and circular feeds is used.

Speed, 94 Revolutions.
Feed, 2 1-4" per minute.
Time per piece, 7 minutes.



The next operation consists of milling out the fork for the ball seat. There are two fixtures. While the operator is filling one, the other piece is being milled. Time for this cut, one minute.

You will notice that the cutter is different from the usual end mill—suggests some of our advanced ideas in cutter design.

We are pretty far ahead in everything that relates to milling.

Ask for our New Examples of Modern Milling Practice.

The Cincinnati Milling Machine Co.

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Ayres.

SKINNER CHUCK Co., New Britain, Conn. 1912 catalogue and price list covering independent, universal and combination lathe chucks; drill chucks; planer chucks; faceplate jaws; drill press vises and reamer stands. A new line has been added to the products of this company, consisting of all-steel independent lathe chucks and all-steel faceplate jaws. The catalogue gives complete tabulated dimensions and price lists of all the tools illustrated and described.

LINCOLN-WILLIAMS TWIST DRILL Co., Taunton, Mass. Catalogue of carbon and high-speed steel twist drills, reamers and milling cutters; also arbors, disks, countersinks, mandrels, saws, sockets and sleeves, taps and dies. The catalogue includes a number of tables of general value on cutting speeds, decimal equivalents of listed sizes, dimensions of Morse taper shanks, dimensions of Brown & Sharpe taper shanks, drill feeds and speeds, melting points of the elements, and tap drill sizes.

WATSON-STILLMAN Co., 192 Fulton St., New York. Catalogue No. 83, entitled "Hydraulic Benders," covering 64, 6- by 9-inch pages, and illustrating and describing hydraulic and motor-driven rail benders; shaft straighteners for lathes; portable shaft straighteners; straightening presses; pipe benders; axle straightening presses; bar straighteners; hydraulic shaft straightening presses; plate straightening and forming presses; beam bending presses; strake benders; crank pin presses; bending jacks, etc.

EUGENE DIETZGEN Co., 214-220 E. 23d St., New York. Circular illustrating the "Dietzgen" economy box for storing blueprints, drawings, tracing paper, etc. The box is especially adapted for the storing and preservation of blueprint paper, the construction being such that light is excluded. Provision is made for measuring and cutting off the paper to the exact required length. This feature of economy means a substantial saving in almost any drafting-room using blueprint paper, tracing paper and other paper in rolls.

YALE & TOWNE MFG. Co., 9 Murray St., New York. Catalogue No. 12-D, 1912, of chain blocks, electric hoists, trolleys and cranes. This catalogue, containing 96, 6 by 9-inch pages, illustrates and describes in detail the various types of hoisting devices built by the company. Constructional features are plainly illustrated and carefully described and parts and details are numbered and named so as to make it easy to order duplicate parts. All dimensions necessary for preliminary layouts are included, making the book, in general, valuable for the designing engineering and manufacturer.

NATIONAL-ACME MFG. Co., Cleveland, Ohio. Booklet entitled "Parts for the Trade," illustrating a large number of specialties made on National-Acme automatic screw machines to customers' specifications and to order only. The parts shown comprise spark plugs, automobile engine parts, special screws and nuts, carbureter and magneto parts, sundry accessories, lubrication parts, motorcycle parts, heavy machinery parts, screws, bushings, nuts, etc., for speedometers, cyclometers, indicators, typewriters, phonographs, sewing machines, washing machines, hardware, tools, plumbing supplies, gas appliances, locomotives, cars, etc.

WESTINGHOUSE ELECTRIC & MANUFACTURING Co., East Pittsburg, Pa. Descriptive leaflets No. 2303, Direct-current Crane Motors; Nos. 2313, 2314, and 2315, Commutating Pole Mine Motors; No. 2368, Strap Wound Armature Coils of Westinghouse Railway Motors; No. 2370, Details of Railway Motors; No. 2376, Box Frame Interpole Railway Motor for use on 600- to 1200-volt service; No. 2377, Box Frame Interpole Railway Motor for Locomotive Work; No. 2393, Dynamotor-Compressor for 1200- to 1500-volt Direct-current Service; No. 2444, Equalizer Flywheel Hoisting Sets; No. 2464, Rheostats for Direct-current Motors.

STANDARD MACHINERY Co., Providence, R. I. Catalogue, eighth edition, on drop presses, comprising plain drop presses in eight sizes with hammers weighing from 60 to 800 pounds; power lifters for plain drop presses for 40- to 1000-pound hammers; automatic drop presses in eight sizes with hammers weighing from 50 to 1200 pounds. A valuable chapter on foundations is included illustrating the construction of approved forms. The company also builds trimming presses, roller bearing and plain bearing rolling mills, rotary swaging machines, wire-drawing machinery, roller bearings, ball bearings and special machinery.

J. H. WILLIAMS & Co., 61 Richards St., Brooklyn, N. Y. Catalogue of drop-forged wrenches for all uses, spanners, wrench sets for automobilists, "Ratcho" wrenches, lathe dogs of the safety and ordinary forms, C-clamps, machinists' clamps, strap clamps, external caliper gages (unfinished), machine balanced handles, toolpost fittings, thumb nuts, eye-bolts, swivels, hoist hooks, rope sockets, rod ends, yoke ends, shafting collars or bushings, key forgings, weldless pipe ferrules and flanges, chain pipe vises, chain pipe wrenches, crankshafts, connecting rods, valve stem forgings, levers, etc. The company makes drop forgings of iron, steel, copper, bronze and aluminum. The front cover of the catalogue is double, bearing on the front face a drop-forged engineer's wrench with the "flash." The second cover shows the trimmed wrench, the opening in the front cover having the effect of a trimming die used for removing the flash of drop-forgings. The design is unique and peculiarly appropriate.

WIENER MACHINERY Co., 50 Church St., New York. Catalogue of Ernst Schiess, Ltd., Dusseldorf, Germany, builder of heavy machine tools. This well-known German concern has built some of the largest machine tools in the world as, for example, a turning and boring mill with table 36 feet 1 inch diameter, weighing approximately 660,000 pounds. The catalogue illustrates the works' interior, erecting shop, heavy type roughing lathes, "sliding and surfacing lathe" for turbine shafts, turning lathe for turbine shafts, turning lathe for large turbine shafts and drums, weighing 732,600 pounds, heavy roll roughing lathe, hollow boring lathe, turning and boring lathe, turning and boring mill, portable boring mill, planing and milling machine, standard type planing machine, pit planing machine, transverse planing machine, shaping machine, triple slotting machine, combined slotting and drilling machine, universal radial drilling machine, horizontal boring and milling machine, cylinder boring machine, double punch press, bending machine, horizontal cold saw, etc.

CINCINNATI-BICKFORD TOOL Co., Oakley, Cincinnati, Ohio. Catalogue of "Cincinnati" heavy pattern upright drilling and tapping machines, comprising 20-inch high-speed sliding head drill, square or round table and hand or power feed, with or without tapping attachment, belt or motor drive; 21-inch stationary head, heavy pattern drill, with and without back gears, belt or motor drive; 21-inch sliding head, heavy pattern drill with and without tapping attachment; 24- to 42-inch regular heavy pattern drill, with and without tapping attachment, belt or motor drive; 24- to 36-inch, special pattern drill with geared tapping attachment; 20-inch high-speed sliding head gang drill, furnished with two to six spindles, each with or without tapping attachments and with or without power feed; and 21- to 42-inch heavy pattern gang drill with four spindles. The details of table equipment are illustrated; also right angle drive, belted motor drive, geared motor drive, motor and speed-box drive, friction back gear and tapping attachment, feed box, depth gage, automatic trip, etc.

TRADE NOTES

HILL, CLARKE & Co., INC., has removed its Philadelphia office from 512 Arch St., to 1011 Chestnut St.

CUTLER-HAMMER MFG. Co., Ampere, N. J., opened an office in the Title Insurance Bldg., in Los Angeles, Cal., April 1.

NILES-BEMENT-POND Co., removed its Chicago offices from the Commercial National Bank Bldg. to the McCormick Bldg., 332 S. Michigan Ave., May 1.

BROWN & SHARPE MFG. Co.'s drafting-room gave a minstrel show and entertainment for the benefit of the "League for the Suppression of Tuberculosis," May 3.

TOLEDO MACHINE & TOOL Co., Toledo, Ohio, has contracted for a three-story iron and brick building 90 by 115 feet which will be used in connection with the present business.

WILLIAM GANSCHOW Co., Chicago, Ill., gear cutter, has taken another floor in the building now occupied, adding new machinery and increasing the capacity one-third. The company has also fitted up a finely equipped office.

STANDARD ROLLER BEARING Co., 50th St. and Lancaster Ave., Philadelphia, Pa., recently purchased and installed over $100,000 worth of additional machinery equipment to increase its facilities for the manufacture of ball and roller bearings.

PHILADELPHIA GEAR WORKS, 1120-1122 Vine St., Philadelphia, Pa., has established a special automobile service for local customers, thereby shortening local delivery time considerably, and also enabling the company to quickly place cut gears in the express companies' care when ordered from out of town.

NORTON Co., Worcester, Mass., broke ground April 5 for a $100,000 administration and research laboratory building which will be situated between the present buildings and those of the Norton Grinding Co., facing on New Bond St. The new building is to be of brick, and will be three stories high, with a basement 98 by 157 feet.

BIGNALL & KEELER MFG. Co., Edwardsville, Ill., manufacturer of Peerless, Duplex and P. D. Q. C. pipe threading and cutting machines, emery surfacers, die grinders and rolling cutters, has made an exclusive sales agency arrangement with Manning, Maxwell & Moore, Inc., for the sale of its machines throughout all the Eastern states.

QUIGLEY FURNACE & FOUNDRY Co., 50 Church St., New York, has been formed by Mr. W. S. Quigley, formerly vice-president and general manager of the Rockwell Furnace Co., New York. The new company will carry out some advanced ideas in furnace construction and has secured the services of able furnace engineers who have been associated with Mr. Quigley for a number of years.

BILLINGS & SPENCER Co., Hartford, Conn., and Claire L. Barnes Co., Chicago, Ill., have discontinued the selling arrangements existing between them by mutual consent. In future the Billings & Spencer Co. will market its products of drop forgings and tools direct. During the past two years the company has more than doubled its manufacturing capacity, and its new plant at Dividend, Conn., devoted exclusively to the making of drop forgings, is now in full operation.

CINCINNATI ELECTRICAL TOOL Co., 652 Evans St., Cincinnati, Ohio, announces that it has just completed two sizes of universal drills which will operate on direct current as well as alternating current. Type OX2 will drill up to 3/16 inch in steel and hard wood and up to ⅝ inch in soft wood. Type OX3 will drill ¼ inch in steel and hard wood and ½ inch in soft wood. The armature runs in ball bearings, and the gears are enclosed and run in grease.

KELLY REAMER Co.'s stockholders held their annual meeting at the company's office in Cleveland, Ohio, April 20 and elected Wm. E. Kelly, W. A. Calhoon, H. J. Maxwell, O. H. P. Davis, E. B. Jessup, George Bauer and Thomas A. Torrance, directors, who elected the following officers for the year; president and general manager, Wm. E. Kelly; vice-president, W. A. Calhoon; secretary, H. J. Maxwell; and treasurer, O. H. P. Davis. The company reports a large increase in business during the past year.

JOSEPH TRACY and HENRY F. DONALDSON have associated themselves as automobile engineers to undertake consultation, research and development work, design and construction, laboratory and road tests, and have removed the office which Mr. Tracy has maintained for several years at 116 West 39th St., to 1786 Broadway (cor. 58th St.), New York. The testing laboratory in New Jersey, near New York City, will be maintained as heretofore, and its facilities will be increased by additional equipment.

STARK TOOL Co., Waltham, Mass., manufacturer of precision bench lathes and attachments, bench milling machines, watchmakers' lathes and fine tools completed its fiftieth year in business May 1. Since the business started it has not had a shutdown, lock-out or cessation of the regular work, beyond the regular yearly vacation of a week. The business was founded by John Stark who was succeeded by the present John Stark at his death. The company is the fourth oldest industry in Waltham, being antedated only by the Boston Mfg. Co., Davis & Farnum Co., and the Waltham Watch Co.

J. L. OSGOOD TOOL Co., 121 Erie Co. Bank Bldg., Buffalo, N. Y., recently took over the business of J. L. Osgood, manufacturer of Osgood's indestructible tool handles. Several new types of indestructible handles have been added; also a line of black diamond hand tools, and the "junior class" indestructible file and tool handles. These handles will not split, having a steel-bound inner core which resists the splitting action of the file tang. A line of screwdriver handles made on the same principle has also been added, having hard wood handles with steel reinforced core and transverse scores on the grip, making a strong and powerful handle.

W. ROBERTSON MACHINE & FOUNDRY Co., 32 Greenwood Pl., Buffalo, N. Y., is a new concern recently organized under the laws of the state of New York with $15,000 capitalization, $12,000 of which is paid in. The officers are: W. Robertson, president and manager; T. J. Reed, vice-president; F. H. Keil, secretary; and F. M. Robertson, treasurer. The company will manufacture machine tool specialties, including a complete line of power hacksaws for all kinds of metal cutting, and special drilling machines. It will also manufacture, to order, gray iron pistons, cast within 0.005 inch of finished size by a new process which insures the wrist-pin holes being absolutely round and to the dimensions specified in the drawings, and produces a balanced piston which is very essential for quiet and serviceable motors. Mr. W. Robertson, the president of the company, has been a successful designer of tools and appliances, having placed over 1600 of his power hacksaws on the market. He was formerly connected with the Frontier Iron Works of Buffalo, N. Y.

EARLE GEAR & MACHINE Co., Stenton and Wyoming Aves., Philadelphia, Pa., was recently awarded a contract for one of the most interesting features in connection with the operation of the locks of the Panama Canal, that is, the mechanism which controls the collapsible hand-rails on the top of the various gates, forty in number. When these gates are closed a standing rail on each side serves to prevent persons from falling into the water. As the gates are opened to permit the passage of vessels, these rails are automatically collapsed or folded by means of a unique driving mechanism, motor operated. The worms, gears and screws for this device incorporate some very interesting engineering features. All parts are exceptionally heavy and the design of the entire outfit has been made with a view to quick operation and accessibility. There are eighty sets—forty right-hand and forty left-hand. Each gate is approximately seventy feet long, and some idea of the rugged construction necessary can be gained from consideration of this dimension. The company, to which the contract was awarded, is a specialist in the manufacture of work of this character; it recently produced a large number of lock-working mechanisms for the New York state barge canal.

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

July, 1912

EIGHT-MOTOR ARTICULATED-TRUCK LOCOMOTIVES FOR THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD

THIRTY-NINE heavy-service, electric locomotives are now being built by the Baldwin-Westinghouse combination for use on the New York, New Haven & Hartford R. R. between New York and New Haven. This is one of the largest consignments of electric locomotives ever constructed. The design adopted differs from any heretofore used for electric engines, in that thirty-six of the engines are arranged for single-phase service only.

A side view of one of these locomotives is shown in Fig. 1. Each locomotive has four twin motor driving units similar to the one shown in Fig. 3, there being eight motors in all. One of these motor units is mounted over each driving axle. This arrangement has proved very desirable for the following reasons: 1. The peripheral speed is a limiting feature in railway motor design. With two small motors it is possible to use a rotative speed of approximately twice that obtainable with one large motor. Each motor has, therefore, one-half the number of poles of practically the same size as would be required by one large motor of equivalent capacity. Hence, two of the small motors have practically the same number of parts, such as field coils, armature coils, and brush holders, as would be required by one large motor. 2. Each of the small motors has a diameter practically half of that of one equivalent large motor; hence a saving in weight and space results. 3. There is a further saving in weight because each small motor exerts but one-half the torque that must be exerted by one equivalent large motor; therefore a single gear meshing with the pinion of each motor can be used in place of the two gears necessary with a large motor of the same total capacity. 4. By the use of a single gear, the motor can be longer which permits of a more economical design. 5. The motor armatures are interchangeable with those used on the New

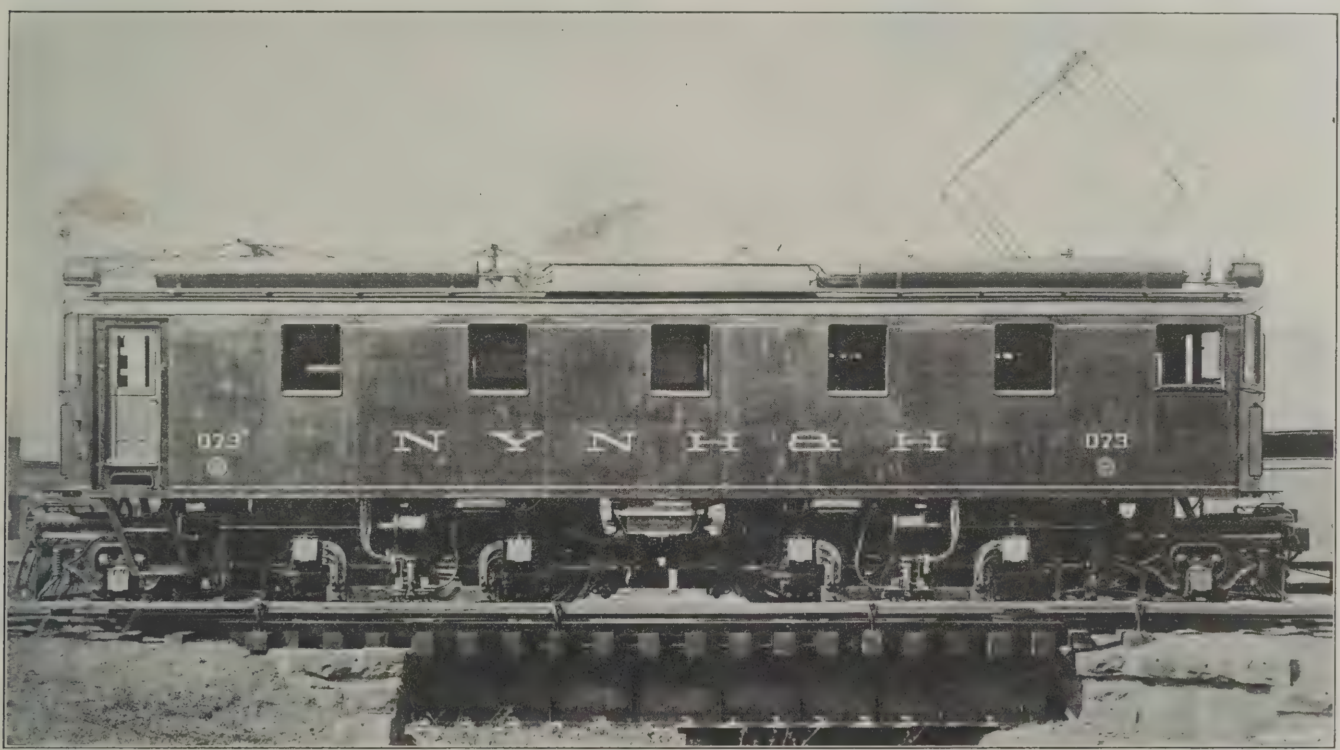


Fig. 1. Side View of Eight-motor, Articulated Truck, Electric Locomotive

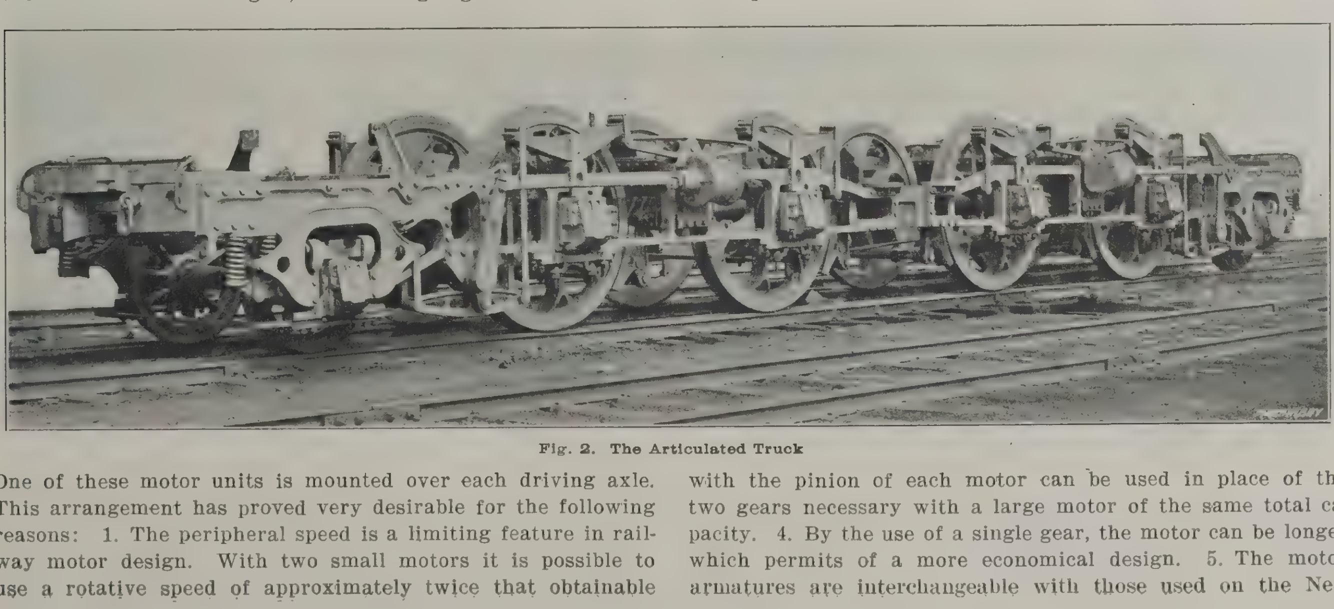


Fig. 2. The Articulated Truck

York, New Haven & Hartford and the New York, Westchester and Boston motor cars. 6. Finally, eight motors actually cost less than four having the same aggregate output.

These engines have an articulated running gear (Fig. 2)

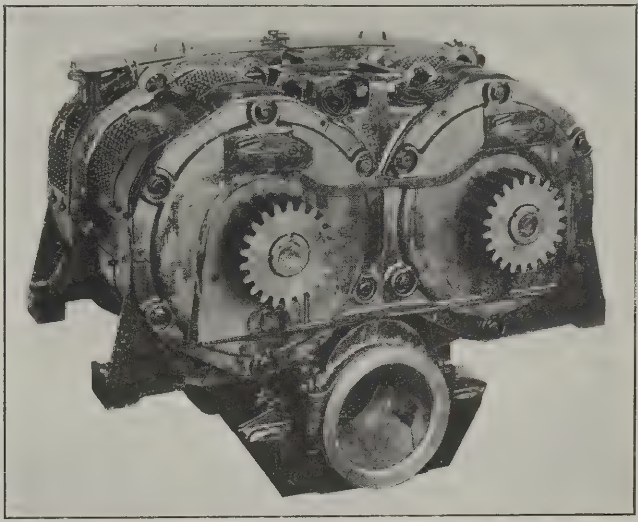


Fig. 3. One of the Twin Motor Units

which is very similar to that used for the 072 type New Haven locomotives. (The 072 engines were driven by four motors.) This running gear has proved very "easy running" as far as shock to the equipment in the locomotive cab is concerned,

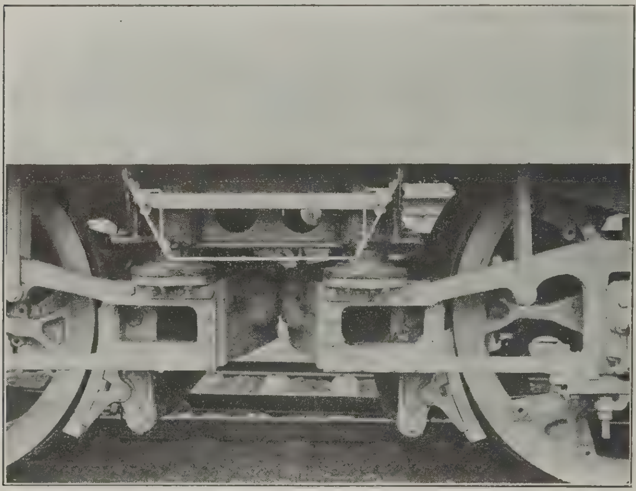


Fig. 4. Spring Buffers and Bumper Girders

which is one of the reasons why it has been used. The cab is carried by semi-elliptic and helical springs in series. This spring arrangement resembles, in general principle, at least, that which is employed for passenger cars.

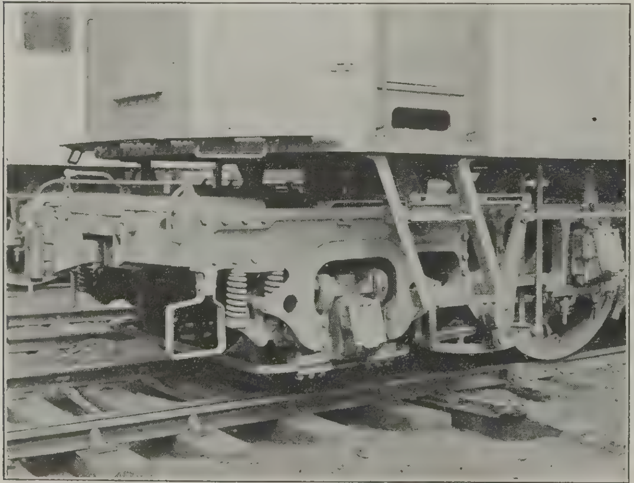


Fig. 5. The Rushton Truck

In general design and arrangement, all of the locomotives are the same, but the three bearing the road numbers 073 to 075, are for both alternating- and direct-current operation. They are intended for fast freight and heavy passenger service and are designed to handle a trailing load of 800 tons at a maximum speed of 45 miles per hour. When operating on single-phase alternating current, they take energy at 11,000 volts and 25 cycles, and on direct current at 650 volts.

Thirty-six of the locomotives are equipped for 11,000 volt, 25-cycle, alternating-current operation only. These are primarily for fast freight service, but will sometimes haul passenger trains. They are designed to handle a trailing load of 1500 tons at a maximum speed of 35 miles per hour, and to exert a maximum tractive force of 40,000 pounds.

The four pairs of driving wheels and two pairs of small leading wheels, are in two groups having outside frames.

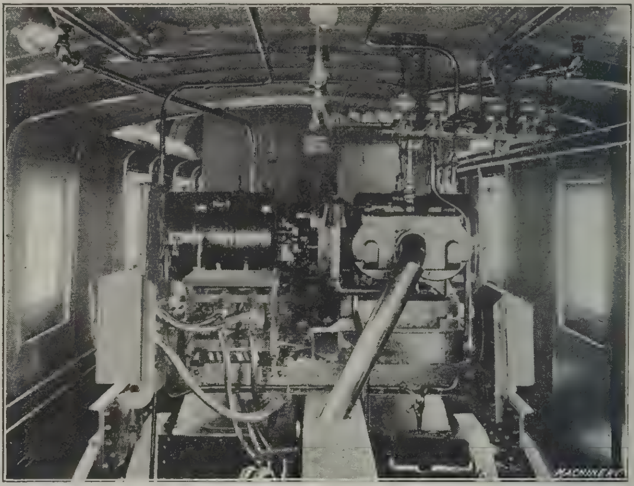


Fig. 6. View of Locomotive Interior showing Reverser, Air-duct to Main Motors, Motor-generator Set for Charging Storage Batteries and Operating Unit Switch Control, Air Compressor, Blower Motor, and Transformer in the Background

These cast-steel frames are four inches wide and are similar to those used in steam locomotive practice. The pulling and buffing strains are transmitted entirely through the truck frames which are braced transversely at the end of the trucks

Fig. 7. View of Cab Interior showing Engineer's Operating Equipment

and between the driving axles. The inside faces of the driving pedestals are tapering and are fitted with adjustable wedges. The pedestal binders are of cast steel.

The drawbar pull is transmitted from truck to truck by means of a drawbar adjusted to leave a ½ inch maximum clearance between the end ties or bumper-guides of the trucks

when all the slack is taken up. The truck cross-ties, which are attached to the inner ends of the trucks, are equipped with spring buffers (see Fig. 4) which assist in transmitting the buffing shocks from truck to truck. Midway between the driving wheels, the bar frame of each truck is braced transversely by a built-up structure on which the truck center-pin is mounted. The center-pin of one truck is allowed a limited longitudinal movement with reference to the cab under frame, to relieve the frame from pulling and buffing strains.

A two-wheeled truck of the Rushton type (Fig. 5) with outside journals, is arranged under each end of the locomotives and carries the small truck wheels. This truck is of the radial type, its frame being connected to the main truck cross-tie by two links which are so arranged in relation to each other that the intersection of their center-lines, if they were extended, would be on the center-line of the locomotive at the correct point for the truck radius-bar pin. This construction was adopted because the motors are so located that it is impossible to place the radius pin at its normal position on the center-line. A radial type drawbar, arranged to receive a housing for a Westinghouse friction draft gear, is mounted on each end of the engine. Thrust springs are provided to limit the lateral movement of the drawbar. The coupler shank is supported by a carrier iron which is bolted to the end bumper casting.

Each group of two pairs of driving wheels and a pair of truck wheels, is equalized on each side of the locomotive. The springs (see Fig. 2) are of the usual elliptic form and are mounted directly over their respective boxes. Helical springs support the truck frames at their outer ends. The equalizing beams are of cast steel. The weight of the cab is transferred to the truck frames through coiled springs, and the spring pocket plungers slide on the frame cross-ties when the engine is traversing curves. The thirty-six locomotives have a length between coupler faces, of 50 feet, and the driving wheels are 63 inches in diameter.

The eight single-phase, commutator type, series motors which drive each locomotive, have a capacity of 170 horsepower on a one-hour rating. The motors are grouped together in pairs, as shown in Fig. 3. The two motors of each pair (a right-hand and a left-hand motor) are bolted together so as to form a unit. Each pair of motors is provided with two axle bearings which carry a quill that is concentric with and surrounds the axle. A single gear is secured on one end of the quill and into this gear mesh the pinions keyed on the motor armature shafts. Mechanical connection between the quills and the driving wheels is effected through helical springs which are mounted between the driver spokes and the projecting arms provided on each end of the quill. A radial clearance of 1½ inch is provided between the inside of the quill and the driving-wheel axle, so that the drivers are free to follow irregularities in the tracks. This method of mounting relieves the axles of the dead weight of the motors and insures that the operation of the locomotive will be easier on the tracks.

A low deck is built over each pair of motors and doors are provided in the decks in such positions that free access to the commutators and armature bearings is afforded. Flexible leads of ample length to accommodate all movement of the motors relative to the cab, extend through insulating bushings in the floor and electrically connect the motors with the controlling apparatus.

The three locomotives arranged for operation on either alternating or direct current are provided with control equipment that can be used in either service. The pneumatically-operated control switches work in combination with a transformer and preventive coils when the locomotive is receiving alternating current, and in combination with grid resistors, when it is receiving direct current.

Each pair of motors is connected permanently in series. In alternating-current operation, the four pairs are connected in multiple and on direct current they may be connected two pairs in series or all four pairs in parallel. When operating on alternating current from the line at 11,000 volts, the energy passes through an oil circuit breaker to the primary of the main transformer and thence to the ground. A number of taps are provided on the secondary winding of this main transformer and are connected to the motor circuits through preventive coils, by means of the pneumatically-operated switches. There are twelve voltage steps on the transformer winding, nine of which are for running points.

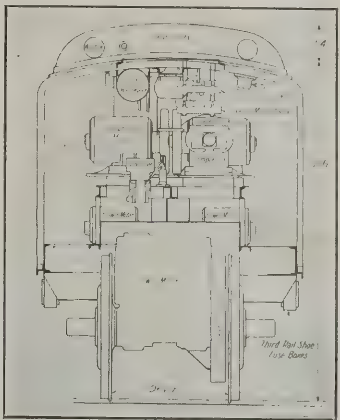


Fig. 9. Transverse Section

The pneumatic switches, used for operation on alternating current, are assembled in one group. This group is located close to the transformer. Reversal of the direction of rotation of the motors is effected by two pneumatically-operated drum-type reversers. Each reverser is so connected as to handle two pairs of motors. When the locomotives are on direct current, the control of the motors is accomplished by two other groups of pneumatically-operated switches which connect the pairs in series and in parallel, in combination with the resistors. The switches are arranged in a straight line with the resistors directly above them, so that the connecting leads between switches and resistors are of minimum length.

Fig. 6 shows the interior of a locomotive for single-phase operation. A master controller is located at each end of the cab as shown in Fig. 7. Two Sirocco-type blowers, for handling cooling air, are located in the center of the cab directly under the main transformer. These blowers draw air from the outside of the locomotive and discharge it through the main transformer, motors and resistors. This keeps the equipment at a moderate temperature even when operating under severe overloads. A double air-brake apparatus is provided on each locomotive. Two compressors each having a capacity of 50 cubic feet of free air per minute, are mounted within the cab

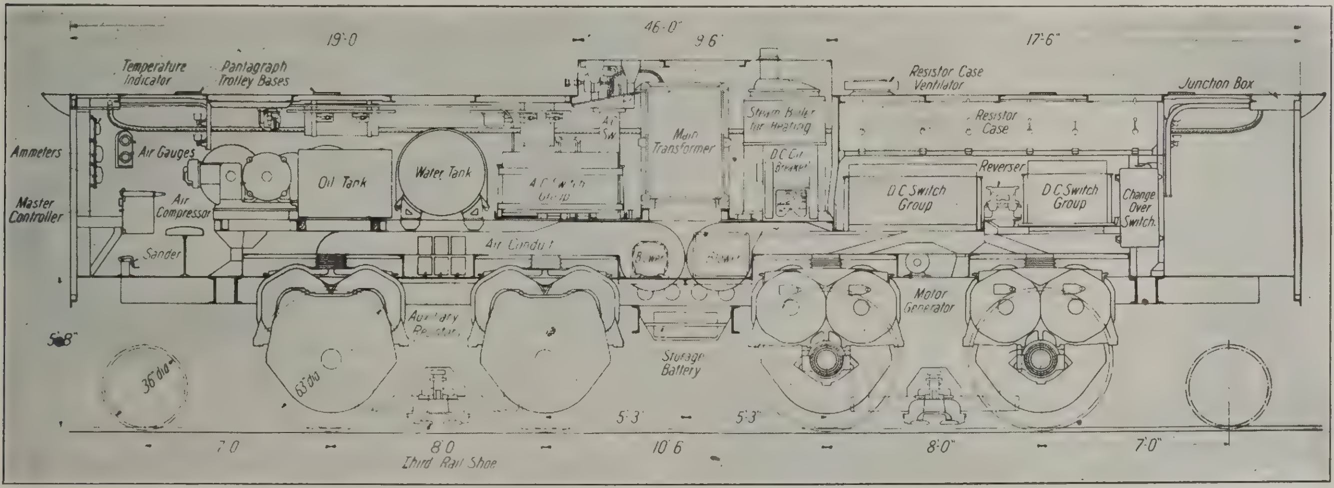


Fig. 8. Side Elevation of the Electric Locomotive

to supply air for the brakes and controlling apparatus. An oil burning steam-heater plant capable of supplying 800 pounds of steam per hour, is installed in the three alternating and direct current locomotives for the heating of passenger trains.

* * *

PIERCING AND EMBOSSING DIE

By ARON LAWRENCE*

The piercing and embossing die shown in Fig. 2 was designed to pierce eight holes in the periphery of the automobile head lamp front shown in Fig. 1, and at the same time to emboss an arch-shaped rib around the sloping neck portion. This rib or ledge is used to support the head of the lamp when assembled to prevent it from being buckled out of shape when polishing. The pierced holes are for attaching the front to the lamp body, and also for fastening the door hinge and catch.

Referring to Fig. 1, it will be seen that the punches for the body rivet holes in the small diameter or top portion of the front must have a considerably longer stroke than the punches for the hinge and catch holes. The base *A* of the die shown in Fig. 2, is a gray iron casting bored out in its upper central portion to fit the locating ring *B*, also made of cast iron. The ring *B* is fastened to base *A* with large screws and dowels. The piercing die bushings *C* and *D* are pressed into the locating ring *B*, and are made from hardened tool steel. The scrap from the punches passes in toward the center of the die and falls down through the opening to the bolster plate. The hardened tool-steel embossing punch punches are operated by the angular-faced lugs *I*, cast integral with the upper portion *T* of the die. The punch holders *G* are slotted out to receive a cross-pin *J*, which limits the length of the return stroke.

The lower punches *K* are similar in construction to those just described except that the punch carriers *L* are shouldered and are returned by means of helical springs *M*, held in counterbored holes in projecting bosses on the base *A*. The punches are limited in their outward travel by a pin *N* which works in an elongated slot in the base. This pin also serves to preserve the proper alignment of the angular end of the carrier *L* under the angular projections *I*. Oil holes are provided for the proper lubrication of the various plungers.

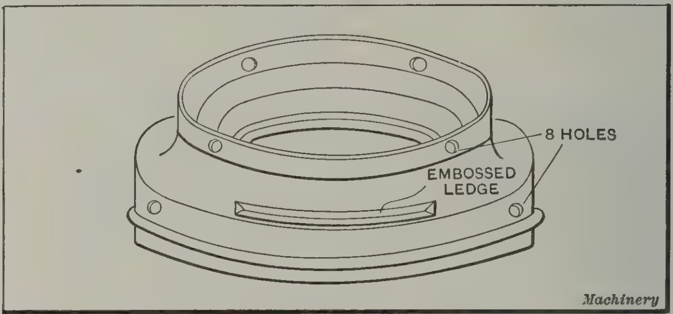


Fig. 1. Automobile Head Lamp Front

The embossing die *O* is of hardened tool steel, set into a cast-iron ring *P*, which slides vertically below the upper die member *T*, being guided by four steel pins *Q*, and limited in its travel by the shoulder screws *R*. A heavy rubber ring *S*, of sufficient resiliency to accomplish the embossing before further compressing, is introduced between the ring *P* and the casting *T*. Of course this rubber ring must be under initial tension or it will not operate properly.

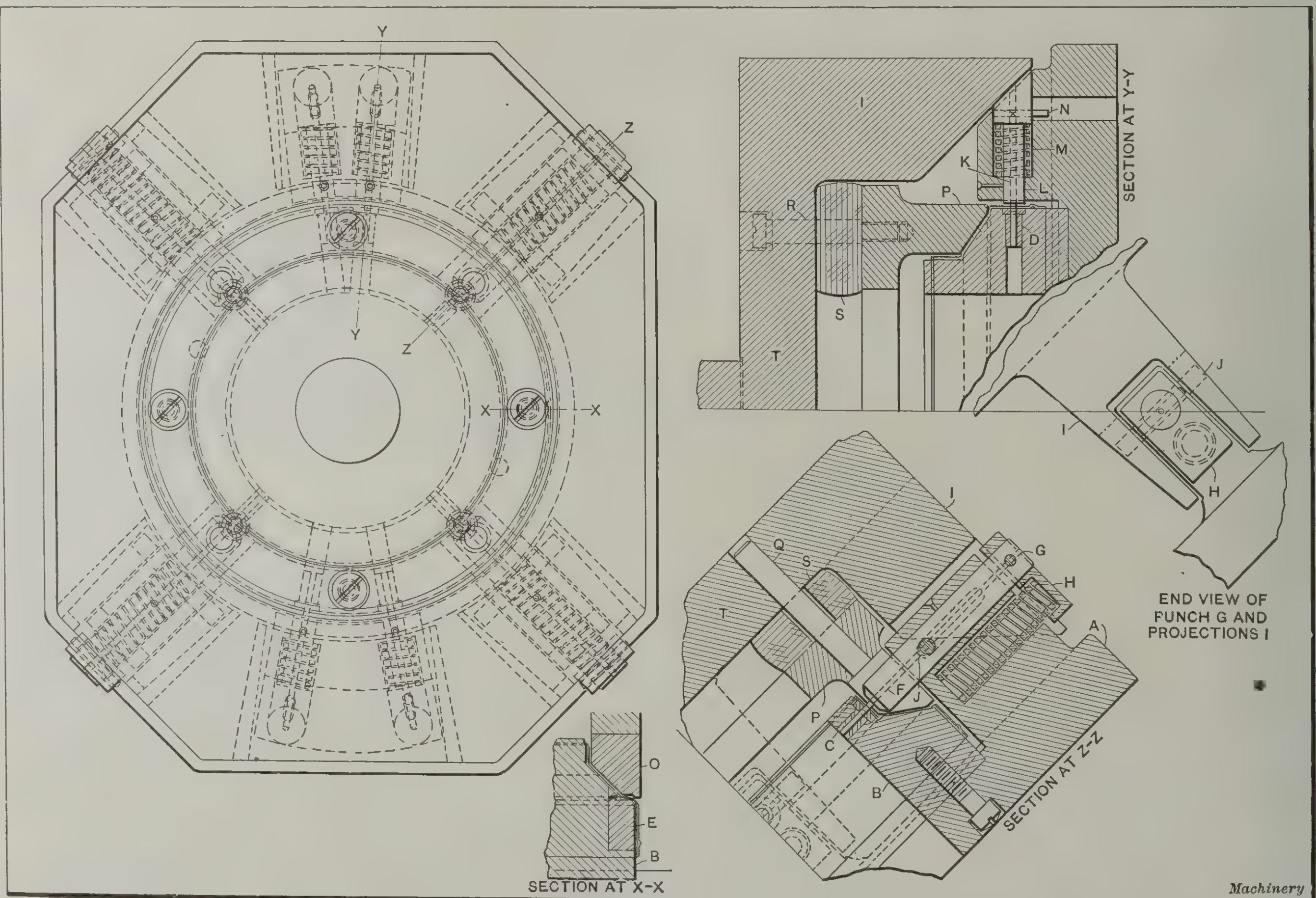


Fig. 2. Piercing and Embossing Die for Automobile Head Lamp Front

E is let into the ring *B*, as shown in the section at *X—X*, and is fastened to it by suitable screws.

Cast integral with the base *A* are two blocks projecting upward for the reception of the hinge and catch punches, and four blocks for the punches used in piercing the holes in the body. The shape of these blocks is clearly shown in the sectional views at *Y—Y* and *Z—Z*, respectively. The punches *F* are of hardened tool steel, set into the heavy punch carriers *G*, which are provided with a tool block *H* against which a helical compression spring acts to withdraw the punches. The

In operation, the die is used in a heavy arch press with a stroke of about 8 inches; the piece, Fig. 1, is located over the ring *B*, and the press is tripped. The arch-shaped rib is first embossed, after which the rubber ring compresses, allowing the piercing punches to be operated. This method of holding the work while forming and piercing insures the correct relation between the various holes.

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GRINDING AND CORRUGATING FLOUR MILL ROLLS*

By F. B. JACOBS†

In the process of flour milling, the grain is first fed between spirally corrugated rolls, generally called breaking-down rolls. The rolls in common use are from six to twelve inches in diameter, and from one to three feet in length, and are made

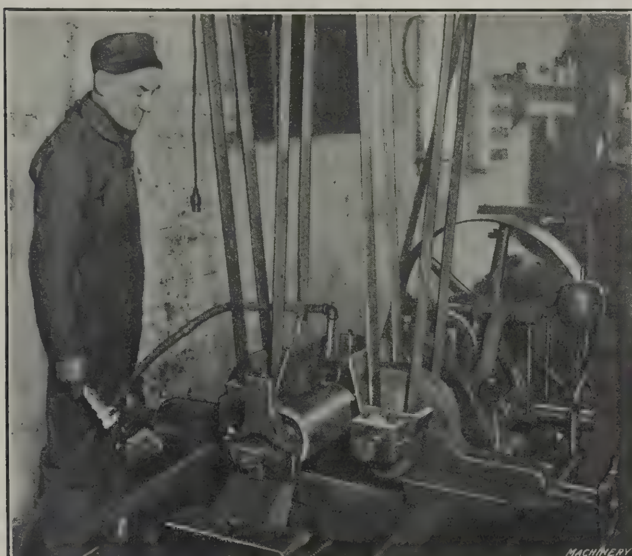

Fig. 1. The Grinding of Corrugated Flour Mill Rolls

of cast iron, the surface of which is chilled to a depth of from one-half to two inches. The crushing of the grain which often contains foreign substances, nails, pebbles, etc., soon wears away the corrugations. In this case the rolls are repaired by grinding away the worn corrugations in a regular roll-grinding machine, and cutting new corrugations in a machine built especially for the purpose. The machine shops of

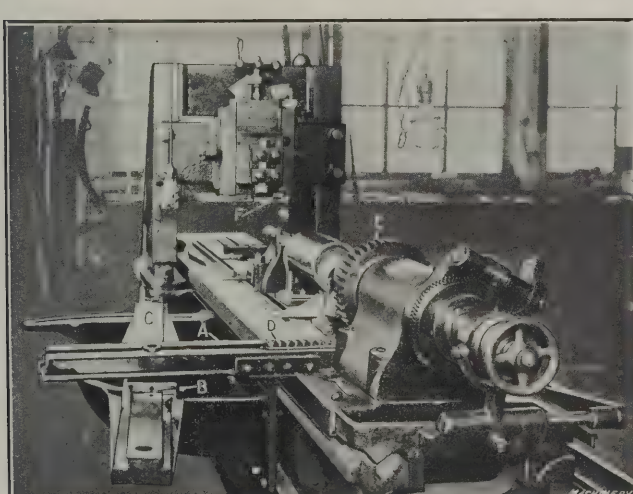

Fig. 2. Machine for Corrugating the Rolls

the larger milling concerns are equipped for this purpose; the smaller milling concerns, however, depend on contract shops which make a specialty of this class of work.

The grinding operation is shown in Fig. 1, the roll being located by its journals or necks and driven by a shaft having two toggle-joints. The object of the toggle-joints is to overcome the tendency of cramping. The grinding wheels used on this machine are carborundum, 10½ inches in diameter, 1½-inch face, 80 grit, K grade, G-4 bond, and are run at a surface speed of approximately 5000 feet per minute. The roll shown is 6 inches in diameter and 12 inches long, and is revolved at a speed of 40 revolutions per minute. The traverse speed is ¾ inch advance for each revolution of the work. When removing 1/32 inch, the grinding time on this roll was 12 minutes and the finish left was excellent. In grinding rolls of this kind, but little attention is paid to size, the object of the grinding being to remove the worn corrugations only. It may be added, however, that it is absolutely necessary that the rolls be parallel. This is accomplished by adjusting the rests that carry the shoes in which the journals run, until the roll is in line with the travel of the wheel carriage. In the roughing operation the depth of cut should be as great as the wheels will stand, which in some cases equals 1/64 inch. The final finish is produced by allowing the wheels to pass the work several times until they cease to spark heavily. With free-cutting wheels, this will be accomplished in a very few passes.

In Fig. 2 is shown the type of machine generally used for the corrugating operation; this, at first glance, looks like an ordinary iron planer equipped with a taper attachment. In Fig. 3 it is seen that the roll is located from its centers and also supported by its journals on V-blocks. In setting up the machine for the corrugating operation, the operator determines the amount of spiral by practically the same method as is used by a toolmaker in setting up a universal milling machine for cutting a spiral cutter. By referring to Fig. 2, it will be seen that the bar *A* is moved by the block *B* which

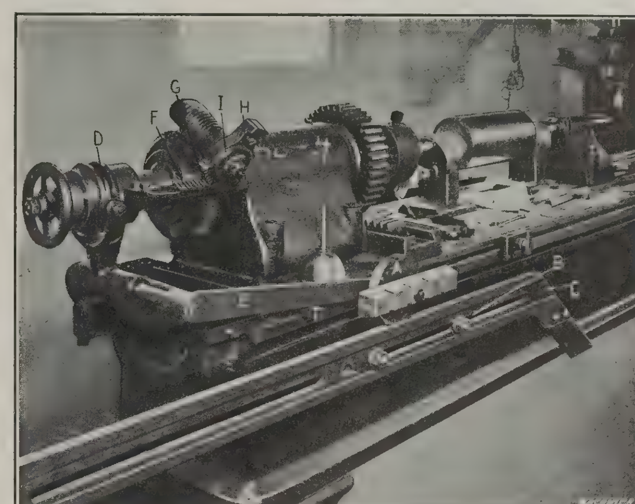

Fig. 3. Indexing Arrangement of Corrugating Machine

travels over the taper slide *C*. The rack *D* meshes with the gear *E* which imparts the spiral motion to the roll. By setting the taper slide at a greater or less angle, different spirals are obtained. This adjustment is of great importance as usually no two rolls, if they come from different milling concerns, have the same spiral, owing to the fact that the various milling concerns hold widely different views regarding the correct spiral for rolls of this kind.

At *A* in Fig. 4 are shown several corrugating tools. These are made of a high grade of tool steel, hardened and drawn to a straw color. As they have several teeth, they work on the principle of a gang tool, thus making it possible to corrugate a roll to the required depth by going around it once. The tool, which is securely clamped in a tool-holder as shown at *F* in Fig. 2, is set at an angle with the roll; thus the first tooth barely scratches the roll, the next going a little deeper and so

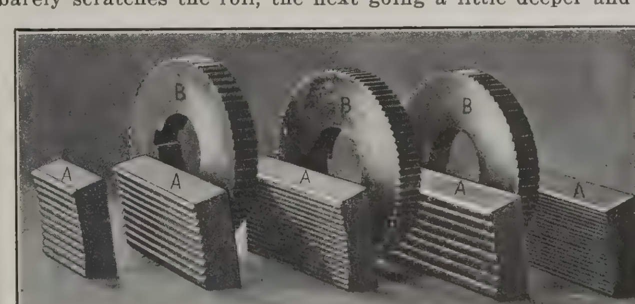

Fig. 4. Tools and Ratchets used in the Corrugating Machine

on until the correct depth is reached by the last tooth. As the material cut is hard chilled iron, the speed for this operation is necessarily slow—one foot in twenty-five seconds. For every stroke of the platen the roll is turned three teeth, this being accomplished by the ingenious arrangement shown in Fig. 3. When the platen is nearing its forward position, the roll *A*,

* See MACHINERY, May, 1909, "Grooving Chilled Flour Mill Rolls," and June, 1906, "Roll Corrugating Device."

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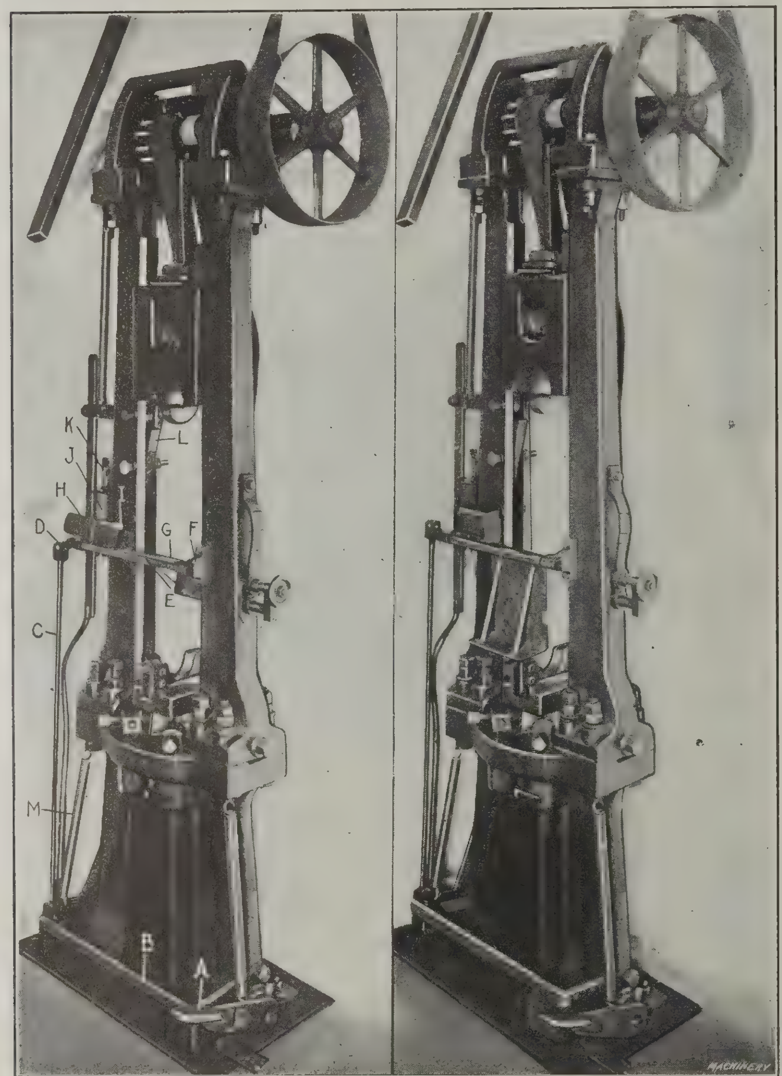
running over the guide *B*, drops upon reaching *C*. By means of the clutch *D*, the lever *E* actuates the rack *F* which turns the sector *G*, thus causing the pawl *H* to slide over the teeth of the ratchet *I*. At the return stroke of the platen, pawl *H* engages the ratchet teeth, thus turning the worm, worm-wheel and roll. By adjusting the slide *B* and substituting different ratchets, a few of which are shown at *B*, Fig. 4, the roll can be turned from one to as many teeth as the operator desires. Where very deep teeth are to be cut, the roll is generally turned one or two teeth for each stroke of the platen. In cutting fine teeth, however, it is often turned several teeth for each stroke.



Figs. 1 and 2. Safety Device applied to a Drop Hammer

As there are many different sizes and shapes of corrugations it is necessary that the machine be provided with adjustments to cover a wide field. The time for corrugating a roll of the same size as shown in the grinding operation, was one hour and fifteen minutes. The corrugations were 0.010 inch deep and spaced twenty to the inch. As roll grinding and corrugating is a special branch of the machinist's trade that calls for skill and judgment along special lines, an expert who is experienced on this particular line of work generally receives the highest wages paid to machinists in the locality in which he is employed.

* * *

In an article in *Industritidningen Norden*, issue of April 12, attention is called to the fact that the Tesla steam turbine described in the November, 1911, number of MACHINERY makes use of a principle which is by no means new, as in 1894, Messrs. P. Nordenfelt and A. Christophe, the former a Swede, the latter a Frenchman, applied for a Swedish patent on the same type of steam turbine, which was granted. This turbine, however, was never developed beyond the experimental stage. Whether or not the Tesla turbine, employing the same principle, will meet with a better fate remains to be seen.

A MECHANICALLY AND ELECTRICALLY OPERATED SAFETY DEVICE

By BENJAMIN C. WAITE, JR.*

The problem of properly equipping machine tools with safety devices is a difficult one and, as a rule, the older the machine, the more difficult it is to guard. A great many firms of late have been forced to properly safeguard their machine tools on account of the stringent laws recently passed for the safeguarding of workers. There is one machine especially which is very difficult to guard, and that is the drop hammer.

In the accompanying illustration an efficient guard for a machine of this type is shown. This guard is operated by moving the foot from the trip lever shown at the lower right-hand side at *A* to the treadle *B* in front of the machine and the operator. The tripping of this extra treadle does not require any more action or effort on the part of the operator than was required before the guard was put on, for previously the foot was in continuous motion from the floor to the trip lever, while now the foot movement is from the trip lever to the treadle, which is held down while the work is removed and replaced. While the foot is in this position, the swinging guard *G* is located as shown in Fig. 1, and is held practically in a horizontal position, being operated by the shaft, crank, and straight rod and spring shown to the left of the hammer. These parts constitute the mechanical connections of the swinging guard.

The electrically controlled parts of the safety device are also shown to the left of the frame immediately above shaft *E*. The box cover *H* protects a small carbon contact switch which opens the circuit when the swinging guard is in the horizontal position, thus causing the dog *L* which is controlled by the magnet *J* and connected to it by the link *K*, to fall into the path of the hammer head, thereby preventing the hammer from falling. Hence the hammer cannot "repeat" or be accidentally tripped, these being the usual causes of most accidents in hammers of this type. When the foot releases the safety treadle *B*, the guard swings down to a vertical position, the circuit is closed, and the magnet, pulling downward, draws dog *L* within the housing of the hammer, providing a clear path for the falling hammer, as soon as it is tripped. While the swinging guard is in the vertical position, as shown in Fig. 2, it is so located that the operator cannot conveniently reach underneath or around it.

This combination of a mechanically and an electrically operated safeguard has been in successful operation for nearly two years, and although there may not be many hammers in use of the exact type shown in the illustration, the principles can be applied to many other tools. An important and unique feature of the device is that should the electrical current fail, the hammer is instantly placed in the safety position, because dog *L* will then immediately fall into the path of the hammer. This condition is shown in Fig. 2.

* * *

TREATING TUNGSTEN FOR WIRE MAKING

A process for increasing the ductility of tungsten so that it can be made into wire for lamp filaments with less difficulty than formerly has recently been patented by Werner von Bolton of Charlottenburg, Germany. The tungsten is treated at a red heat with a mixture of hydrogen and chloride of sulphur. This serves to remove any oxide of tungsten in the metal which is a cause of brittleness. The oxide is converted into sulphide which is, in turn, decomposed by the hydrogen. The metal thus purified contains some sulphur. It is heated to a white heat in a vacuum furnace to expel it, when pure, metallic tungsten of great ductility is obtained which can be easily drawn into wire. When the oxide is reduced by hydrogen in the usual manner, some hydrogen is left which causes brittleness; by the sulphur method, this is avoided.

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WATCH CASE MANUFACTURE*—1

COMPOSITION PLATE—TYPES OF CASES—FORMING CENTER, CAP, BACK AND BEZEL—THREADING

A watch case is simply a metal box which acts as a container for the movement and protects it from injury and dust. Watch cases are made from alloyed gold (pure gold—24 carat—is too soft), silver, gunmetal and other composition metals. A material which is used extensively is what is known as "gold filled"; this consists of a bar of composition metal to which a thin strip of gold is soldered. These built-up bars, shown at *A* and *B* in Fig. 2, are rolled out to the desired thickness, and worked up in punch presses to form the various members of the case. A gold filled watch case wears as well if not better than a solid gold case, does not tarnish, and is a stronger protector for the movement.

Preparing the Gold-plated Bars

Considerable experience is necessary, in preparing gold-plated bars, to produce a uniform thickness of gold on the surface of the bar. The gold plate, of course, is much softer than the composition metal to which it is soldered, and does not harden as quickly or as much during the rolling operation as does the composition metal. Hence, it is absolutely necessary to have a perfect union between the two metals.

Before uniting the gold strip and composition bar, it is necessary that the surfaces which come in contact should be made as nearly true planes as possible. The solder for uniting the composition bar and gold strip is made from alloyed silver, which is rolled out to the proper thickness. The composition bar, solder and gold strips are first coated with soldering acid on those faces which come in contact. If the plated bar is to be used for a bezel, center or cap, it is furnished with a gold plate on one side only, but if the bar is to be used for the back of either a screw or hinged case, a strip of gold is soldered to both faces, as shown at *B* in Fig. 2.

After the bar has been prepared in this manner it is wired so that the various strips will be held in close contact with each other. Then it is placed in a furnace where it is heated to about 1000 degrees F., which is sufficient to melt the solder and join the various strips. When the bar has remained in the furnace long enough for the solder to melt, it is taken out and allowed to cool off gradually. The wires used in binding are then removed, leaving the bar in a condition to be rolled out into a sheet of the desired thickness. The bar is first passed through "breaking-down" rolls, and after about ten passes through the rolls, it is annealed and pickled. This procedure is continued until the bar is rolled out into a strip of approximately the desired thickness. To bring the strip to the exact thickness, it is passed through finishing rolls which give it a better surface.

Types of Watch Cases Manufactured

At the present time there are six distinct types of watch cases made. The first and the most common is the open face case, shown at *A* in Fig. 1. This consists of a center *a*, cap *b*, back *c*, and bezel *d*. The stem *e*, pendant *f*, crown *g*, and bow *h*, of course, are common to all ordinary watch cases. Another type of case which has come into prominence of late is the screw case shown dismantled at *B*, *C* and *D*. This consists of a center, back and bezel, the center *B*, back *C*, and bezel *D* being threaded so that the various parts of the case can be screwed together. There are other cases which are made to suit individual requirements and consequently are of a special nature. There are four cases, however, which are made regularly: the hunting case, consisting of a center, cap, two backs and a bezel; the cup case, consisting of a screw-cup, bezel and a ring to hold the watch movement; the swing-ring case, consisting of a center, cap, bezel, and swing ring; and the bracelet case consisting of a back, center and bezel. The latter case is made in an open face.

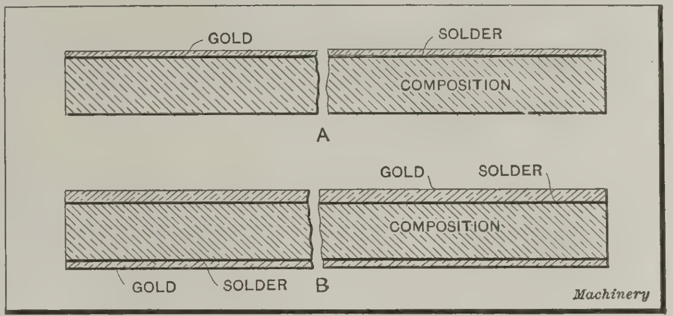

Fig. 2. How the Stock used in making "Gold Filled" Watch Cases is prepared

In this article is given a description of the methods employed in manufacturing an open face case of the type shown at *A*, Fig. 1. Occasional references are also made to the screw case, parts of which are shown at *B*, *C*, and *D*.

Making the Watch Case Center

After the bars previously referred to have been rolled out into strips of the desired thickness, they are cut up in a small power shear into squares, as shown at *A*, Fig. 3. These squares are then taken to the punch press department where they are worked up to form the various members of the case. The case centers are blanked out and cupped up in one operation in a double-action punch press, their condition after the operation being shown at *B*, Fig. 3.

From the punch press the cups are taken to the annealing furnace where they are annealed, and then pickled to remove the scale. They are then again taken to a punch press, the next operation consisting in "coaxing over" the top edge of the cup so that it assumes the shape shown at *C*. It is next taken to a spinning machine in which it is given the shape indicated at *D*. The next operation is what is known as the inletting operation for the movement; this consists in turning away the material on the inside edge of the case center, so that it will fit the movement, and is accomplished in the

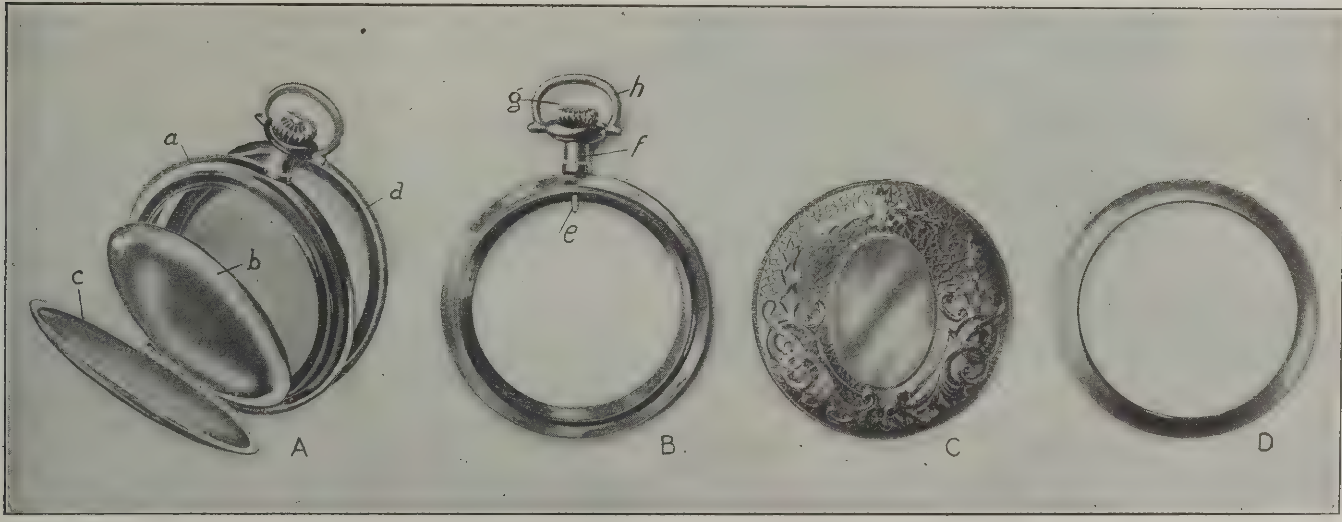

Fig. 1. Hinged and Screw Types of Open-face Watch Cases

* For articles on watch making previously published in MACHINERY, see "Watch Movement Manufacture," in the May and June, 1912, numbers, and articles there referred to.

inletting machine shown in Fig. 4. The center, which, by the way, has been fitted up with a pendant, is placed in the spring chuck *A*, the latter being tightened by the knurled nut *B* with a spanner wrench. Tool arbor *C* is now placed in the U-rests *D* and *E*, located at right angles to the axis of the spindle. This tool arbor *C* carries cutters *F*, which are used for making the various cuts, and are held by set-screws in the tool arbor.

In action, the operator grips the tool arbor *C* in both hands, holding it rigidly in the U-rests. He then brings the cutting tools *F*, one at a time, into contact with the work, allowing them to bear or rest on the strip *G*, which is placed across the face of the chuck. The tool arbor is located so that the cutting tools will cut to the correct diameter for the various steps on the case center by means of the stop-screw *H*, held in collar *I*, which comes against the rear face of the U-rest *E*.

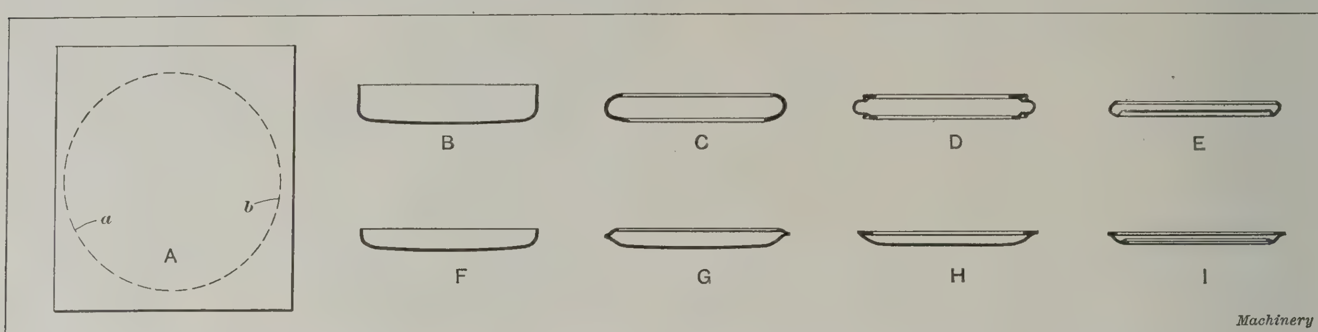

Fig. 3. Evolution and Development of a "Gold Filled" Open-face Jointed Watch Case—Punch Press and Spinning Operations

Threading the Case Center

The case center for the screw back and front type of case shown at *B*, Fig. 1, is threaded in the machine shown in Fig. 5. A case center of the type shown at *A* is placed in the spring chuck *B* and the nut *C* is tightened. The belt *D* is then shifted to run the spindle forward, and the work is prepared for threading by means of the tools held in the turret *E*, which latter is operated by handles *F* and *G*. When the turning is completed, the spindle is reversed to run backward, and the clutch which drives the rear driving shaft through change gears is thrown in by operating the handle *H*. The rear driving shaft carries cams *I* and *J* for operating the tool carriage which holds the circular threading tool *K*. Face cam *I* in conjunction with the change gears traverses the tool-slide longitudinally at the proper speed in relation to the rotation of the spindle, to cut a thread of the desired pitch—40 threads per inch.

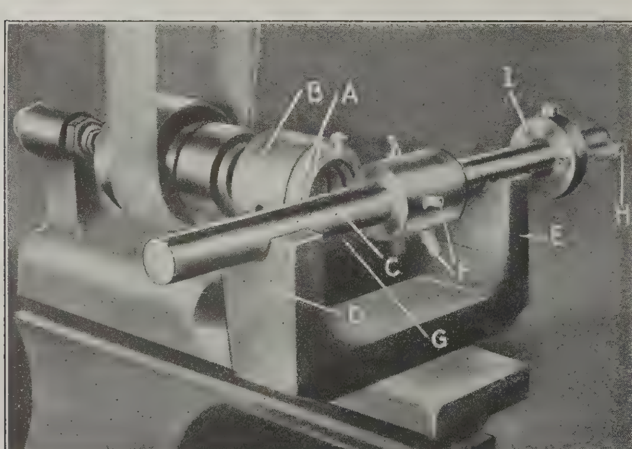

Fig. 4. Inletting the Watch Case Center for the Movement

The threading tool *K* is brought in to and out of action by means of the cam *J* which is timed with cam *I* to bring the tool in to action while the slide is being traversed toward the head of the machine. When the roll attached to the slide drops into a cut-away portion in both cams *I* and *J*, the tool *K* is withdrawn from the work and returned to the starting point by springs. The threading tool is fed in to the correct depth by means of handwheel *L*, operating the top slide *M*, which is provided with an adjustable stop. The case center for the hinged type of case is not threaded, but is jointed. This operation consists in cutting two grooves in the side of the case in which two short pieces of gold-plated hollow wire* are soldered. The grooves are cut with two slitting saws, thus enabling the grooves in both sides of the case center to be cut at the same time.

Making the Cap and Back

The cap and back *b* and *c*, Fig. 1, used in the hinged case for protecting the movement are also made from squares of gold-plated stock which are blanked and drawn up in a double-action punch press. The condition of the cap after this operation is shown at *F* in Fig. 3. The only difference between the back and cap is that the latter is slightly smaller in diameter than the former. After the back and cap are drawn up into the condition shown at *F* they are annealed and pickled after which they are "coaxed" over. The "coaxing" die and punch bend the top edge of the cap over slightly, as at *G*, Fig. 3. After the "coaxing over" operation, the cap is "snapped" by a punch and die, which operation consists in flattening out the edges and forming it so that it fits the center of the case, as indicated at *H*. The die used for the snapping operation also produces the little thumb catch on the edge, which is used for opening the cap. This finishes the cap with the exception of jointing and polishing. The same operations are performed on the back. The jointing consists in soldering a short piece of gold-plated hollow wire on the edge of the cap and back, which, in conjunction with the hollow wire soldered onto the case center, forms the hinges, a piece of gold wire being used as a pin. A seat for the hollow wire is milled in a small milling machine which is provided with a cutter for this purpose, and a chuck for holding the work. The polishing of the cap and back will be taken up in another installment of this article.

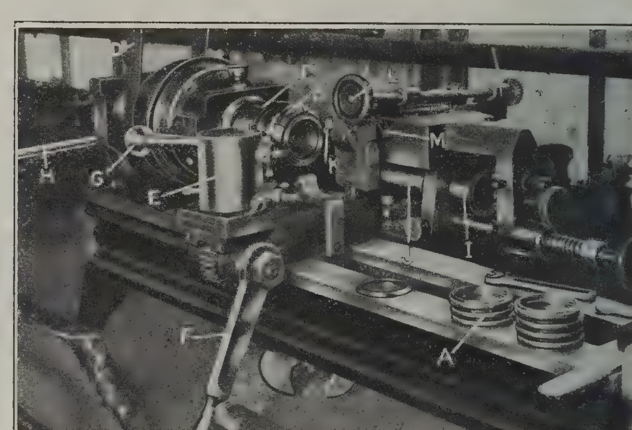

Fig. 5. Cutting the Thread on a Screw Watch Case Center

Threading the Back

The back shown at *c* in Fig. 1, which is used on the screw case is threaded in the machine shown in Fig. 6. The work is held in a draw-in chuck *A*, which is operated by handle *B*. The work spindle is provided with a master thread *C* of the same pitch as that which is to be reproduced on the back—40 threads per inch—and a leader held in the forward end of handle *D* is brought into contact with this master thread

* For information regarding the manufacture of gold-plated hollow wire, see the article entitled "The Making of Seamless Gold Wire." March, 1911, engineering edition.

by the operator. Shaft E is connected to the carriage which holds tool-slide F, and as this shaft is traversed by the master thread, it evidently carries the tool-slide with it.

Before cutting the thread, the back is prepared for it by a tool H which is held on slide I and is operated by a foot treadle. When ready for threading, the operator grasps handle D with one hand, and operates handle J with the other. The leader is brought into contact with the master thread, and at the same instant the circular tool G is fed into the work. The handle D is then dropped, and the carriage is returned by a spring. The handle J feeds the slide in to an adjustable stop. The screw back is practically completed after the threading operation with the exception of polishing and engine turning.

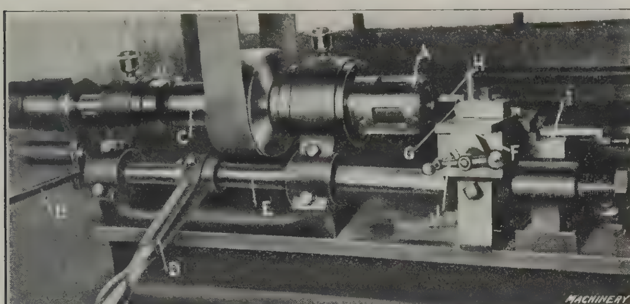

Fig. 6. Cutting the Thread in a Screw Back for a Watch Case of the Type shown at B, Fig. 1

Making the Bezel

The bezel for the hinged case is shown at d in Fig. 1, and also at E and I in Fig. 3; it is used to retain the glass and is made from a square of gold-plated stock in a similar manner to the other parts of the case. The first operation consists in forming it into a cup, similar to that shown at F in Fig. 3. This is accomplished by a combination blanking and cupping die A, punch B, and plunger C, shown in Fig. 7.

After blanking and cupping, the bezel is annealed and pickled; then it is coaxed over in the die D by punch E. This leaves it in the condition shown at E in Fig. 3. After this operation, the bezel is taken to the punch press and the center blanked out with the die F and punch G, shown in Fig. 7. This leaves the bezel in the condition shown at I in Fig. 3, when it is ready for inletting for the glass. This operation is accomplished in a machine of the type shown in Fig. 4. The bezel is then jointed and pinned to the center. The bezel D, shown in Fig. 1, which is used on the screw case is threaded in the machine shown in Fig. 6.

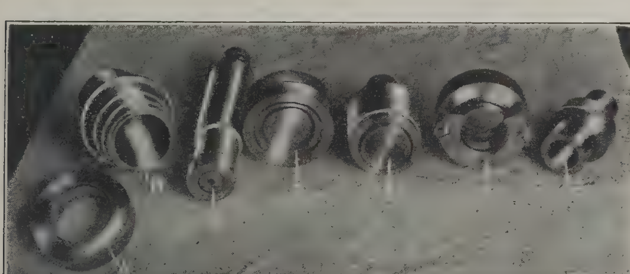

Fig. 7. Punch Press Tools used in Producing the Bezel for a Jointed Open Face Watch Case

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PATENT LAW INVESTIGATING COMMISSION

A special message sent by the president to Congress, relating to the appointment of a commission to investigate the patent laws and report on necessary changes, is one which will be endorsed by all persons who have a wish for the sound development of the country's industries at heart. One of the main reasons given by the president for this message is that the present patent laws make it possible for large corporations to buy up patents and suppress their manufacture, so that the public never receives the benefit of many inventions during the life of the patent. Meanwhile any other inventor is prevented from developing ideas of his own, if they should have enough similarity to the already patented but unused devices to constitute an infringement.

COMBINATION FORMING AND TESTING MACHINE

By F. B. HAYS*

Recently the writer had occasion to make a series of experiments with plastic masses pressed into hard substances of various shapes. As the experiments covered an entirely new field of development, special machines were required for treating the raw materials used in producing the plastic masses, for pressing the latter into the required shape, for accurately determining the pressure used in the compression, and for testing the compressive strength of the shapes after forming. After considerable study and a few preliminary tests the machine shown in Fig. 1 was designed and built for performing the last three operations.

The machine consisted of a heavy cast-iron frame A, and a screw B operated by a steel gear C. This was driven by the pinion D which was keyed and pinned to the shaft E. The screw was kept from turning by a key. The lower half of the casting was bored and reamed vertically and horizontally as shown, and then bushed by steel tubing R, ground externally and internally. The ends of these holes were closed by absolutely tight plugs and gaskets after the pistons F and H had been inserted into the bushed holes, and the space back of them filled with a very heavy oil.

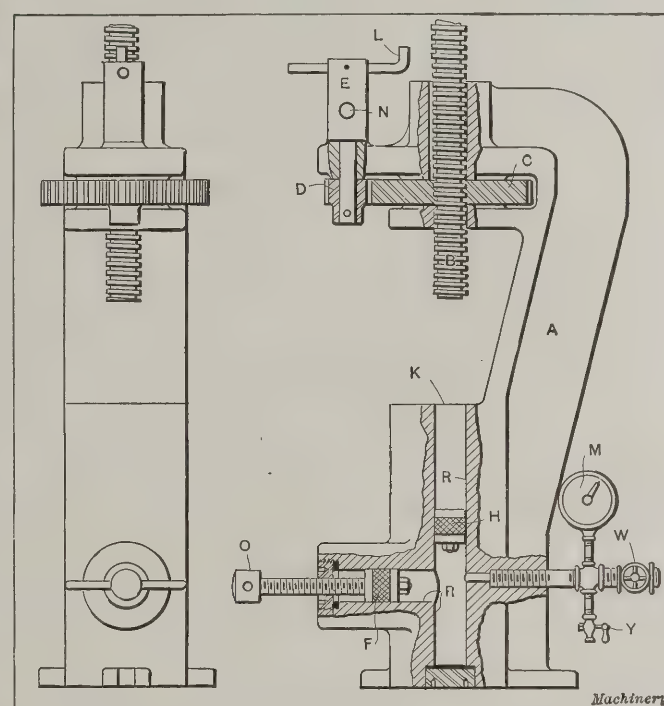
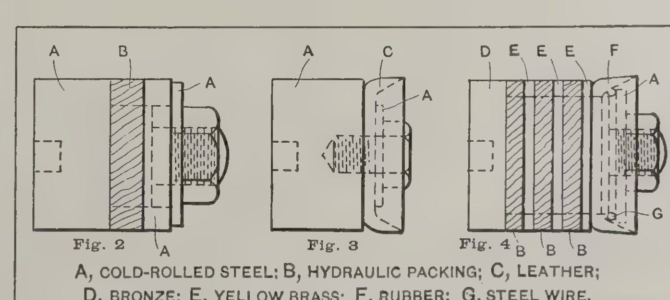


Fig. 1. Combination Forming and Testing Machine



Figs. 2 to 4. Various Forms of Pistons for Hydraulic Testing Machine

The operation of the machine is as follows: A split die is inserted at K, so that it rests on the piston H. The die is partly filled with the plastic composition, and a steel plunger is inserted into it at the top. The screw B is then run down by means of the crank L until it presses on the top of the plunger. A round steel lever is then inserted into the hole N, and the screw B run down until the pressure desired is registered by the gage M. The screw is then run up, and the valve W per-

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mits water to enter from a city water main, which causes the piston *H* to rise to the top of hole *R*, thus pushing the die and plunger out of the machine.

When testing, the formed composition (after being treated) is placed on the piston *H* and the screw run down upon it until it cracks. The piston compresses the oil and water so that the pressure at which the test piece cracks is registered by the gage *M*, the valve *W* being closed. The cock *Y* is then opened and the water drains from the machine so that the piston may be pushed back into place. The heavy oil will not pass through the cock. The hand screw *O* and the piston *F* are used when the city water pressure is not sufficient to raise the piston *H*. In this manner the machine both made and tested the formed pieces.

In making experiments with this machine a number of interesting facts were noted which may be useful to persons coming in contact with high-pressure hydraulic work. The pressure used in the experiments varied from 40 to 20,000 pounds per square inch.

The first interesting fact noted was that water worked through the heavy cast-iron walls at about 1800 pounds pressure per square inch, and that it ran through so rapidly at 6000 pounds pressure that it was impossible to increase the gage pressure. Upon the substitution of heavy black oil this leakage was eliminated below 5000 pounds. Upon coating the internal walls with water glass and pressing in the steel bushings, practically all leakage was prevented up to 20,000 pounds per square inch, so long as oil was used. Originally the greatest source of leakage was around the pistons, which were first made as shown in Figs. 2 and 3. These pistons leaked a great deal at 1400 pounds when water was used, and at 2500 pounds when oil was used. Pistons of the type shown in Fig. 4 were then substituted with very satisfactory results up to 16,000 pounds pressure per square inch. This type of piston leaks less after being used for a short time than when first inserted.

* * *

An alloy of iron and cobalt in the proportions of iron from 65 to 70 per cent and cobalt from 30 to 35 per cent is highly magnetic; the magnetism of this alloy at saturation is stated to be 10 per cent greater than that of the pure iron.

CONTENTS OF HORIZONTAL CYLINDRICAL TANKS

By FRANCIS J. FRENCH*

When a cylindrical tank placed in a horizontal position is partly filled with a liquid, the cross-sectional area of the fluid in the tank is, of course, a circular segment. The usual way of calculating the volume of the fluid in the tank would be to find the area of this segment and multiply this area by the length of the tank. In this way, the volume of the fluid would be found in cubic feet or cubic inches, according to the unit of measurement used. This expression, then, would usually have to be converted into gallons.

A rapid approximate method is provided by the accompanying diagram, the use of which is illustrated by an example in dotted lines. The scale on the left-hand side of the diagram gives the ratio of the depth of the fluid in the tank to the total diameter. The diagonal lines on the diagram give, respectively, the diameter of the tank and the total length. The scale on the right-hand side of the diagram gives the volume of the contents in U. S. gallons per foot of length, while the scale at the bottom of the diagram gives the total contents of fluid in the tank.

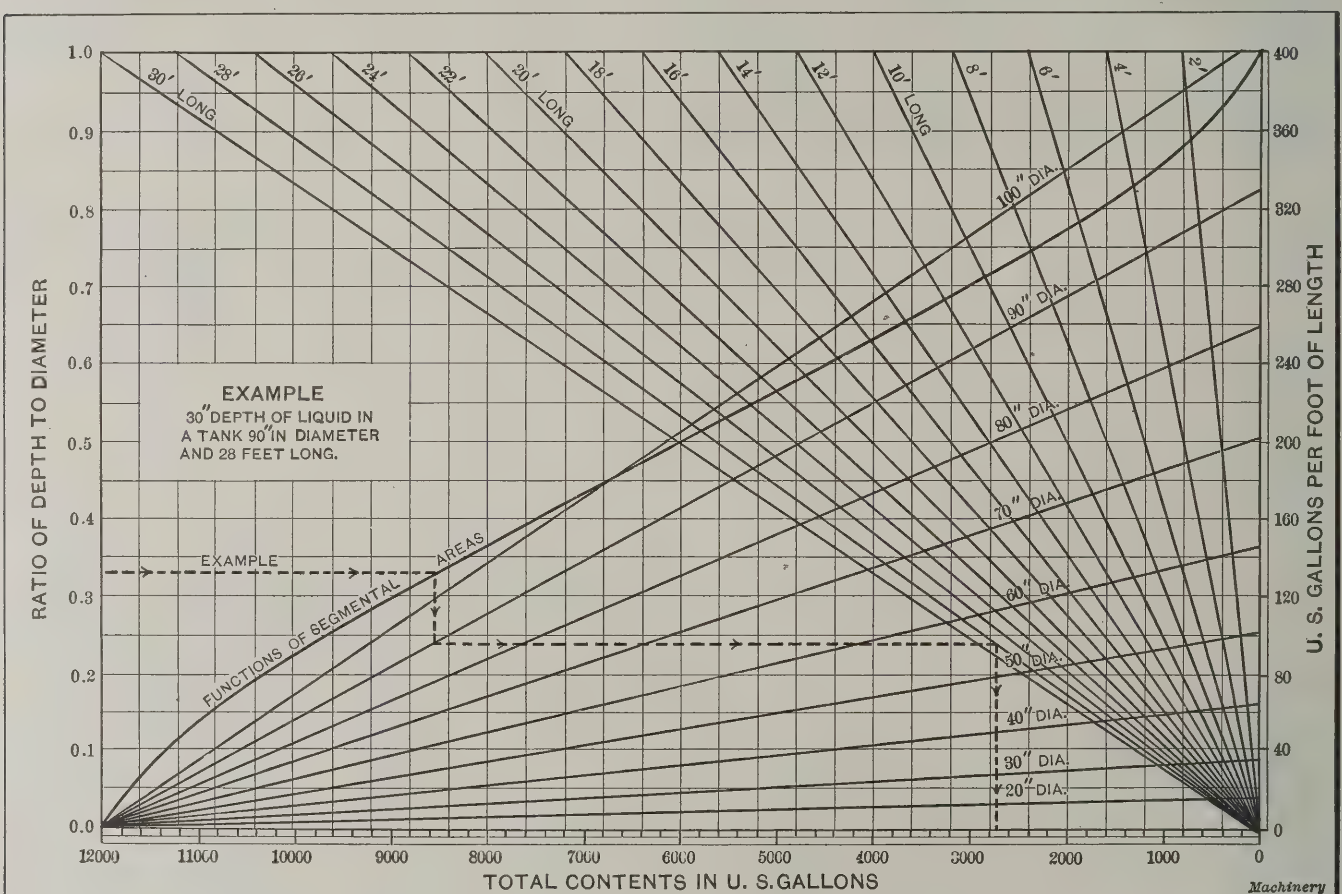

Diagram for Finding the Contents of partly filled Horizontal Cylindrical Tanks

As an example, let us assume that the liquid fills the tank to a depth of 30 inches, that the total diameter of the tank is 90 inches, and that it is 28 feet long. The ratio of depth to diameter is then one-third, and, beginning at this point on the scale to the left, we follow a horizontal line until it intersects the line marked "functions of segmental areas." From this line we follow a vertical line until it intersects the line denoting the diameter of the tank, and then again a horizontal line until it intersects the line for the total length of the tank; from this point we follow a vertical line to the bottom scale which gives the volume of the liquid in U. S. gallons. If from the last point of intersection we had continued following a horizontal line, instead of a vertical line to the bottom scale, we would have located a point on the scale to the right which would have given the volume of liquid per foot of length of tank in U. S. gallons.

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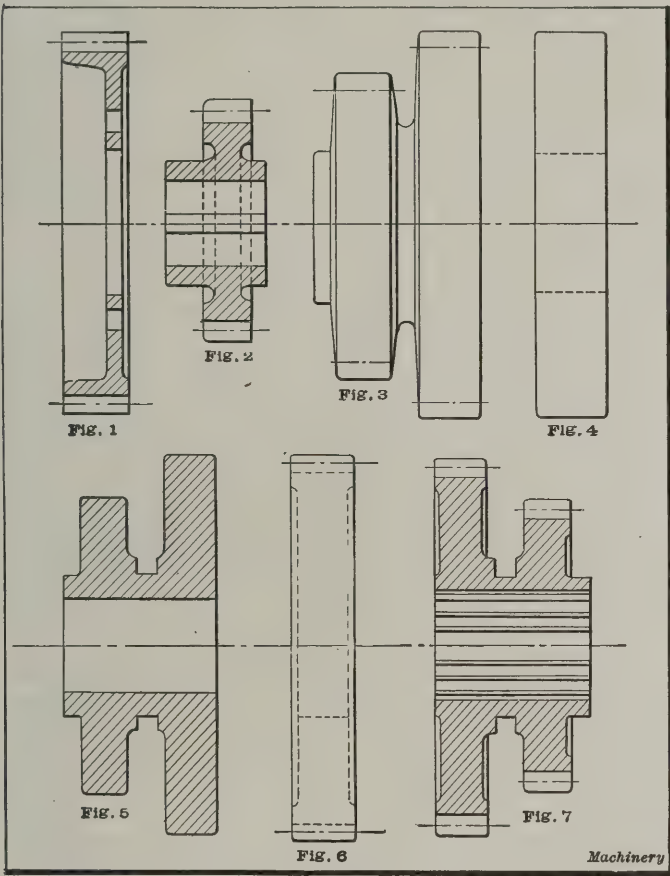
PROCESSES IN PRODUCTION OF AUTOMOBILE TRANSMISSION GEARS*†

One of the most important problems in modern automobile construction, and one which has received a great deal of attention from mechanical engineers during the past few years, is that of the quiet working of the running parts. Next to the engine itself, the gears have proved the greatest offenders in making noise. Therefore, the demand for gears which are accurate, interchangeable and silent, together with the necessity for producing them both rapidly and at a low cost, has caused a great deal of attention to be devoted to the various processes, tools and appliances whereby that demand may be satisfied. We thus find that there are being placed on the market an increasing number of machine tools, steels and carbonizing materials, each of which claims some advantage over its predecessors, such as increased output, greater simplicity, superior generating features, and better hardening results. It is the intention, however, to deal here chiefly with the processes of manufacturing gear-box gears by means of a complete equipment of gages, tools, jigs, etc., with the object of insuring interchangeability. To a very large extent fitting is thus dispensed with. After the final machining operation has been performed, the parts should be ready to be assembled. When a duplicate part is wanted it can be supplied from stock, as the methods here to be described insure that it will fit into its correct position without trouble.



Figs. 1 to 7. Automobile Transmission Gears at Various Stages of Completion

There is probably no part of an automobile that is subjected to greater use—and abuse—than the gears, especially the gear-box gears. Carrying, as they do, practically all the power developed by the engine, and receiving at the hands of a careless driver the strains imparted by suddenly applied load or by rapid changes, it is absolutely necessary that the gears be made of the highest grade materials, and that the very greatest care and the best workmanship should be bestowed upon them. As the saving in weight is an important factor in the design of the transmission, the gears must be made as small and as light as possible, and yet be sufficiently strong to carry suddenly applied loads with no danger of breaking. Owing to the methods by which the speeds are changed, and the clashing and bruising to which the gears are thus subjected, the transmission mechanism must be made of material which is both hard and tough. Different kinds of steel have been used, and each has been treated by various methods in the attempt to discover the perfect gear material. Although this has not yet been found, so much progress has already been made that the transmission gear of a modern well made automobile, when carefully handled, will last nearly as long as the car itself.

Steels used for Automobile Gears

Of the various kinds of steel which have hitherto been employed, nickel, nickel-chrome and chrome-vanadium steels seem to have more advocates than any others. In most factories the gears are casehardened, and it is this class of gear which will be dealt with in the following. Gears treated in this way have been taken out of cars which have been run many thousands of miles, and in some instances the original tool-marks on the face of the teeth were still visible.

The processes in the manufacture of low carbon nickel-steel casehardened gears, such as the finished gears shown by Figs. 1, 2 and 8, will be described in the following. The various processes will be explained in the order in which they are performed. The composition of nickel steel, suitable for high-speed gears, is as follows: Carbon, 0.20 per cent; manganese, 0.65 per cent; silicon, not exceeding 0.20 per cent; phosphorus, not exceeding 0.04 per cent; sulphur, not exceeding 0.04 per cent; and nickel, 3.50 per cent. Steel with 3.50 per cent nickel rolls and forges well, and when hardened, the ratio of the elastic limit to the ultimate strength is very great. The influence of nickel on steel is that it increases the tensile strength and the elastic limit.

Nickel steel of the composition just mentioned should have an elastic limit, after treatment, of about 30 tons per square inch. The influence of silicon on the results of quenching is similar in many ways to that of carbon. It is dependent on the co-existing amount of carbon and manganese, and it is difficult to obtain silicon in steel without the presence of manganese. Silicon appears to increase the tensile strength and diminish the ductility; but for various reasons it is generally considered objectionable.

Phosphorus is the least desirable element in steel, but up to one per cent it appears to increase the tensile strength. Sulphur tends to produce hot-shortness and difficulty in working, but in the presence of manganese the effect is diminished.

The Gear Blanks

Blanks for gears of the type shown in Fig. 1 should be cut from the bar, since it has been proved that steel is not improved by drop forging, although some steels are less sensitive to injury than others. An investigation of drop forged and bar-cut nickel steel gears, details of which were given in a paper read by Mr. John A. Mathews before the Franklin Institute (see MACHINERY, August, 1909, engineering edition, "Alloy Steels for Motor Car Construction"), showed that under static tests the bar-cut gears were fully 25 per cent stronger, and also that the resistance to shock was greater. The gears shown in Fig. 8 should be made from a drop forging, as shown by Fig. 3, although when only small quantities are required, it would not pay to make dies. In this case ordinary forgings should be considered. Gear blanks should be annealed previous to machining.

The reasons for leaving so much extra metal will be explained in the order in which they concern the various operations necessary in the attempt to get a perfect gear—an end which, it is needless to say, is seldom, if ever, attained. In the case of a gear as shown in Fig. 2, made from a bar, it is not necessary, for reasons which will be seen later, to leave any extra metal. Much of the trouble due to distortion in the heat-treatment is caused by the forging operations being done at too low a temperature, in which case the metal does not have a chance to flow properly, but is merely forced into shape by the die. This sets up internal strains that will be released when the part is annealed.

Rough-turning and Annealing

The first operation is to rough-turn the part all over for the purpose of removing the outer skin, previous to the second

* Paper read by Mr. Walter Betterton before the Graduates' Section of the Birmingham (England) Branch of the Institute of Automobile Engineers, April 25, 1912.

† See the following articles previously published in MACHINERY: "Alloy Steels for Motor Car Construction," August, 1909, engineering edition; "Casehardening," August, 1905, engineering edition. See also MACHINERY'S Reference Book No. 63, "Heat Treatment of Steel."

annealing, leaving a one-sixteenth inch case on the parts required to be hardened, such as the top diameter of the gear, and the sides of the teeth. For the bore a one-eighth inch allowance is required, in gears where the hole is to be a running fit, or castellated, and has to be hard. A one-quarter-inch allowance, however, is necessary when the gear has to be bolted to a center, or to another gear, in which case the bore need not be hard, as it is only used for locating the gear centrally. In rough-turning, allowance must be made for the extra metal, the gears, after machining, appearing as shown in Figs. 4 and 5.

When making gears it is, of course, necessary to have the steel carefully and uniformly annealed. The process of annealing is one of great importance, and is better performed in a specially designed sealed furnace, constructed as a muffle, so that the required heat is obtained uniformly by radiation, without any flame to impinge on the steel. In addition to softening the steel, and making it easy to machine, annealing has the effect of bringing it to a more homogeneous condition by eliminating the molecular strains which are set up by rolling, hammering and stamping. Hence, when the steel is heated preparatory to hardening, equal expansion should follow, and also equal contraction when cooled.

It will thus be seen that should the steel not be annealed uniformly throughout, the risks of warping when hardening are considerably increased. The object of rough-machining is to break down the scale preparatory to the second annealing, and as the strains set up by rough-machining are released by the second annealing, the metal is then in as normal a condition as possible. At the present time there are many compounds used for annealing. A few years ago, the ashes from the forge were considered sufficient for properly annealing steel, but today many special preparations are manufactured and sold for the purpose.

The more common materials used are powdered charcoal, charred leather and hydro-carbonated bone-black. These same materials are used for carbonizing, but after having been used once they are of very little use for that purpose. However, their use for annealing has the additional merit of economy, because they can be used repeatedly, adding each time a little that has only been used for the carbonizing process. Air-slacked lime may also be used for this process. The piece to be annealed is usually packed in a wrought-iron box, using one of the previously mentioned materials, or combinations of them, for the packing. The whole is then heated to the proper temperature,which is about 1760 degrees F. In the case of the gears in question, this temperature should be maintained for one hour. The box may then be set aside with the cover on in order to cool down to atmospheric temperature, or it may cool off with the furnace. It should be noted that the annealing temperature ought always to be higher than that for carbonizing. For all kinds of steel and for all grades of annealing, the slow-cooling furnace gives the best results, because the temperature can easily be raised to the right point, kept there as long as necessary, and then regulated to cool down as slowly as desired. Gas, oil, or electric furnaces are, of course, the easiest to regulate.

Finish-boring and Broaching

Gears to be broached as shown in Fig. 8, should be finish-bored with an allowance of 0.015 inch for grinding after hardening, and faced on one end true with the bore to take the thrust of the broaching on a La Pointe or similar broaching machine. The broaches should be made of carbon steel, oil hardened, tempered and ground, and should be specially treated. It is necessary to treat the steel with some carbonaceous material until it will harden in oil, as it is well known that steel hardened in oil is less likely to spring than if hardened in water. The tendency for steel to crack is almost eliminated and it has a maximum of toughness, unless, of course, the steel has been improperly treated in the fire. The special treatment consists essentially in supplying the surface of the steel with an additional amount of carbon by some material that will not injure the steel. No form of bone should be used on tool steel for this process, as bone contains a high percentage of phosphorus, and the effect of this is to make the steel weak and brittle. Charred leather gives the best results.

The over-all length of the broach suitable for the gears shown in Fig. 8 is about 26 inches, the cutting portion being about 17 inches, and the teeth of ⅝-inch pitch, cut straight and backed off. The pilot should be about 3 inches long. The teeth should never on any account be cut spiral, as this tends to twist the broach while in operation, and consequently the castellation would not be true. To produce an accurate castellated hole, as shown by Fig. 8, in nickel steel, it is necessary to use about ten roughing broaches and one finishing broach, especially when this operation is to be performed to very fine limits, as in the case of the gears in question. The last four teeth in each broach should be parallel, and the rest tapered in equal progression. On the first broach the pilot should be round and of the same diameter as the hole in the gear to be broached. On the following ones the pilot should be a sliding fit in the hole produced by the previous broach, and should at the same time be located from the castellations.

The finishing broach should have a piece at the rear end, about 3 inches long, of the exact size of the castellated shaft on which the gear is to be fitted when finished. This will act as a burnisher. The broaches are pulled through the work, which is quite a good feature, as it tends to keep them straight while in operation. The cutting portion being so long enables the operation to be performed without previous rough-slotting, which is required when the gears are drifted on the power press. After broaching, the gears should be turned.

Finish-turning

Castellated gears should be turned on a mandrel, locating from the castellations. The parts required to be hard, such as the top diameter of the gears, which should have an allowance of 0.005 inch for gear-cutting purposes, and the sides of the teeth and fork groove are then finished, leaving the gear as shown in Fig. 5. In the case of the gear in Fig. 1, the top diameter should be finish-turned with an allowance of 0.005 inch, and the sides of the teeth and the bore with an allowance of 0.125 inch, so that the latter can be bored out again after carbonizing, which would leave the hole soft, as it is not required to be hard. The finish-turning leaves the gear as shown in Fig. 4. Gears such as shown in Fig. 2 can be finish-turned and bored complete at this operation.

Cutting the Teeth

One of the most important operations is the cutting of the teeth after annealing. The method to be described is at present in practice and gives very successful results. The teeth should be roughed out on the hobbing machine and, where possible, several gears should be placed on the work-arbor at one setting. A great deal of time is saved by placing several gears on the work-arbor, which should always be steadied at the top. Suppose six are to be cut at one setting; this would mean that the hob would only have to travel into and clear the work once instead of six times, which would be necessary if they were cut singly. When putting several gears on the arbor, they must be faced exceedingly true, or the arbor will be bent. This is especially true when the hole is small and the gears large in diameter. Plenty of lubricant should be applied in this operation, oil being most commonly used. The hob should be made of high-speed steel, a six-pitch hob being 3 inches in diameter, and a five-pitch hob, 3½ inches in diameter. On account of the accuracy required, single-threaded hobs are preferable. For the roughing operation a cutting speed of sixty feet per minute of the hob, and 0.020 inch feed per revolution, are considered good practice for a nickel steel six-pitch gear.

For the finishing operation at least 0.010 inch should be allowed for a six-pitch gear and other pitches in proportion. If the finishing cut is merely a scraping cut and not enough stock is removed to let the cutter get a real chip, the cutter may glaze over the work, especially if the cutter and the work-arbor are not held rigidly. The gears should be finished one at a time, excepting plate gears, in which case several can be placed on the arbor at one setting. For this purpose a Fellows gear shaper should be used, because the cutter can be made far more accurate than a hob or a rotary cutter. The teeth of this cutter can be ground after hardening, and this

corrects any inaccuracies that may have crept in. On the cutter-arbor, at the back of the gear-cutter, should be placed a round disk made of high-speed steel, hardened, ground and backed off, which will act as a shaving tool and will take off the 0.005 inch left on the top diameter, as previously stated. This will make the outside diameter true with the pitch line. The teeth should be cut about 0.001 inch thin at the pitch line to produce a running fit. The gears should now be tested for center distance, for which purpose a plate with two pins for the bores, set at the correct center distance, should be used.

Owing to the courtesy of Mr. Ward, of the Universal Gear Grinding Co., the author has had the opportunity of seeing in

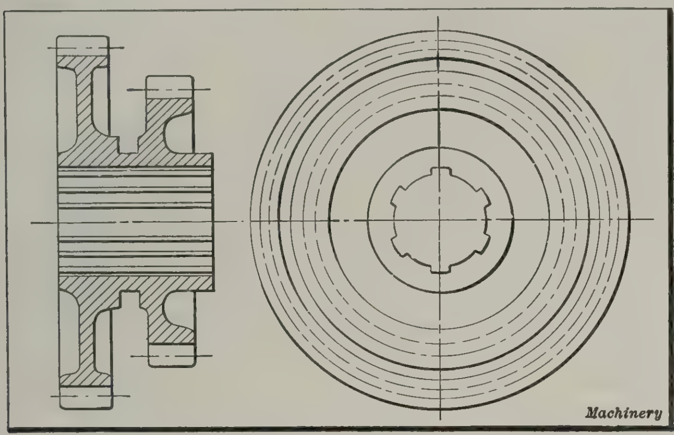


Fig. 8. Completed Gear, shown in Progress of Evolution in Figs. 3, 5 and 7

operation a machine for grinding gear teeth, which has the appearance of filling a long-felt want in the automobile industry. If it is—and the author believes it is—what the makers claim for it, it would not be necessary to finish-cut the teeth, as, with the exception of those of the gear shown in Fig. 8, they could be ground after hardening. This would obviate the final process of "grinding-in" with emery and oil, a process which at present is so unsatisfactory. In the case of the gear teeth shown in Fig. 8, the grinding wheel would foul the large gear when grinding the small one, to overcome which it would be necessary to re-design the gear and make it in two parts. The machine has many good features, the main one being that the shape of the wheel is maintained by three diamonds which dress the wheel, and which are controlled by one former. One is used for truing up the top diameter of the wheel, and one is placed on each side for truing the curvature.

The tooth-rounding should be performed on an automatic tooth-rounding machine. Several gears should be mounted on the same arbor, and the teeth of the wheels may be rounded in succession at one setting. No doubt most readers are quite familiar with the reason for this operation, which, therefore, requires little explanation, unless it be to say that it is done to facilitate the changing of the gears, and also to prevent the teeth from being chipped when engaging, which would occur if the corners were left square. The sides of the teeth which are not rounded should be fraised before carbonizing, which is the next operation.

The Carbonizing Process

In carbonizing, great care should be taken, as, to a very great extent, the life of the gear depends on this process. The result of the process is determined by four factors, namely: the nature of the steel; the nature of the carbonizing materials; the temperature of the carbonizing furnace; and the time taken by the process. The carbonizers in general use at the present time are animal charcoal, hydro-carbonated bone-black, charred leather, and a few other compositions sold under various names. Owing to the various conditions under which the operation is carried out, experience must largely guide the operator. Theoretically, the perfect carbonizer should be a simple form of carbon, and charred leather gives very satisfactory results. Care should be taken to avoid poorly charred leather, or that made from old boots, belting, etc. Good charred leather should contain about 88 per cent of carbonizing matter.

As it is essential that the core of the gears should be left soft in order to withstand the high speed and sudden shocks to which they are subjected, the carbon content in the core should be low. For this reason preference is given to 0.20 per cent carbon steel. The carbonizing pots are made from both cast and wrought iron; the former are cheaper in first cost, but the latter bear reheating so many times that they are really cheaper in the end. The carbonizer having been thoroughly dried and reduced to a fine powder, a layer of not less than 1½ inch in depth is placed in the carbonizing pot and well pressed down. Upon this, are placed the articles to be treated. Care must be taken to have sufficient space all around each piece so as to prevent them from touching each other or the walls of the pot. About 1½ inch is sufficient. Another layer of carbonizing material is then put in and well pressed down, care being taken not to displace any of the gears. The process is then continued until the pot is full, finishing with a layer of about 1½ inch at the top.

The object in view is to make the contents of the pot as compact as possible, consistent with a sufficiency of carbonizer in contact with the gears. The more solidly the pot is packed, the more complete the exclusion of air. The lid is then put on, and the joint all round luted with clay. The pot should be placed in a furnace similar to that used for annealing, and heated to about 1700 degrees F., which heat should be maintained constant for from six to ten hours. The length of time occupied is regulated by the depth of casing required, which

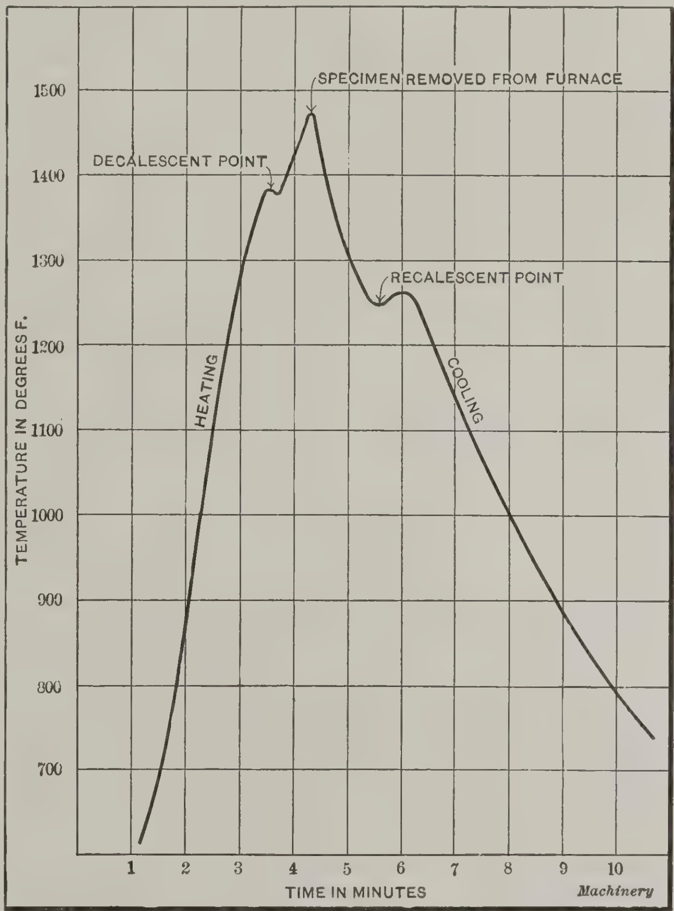


Fig. 9. Curve showing the Decalescent and Recalescent Points for Low Carbon Nickel Steel

should be about three-sixty-fourths inch, and also by the dimensions of the gears. At the close of the carbonizing period, the pot is withdrawn and put in a dry place where it is allowed to cool to atmospheric temperature. It is then opened, the articles are taken out, and the process is completed by brushing to remove all adhering matter.

It may be noted here that the case should only be deep enough to resist wear and battering. If the case is so deep as to form a considerable part of the cross-section of the teeth, the teeth may break unless the case is considerably tempered.

Turning Operations Preceding Hardening

The next operation is to turn out the carbon from the parts required to be soft. In the case of the plate gear shown in Fig. 1, which is to be bolted to another gear or center, as

previously stated, the hole need not be hard. For this reason, it was left with an allowance of 1/8 inch at the previous turning operation. It should now be bored with an allowance of 0.015 inch for grinding after hardening, and faced down on both sides. This refers to both plate and castellated gears as shown in Figs. 6 and 7. The boring operations should be performed while the gear is held in a collet-chuck, locating from the top of the teeth, which were trued up with the pitch line by the shaving tool used when cutting the teeth, as previously explained. This method has been found to be more efficient than locating with balls or rollers on the pitch line. The penetration of carbon being only about three-sixty-fourths inch it is now removed from the parts which have just been turned. Consequently these parts will not be hardened. The excess metal is left as shown in Figs. 6 and 7 until after hardening, in order to prevent warping, which would undoubtedly happen if the gears were finished as shown by Figs. 1 and 8.

The Casehardening and Oil Tempering

Steel of the composition mentioned can be hardened as follows: Heat from 1450 to 1525 degrees F. and quench in water; re-heat to about 1400 to 1450 degrees F., and quench in water. The re-heating must be conducted at the lowest possible temperature at which the steel will harden. It will be found that this is sometimes as low as 1300 degrees F. Then, as a safeguard, re-heat to a temperature of between 250 and 500 degrees F., in accordance with the requirements of the case, and cool slowly in oil. Parts of intricate shape, such as the gears dealt with, having sudden changes of thickness, sharp corners and the like, should always be tempered or drawn in order to relieve internal strains.

Another method of procedure is as follows: Heat from 1450 to 1525 degrees F., and quench in hot brine. Re-heat from 1450 to 1525 degrees F., and quench in oil. The temperature need not be drawn when the gears are quenched in oil. The final quenching should be done at the lowest temperature at which the piece will harden, as stated in the first method.

A small gas muffle should be used for hardening. A properly constructed gas muffle can be regulated with the greatest nicety, and in hardening this is most important. When steel is gradually heated, there is a certain point at which a great molecular change takes place, and perfect hardness can only be obtained by quenching at this critical point. This would lie between 1300 and 1450 degrees F. When steel is cooled, whether slowly or not, it bears in its structure a condition representative of the highest temperature to which it was last subjected. From this it will be quite clear that in casehardening, as in all methods of hardening, the steel must be quenched on a rising heat. Steel which is overheated previous to the final quenching, is very brittle and liable to fracture easily, and although quenched and subsequently hardened, the metal has little or no cohesion, and rapidly wears away. Steel so hardened breaks with a very coarse crystalline fracture, in which the limits of the case are badly defined. If quenching takes place below the critical point previously mentioned, the steel is not sufficiently hard. If above, though full hardness may be obtained, strength and tenacity are lost, in part or completely, according to the degree of heat by which the critical temperature is exceeded.

It may be asked why it is not sufficient, when the pieces are heated at the first re-heating to about 1500 degrees F., to place them in another furnace and reduce to the critical temperature and quench, instead of quenching twice. The answer is that the high temperature has already created a coarse crystalline condition in the steel, and that, until it has been cooled down below the critical point, and re-heated to the critical temperature, a suitable molecular condition cannot be obtained.

As a further means of illustrating what is meant by the critical point, Fig. 9 shows a curve plotted from results obtained by a recording pyrometer, in which the decalescent and recalescent, or critical points are shown. From this it will be seen that the absorption of heat occurred at about 1375 degrees F. on the rising temperature; and the evolution of heat at 1250 degrees F. on the falling temperature which was allowed to fall slowly. The relation of these critical points to hardening is that it cannot take place unless a temperature sufficient to produce the first action is reached in order to change the pearlite carbon to hardening carbon; and also unless it is cooled with sufficient rapidity to eliminate the second action. The temperature would, of course, be gaged with a pyrometer.

Sandblasting

The sandblasting, which serves to scour off any roughness or stains which have been left on the surface during the heat-treatment, etc., is best conducted in a building separated from the remainder of the shop. The sand should be kept in a bin in one corner, and sucked up by a centrifugal blower and forced by air pressure through a blow pipe which terminates in a nozzle. The sand being forced by the air at a high velocity, may be directed at all parts of the piece to be cleaned. This is one of the most efficient methods of polishing and cleaning the gears, and does not injure the hard surface in any way.

Hardness Testing

The gears should now be tested for hardness. The scleroscope appears to be the best instrument for doing this. If a gear shows a considerable drop in hardness, a file should be used to determine whether the cause is due to the piece not being hard, or to crystalization. If the parts can be scratched with a file, it shows that it is not hard enough. If, however, the file will not bite on the spot where the scleroscope reads low, then it is positively known that it has been overheated and is crystalized. A good method of testing the teeth is the drop test. By this method a ten-pound weight with a 56-inch drop is directed at one tooth. The number of blows necessary to break the tooth should be noted. This test would only be applied occasionally, say, on one out of each batch of gears. A gear which has given satisfaction should be tested, and the result used as a standard for future comparison.

Final Turning Operations–Grinding

The metal left for supporting the gears while undergoing heat-treatment is now removed. This operation should be carried out with the gear held in a collet-chuck, and care should be taken that the outside diameter runs true before starting. The hole having been bored after carbonizing, is now soft. The metal can be turned out on both sides, or on one side, as the case may be, leaving 0.005 inch on the face of the web for grinding. This operation should come next, and is most essential in order to get a true running gear when in position. The castellated gears which were finish-bored with an allowance of 0.015 inch before carbonizing are now hard, this being necessary as they have to be a sliding fit on the shaft. The part of the bore which bears against the lands of the castellated shaft is all that can be ground. Unfortunately no method has yet been devised for grinding the castellations themselves, and these, therefore, have to be lapped separately by hand—which is most unsatisfactory. While grinding the bore, the gear should be held in a collet-chuck from the top diameter—hence the truing of the top diameter with the pitch line in the gear-cutting process. Gears ground in this way should be perfectly true, and are now ready to be tested for center distance and true running.

The Drilling

It should be clearly understood that the web of the gear shown in Fig. 1 is now soft. This brings us to the final machining operation, that is, the drilling. There are many advantages gained in leaving this operation until the last. The bore is now the correct size, this being essential for locating the drilling jig. Furthermore, in the grinding operation, the bore is totally ignored, the top diameter being the most important. The hole has been ground true with the latter, so that if the holes had been drilled previous to the hardening, they would not be concentric with the bore, and would not match with the gear or center to which it has to be bolted. Another advantage is that the holes are now soft and can be reamed with the piece to which the gear is to be bolted, it being understood that these would also be left soft in the parts in which the holes are required. All these are important points, and this is the reason for leaving the drilling until last.

The "Running-in"

The gears should now be bolted to their respective parts and finally "run in" before being placed in the car. This should

be performed in a special case, and the "running-in" done under belt power. The bearings, in these special cases, are set at the proper center distance, so as to accommodate the various gears of a train, thus wearing in the gears so that all those for similar parts are absolutely interchangeable. The case is made oil-tight, and a mixture of finely powdered emery and lubricating oil is forced through an opening in the top, so that this grinding material will come in contact with all the teeth in mesh in the train. The grinding is continued until each tooth has been worn perfectly smooth, and to an accurate fit with the teeth of the other gears with which it comes into mesh. As a further means of thoroughly running in the gears of the transmission to a perfect fit, the motor, transmission and driving shaft are installed in the chassis, and the motor is run while the various speeds of the transmission are thrown into mesh. During this run an electric dynamoter, by means of which a variable load may be applied, is connected to the end of the driving shaft. The gears should now be as perfect as, with the best practice yet known, it is possible to get them.

It may be objected here that the leaving of extra metal for heat-treatment is rather costly. This is a question upon which there is room for a considerable difference of opinion. The author is of the opinion that if the method of leaving extra metal is used with discretion, and only in the case of very intricate gears, the most satisfactory results should be produced.

* * *

VANADIUM IN HIGH-SPEED STEEL

When high-speed steel was first alloyed with vanadium the vanadium was used in no greater amounts than 0.2 to 0.3 per cent, but it has been found that greater percentages produce better results, and as much as 0.75 to 1 per cent is now generally used. The efficiency of a tool may be measured either by the cutting speed at which the tool will last for a specified time, or by the length of time it will last under the same speed and general conditions without resharpening. Tests have shown that a tool steel containing 0.3 per cent of vanadium will stand up under a ten per cent increase in speed as compared with the same steel containing no vanadium. If 0.6 per cent of vanadium is added, an increase of twenty per cent in the speed is possible, and with 0.9 per cent of vanadium the speed may be increased thirty per cent. As regards the effect on the time between grindings, the speed and other conditions being the same, 0.3 per cent vanadium in the steel doubles the time between grindings, 0.6 per cent quadruples the time, and 0.9 per cent octuples it, eight times as much metal being removed between grindings, if the same speed and feed are used as would be efficient with the same steel containing no vanadium. These figures are given in a recent publication issued by the American Vanadium Co., Pittsburg, Pa.

* * *

TOO MANY SPEED CHANGES NOT AN ADVANTAGE

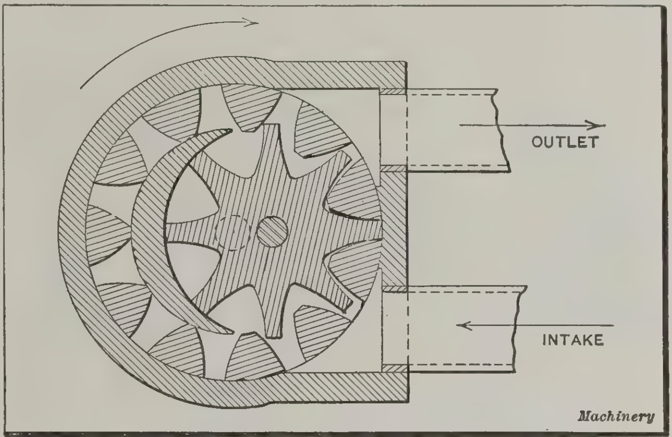
In an article on "Rational Machine Tool Design," by Prof. J. T. Nicolson, published in the *Machine Tool Engineer*, a supplement to the *Practical Engineer* (London), the author states with great emphasis that "the modern craze for large numbers of spindle speeds is not warranted by considerations of commercial economy; and it is to be distinctly condemned from the point of view of technical efficiency. The fewer the number of speeds, the broader, stronger, and more durable can be the gears, the smaller will be the power wasted in friction and the more compact and handy may be the headstock" of a machine tool. He says, further, that there is no money for the user, in a headstock with a large number of spindle speeds, and, even if there were, it is very doubtful whether the operator would use the speed changes intelligently. The added complication is a source of trouble in the working of the machine. A simple headstock with from eight to ten speeds, is, according to Prof. Nicolson, the best for every requirement. The great secret of economical cutting is not a complex headstock with many spindle speeds, but a lathe of moderately simple design which is kept constantly at work.

THE VIKING ROTARY PUMP

The accompanying illustration shows the principles of an interesting rotary pump, invented by Mr. Jens Nielsen of Cedar Falls, Iowa, which has recently been tested at the Engineering Experiment Station of the Iowa State College, and is described in the April number of the *Iowa Engineer*.

As will be seen in the illustration, the pump has but two moving parts—an outside annular gear, and an inside spur gear. The large gear has a shaft at the back which extends through the pump casing and carries the driving pulley. The spur gear is mounted on a stud extending from the opposite side of the casing, which also has a crescent shaped projection on one side, dividing the space between the two gears as shown. While, in the illustration, the lower pipe is shown as the intake pipe and the upper pipe as the outlet, either may be used for the intake, depending upon the direction of rotation. The action of the pump is evident. After the water enters the pump, it is carried around the pockets formed by the teeth in the large gear and the crescent-shaped projection. When the gears come into mesh on the upper side, all water is forced into the outlet port.

Tests have been made with heads varying from 30 to 150 feet of water and at speeds from 200 to 450 R. P. M. At 215 R. P. M., the efficiency was 48.6 per cent. At 400 R. P. M.,



Diagrammatical Section of the Viking Rotary Pump

the efficiency was 76.3 per cent. The average efficiency of all the tests was 64.8 per cent, the average speed being 360 R. P. M. At high velocities, the average efficiency was practically 70 per cent.

The comparatively positive action of the pump is shown by the discharge per revolution. At the lowest efficiency this discharge was 0.209 gallon, and at the highest, 0.235 gallon, which shows that even at the lowest efficiency the leakage was slight. The volume of water discharged per revolution, if there were no leakage, would be 0.259 gallon.

One advantage of the pump is that only one moving part requires packing—the main shaft where it enters through the back casing. The inventor has used one of these pumps in a stone quarry since 1906 pumping water mixed with mud and fine gravel. This pump is still working satisfactorily.

* * *

An interesting departure in advertising has been made by the American Woodworking Machinery Co., Rochester, N. Y., in a recent issue of *Vocational Education*. This firm offers to give, free, with a stereopticon, a series of slides showing in detail the construction of its No. 77 fast feed planer and matcher, from the foundry to the testing floor. The details which accompany each slide enable a teacher to prepare a talk before his class in connection with the exhibition of the views. What better method is there to acquaint a class in machine shop practice, for instance, with the mechanism and process of construction of a machine, than by showing the actual work? This, of course, can best be seen in the shops but if that is not practicable, the next best method is to show pictures of the operations. These few slides will convey more information on woodworking machinery to a class than pages of written matter or hours of unillustrated oral explanation. The value to the advertiser who thus makes known his tools is obvious.

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JULY, 1912

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

NOVELTY IN PATENTS

The communication from Mr. Shaw in another part of this number regarding an application of ball bearings to machine tools, raises an interesting question as to what constitutes novelty in patents. The requirements of construction for a drilling machine spindle as regards bearings are that thrust in the direction of the spindle shall be supported as well as the lateral thrusts due to belt pull and other forces acting against the sides of the spindle. This means that in the simplest form of spindle bearing, as ordinarily made, there shall be two radial bearings and two thrust bearings. Two thrust bearings must be provided, one to take the thrust of drilling, and the other to carry the weight of the spindle when not at work.

The designer of the drilling machine referred to by Mr. Shaw, took up the problem from a new point of view, however, and succeeded in providing a successful ball bearing construction consisting of two radial bearings only. The novelty lies in the elimination of separate thrust bearings by following a perfectly logical assumption. Radial bearings of the well-known annular types are rated as having a thrust bearing capacity of twenty-five per cent of the allowable radial load. Hence the requirements of drilling machine spindle bearings are perfectly satisfied by providing two radial bearings, one of which has a radial bearing capacity of at least four times the thrust bearing requirement. Suppose the maximum thrust to be provided for is 1000 pounds, then a bearing capable of carrying a radial load of 4000 pounds will safely carry the thrust load and, of course, be far above the lateral thrust requirements.

The question is: Does this design, embodying a simple construction found in hundreds of other machines not required to provide for endway thrusts on shafts but which in this case provides for thrusts by greatly increasing the radial bearing factor, constitute novelty? We believe that it does, and that the lucky discoverer of the principle is entitled to all the protection provided under patent laws. The best ideas are generally the simplest, and in this case machine construction has doubtless been improved and simplified at one stroke. This is the height of machine design accomplishment.

* * *

VALUE IN A GOOD NAME

A bill has been introduced in Congress providing that all products intended for interstate or foreign trade shall be stamped with the name and address of the makers. The penalty provided for violation of the proposed statute is a fine of one thousand dollars or imprisonment for six months, or both. The same penalty is provided for erasing or changing the stamp.

It is practically impossible to frame any drastic law that will not work hardship or injustice to a few, and probably this proposed legislation is no exception; but we believe that in the end it would confer material benefits on both manufacturers and consumers. A great step forward would be made for honesty in manufacturing and selling, and dishonest competition would be hard hit.

Every machine tool that carries the maker's name is not only a permanent advertisement for him, but an incentive to produce his best, and security that others shall not appropriate the prestige acquired through honest workmanship and effective design. There can be no objection to a dealer attaching his nameplates to machines sold; but we believe that the policy followed by some dealers of replacing the name of the manufacturer with their own is bad for the industry, because it relieves the maker of all responsibility for the character of his product and places a premium on poor workmanship. A good name and an established reputation are of the greatest help in selling machine tools, and the most successful dealers represent manufacturers who possess them. Their dealers can talk *quality*—the men who are selling tools without any reputation can only talk *price*.

* * *

FIXING RESALE PRICES

Many manufacturers fix the prices at which their products are sold by means of agreements as to resale prices, and by employing the principle of constructive infringement in the case of patented articles. Fixing resale prices has many advantages. The practice enables the manufacturer to advertise a product and the price, and to insure to the retailer a reasonable profit. It secures the retailer's position and prevents unfair competition so ruinous to the trade. Probably one of the most wholesome developments of the past twenty years of American trade has been the establishment of fair resale prices and the elimination of destructive competition.

But the principle of constructive patent infringement, of comparatively recent development, may be used for other purposes than the fixing of fair prices which insure reasonable profit to the retailer. Constructive patent infringement may be used as the means by which monopolistic control of manufactured products can be secured by groups of allied manufacturers. House bill 23417 has been drawn with the view of eliminating the danger arising from the power of the owners of patents to monopolize any manufacturing field, and this bill, it is hoped, will prevent patentees or owners of patents from attaching to the sale of goods unreasonable restrictions as to prices or methods of sale.

The matter of establishing resale prices presents many difficult and conflicting propositions. No one can deny that it is better for the manufacturer, jobber, retailer and consumer to have stable prices. Fluctuating prices mean uncertainty and demoralization. Fixed prices may insure a fair profit to all concerned in the distribution of the goods. The purchaser buys with the feeling that he is paying the market price and no more, and that he must pay the fixed price wherever he purchases the article. On the other hand fixed retail prices may enable groups of manufacturers to eliminate the law of supply and demand and impose monopolistic conditions which are intolerable.

We believe that whatever solution is found the result should not depend upon the provisions of the patent law, for that should not be used to enforce conditions of sale or use. The law should only secure to the inventor a reasonable reward for his ingenuity and labor.

WHAT TO STUDY

Sometimes we receive letters from young mechanics, saying, in substance: "I am a young man employed at the ——— Works, and I want you to recommend some books that I ought to study." The editor who must answer a question of that kind is in a worse plight than the doctor who is required to prescribe for a disease that he cannot diagnose; for the doctor can usually prescribe something harmless and "get away with it," but the editor cannot proceed along such easy lines. He is expected to give good, practical advice with but an indefinite knowledge of the needs of a young man whom he has never seen, and with whose previous education, ambitions and mental capacity, he is not familiar.

Some men should be advised to study anything and everything that would be useful to them in an executive position; while to others such advice, if followed, would mean simply disappointment and waste of time and effort. Some men do not possess the peculiar qualities that would enable them ever to rise to high executive positions; and those men should rather concentrate all their educational effort on practical study of the kind of work they are engaged on, so as to become proficient in that. Others, again, of a more energetic, more resourceful, or a more brilliant make-up, should pursue studies along entirely different lines—studies which may not benefit them within a year or two—perhaps not within five years; but which would ultimately prove useful to them when in positions of an entirely different character from those which they now occupy.

Fig. 1. One of the Drafting-rooms. All Work is designed here and Working Drawings are made for the Pattern and Machine Shop

What a man should study is largely a question which he must decide for himself. It is difficult for anybody else to decide it for him. A man should increase his knowledge of the work in which he is most interested—it will make both his work and study easier. For example, if he is interested in drawing, and has a natural ability for working out ideas or designs of his own, we advise him to study drafting, machine design, mechanics and mathematics, so as to utilize his natural inclinations. The young man whose sole interest is centered upon the practical operations in the shop, different methods of grinding tools to obtain the best results, short cuts for obtaining increased production, etc., we advise to pursue studies along shop practice lines, because for him the shop proper undoubtedly offers the greatest possibilities. If he is familiar with shop practice and has acquired a knowledge of the use of the various machine tools and shop systems, and, in addition, has a personality which makes him capable of handling men, there is no reason why he should not rise to be a foreman or superintendent.

In choosing a course for study, however, do not be misled by the idea that immediate benefit will be derived from it. Many a man who has risen to a prominent position in the industrial field has spent years in studying subjects which have been of no immediate advantage to him. It may have been five or perhaps ten years, before he has found a direct application for his knowledge; but he would have been unable to fill the higher position satisfactorily had he not acquired a fund of knowledge during the years when he had the opportunity.

THE WENTWORTH INSTITUTE*

A TRADE SCHOOL FOR TRAINING SHOP-FOREMEN AND SUPERIOR WORKMEN

By CHARLES L. HUBBARD†

A day spent at the Wentworth Institute, Boston's new school for industrial training, described in the October, 1911, number of MACHINERY, so impressed the writer with the value of the methods employed and the results obtained in training foremen and skilled mechanics, that he believes some of the enthusiasm absorbed from this group of busy men and boys should be passed along so that others may profit by it. What is so important to the efficiency of the shop as a whole, and to the advancement of workmen individually, as enthusiasm? Let the young man of average ability become sufficiently filled with love and respect for his chosen work and appreciation of the principles that underlie it, and the other requisites for success will follow naturally.

The Wentworth Institute is giving its students just this kind of a start, not by way of advice, but in a practical way, which not only makes a greater immediate impression, but is far more lasting. The object of this article is to describe briefly the general scheme followed in bringing about this result, in the hope that it may be developed in other schools of similar character, and also that it may awaken greater interest in practical industrial education, both among mechanics and among manufacturers and employers of skilled labor.

Fig. 2. Wood-working and Pattern Shop equipped with the Latest Machinery and Tools for this Class of Work

A casual inspection of the catalogue of this institution fails to show any particular difference from the methods followed in other trade schools, but as soon as one steps inside the building, he catches the air of the genuine earnestness, efficiency, and system noticeable in the business and engineering offices of the highly organized concerns of the present day. Furthermore, the impression is lasting as one passes through the different departments and notes the interest and industry of the students in their work, their businesslike, intelligent and skillful way of attacking their tasks and overcoming their difficulties, and the complete absence of any action which would tend to detract from the seriousness of the work in hand.

The average boy leaves school at fifteen or sixteen years of age. He enters a shop as an apprentice under the usual conditions, has little to encourage him during his hours of work, and too often little to look forward to in the future. He is placed at some task where he will be of most value to his employer, with scant regard to his own advantage in the way of learning his trade. A desire on his part to find

* The following articles on industrial schools, trade education and kindred subjects have previously been published in MACHINERY: "Features of Apprenticeship System at the General Electric Co.'s Lynn Works," April, 1912, engineering edition; "The Cincinnati Method of Industrial Education—A Friendly Criticism," March, 1912, engineering edition; "The Wentworth Institute," October, 1911; "T. R. Almond Mfg. Co.'s Evening School," July, 1911; "Training of Machinists in the Trade School," July, 1911, engineering edition. See also other information previously published, referred to in connection with the last-mentioned article.

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out the reason for doing things is not encouraged, and those above him have not time for answering questions. It is not the fault of the foreman; he is held responsible for turning out the greatest possible quantity of work with the men in his charge. The fault is really with the system, and to remedy this fault, schools like the "Wentworth" are being established. Mr. Dodge, past president of the American Society of Mechanical Engineers, in speaking upon this subject, says: "The apprentice boy who picks up a trade, learning it chiefly by imitation and with little or no instruction, enters a machine or wood-working shop at sixteen and earns an average wage of $3.00 per week. At twenty-two years he may be earning $13.50, but at twenty-four years he has reached his highest earning capacity, getting $15.80 per week."

What is there to give a young man enthusiasm and draw out the best there is in him under such conditions? There may be a few special cases where young men have sufficient ability and endurance to win out under any condition, but the larger part usually drift from shop to shop, gradually losing hope of better things, and develop into "one-machine" men with practically no chance of further advancement. These statements are not intended to discourage men who are working under these conditions, but rather to encourage them by pointing out the opportunities that are open to them through the development of modern trade schools. Europe has long been aware of the advantages of this method of instruction, while America is only waking up to its possibilities. This is shown by an item which appeared in a recent number of the *Outlook*, and which states that in 1908 Prussia had 400,000 pupils, or nearly 14 per cent of its entire population, enrolled in its industrial schools, while only 2 per cent of the population of the United States were being trained in a similar manner. In some of the best shops, it is true, more care is taken in training apprentices than in others, and in certain cases private trade schools are now being carried on for the purpose of supplementing the training of the apprentices in the shop; but admirable as are some of these efforts to give the apprentice boys a chance, their number is still so small—and is certain to remain small in proportion to the demand—that there is genuine need for the public trade school in every industrial center.

Fig. 3. Foundry in which the Men are trained to become Skilled Workmen and Foremen

Fig. 4. Light and Spacious Core Department located on the Balcony in the Foundry

It has already been stated that one of the prime objects always kept in view in the training at the Wentworth Institute is to awaken in the student a thorough and lasting interest in his work. This is done, in a very simple and practical manner, largely by answering questions, both *asked* and *unasked*, and this really covers the whole field of teaching. Answering unasked questions gradually trains the student to ask them on his own account, and as his reasoning powers are developed, he reaches a point where he answers some of them himself. Now, when a man can both ask and answer his own questions he becomes original, and furthermore, an original man has ideas. Given a man with originality, and a training to properly discriminate between the practical and impractical, and he will neither lack interest in his work nor have a long wait for success. Such men are in demand in all the manufacturing plants of the country at wages that are only limited by their ability.

One or two illustrations will serve to show the general methods followed in accomplishing this result. For example,

Fig. 5. A Student engaged in Pattern Making, which forms a Part of the Shop Course in General Machine Construction

Fig. 6. A Student at Work in the Forge Shop, a Course in Forging also being included in the General Shop Course

Fig. 7. Work in the Milling Machine Department, illustrating the Character of the Work being done

a student is given a piece of work to be done on a lathe. His instruction is not confined to this piece of work alone, but he also makes a study of the lathe itself. Every part which goes to make up this machine is examined, and its use and the principle upon which it operates, are carefully explained. He is taught to make computations in gearing so that the necessary changes for screw cutting, etc., may be made without the use of tables. Tests are made upon the strength and friction of gears, belts, lubrication, etc., until

Fig. 8. General View in the Forge Shop

he has thoroughly mastered the machine itself, and has become proficient in its use. This same general scheme is carried out in a similar way upon all of the various machines in the shop. Thus the student not only becomes familiar with the use of machine tools, but is also able to detect and correct faults in their operation, and make proper adjustments. All of this forms a part of the necessary qualifica-

Fig. 9. General View in the Machine Shop

tions of a foreman, and adds greatly to the chances of future promotion.

Various methods are employed for awakening and holding the ambition of the student besides the regular routine work. One scheme is to incite a friendly spirit of competition in the several departments, which is illustrated by the following incident connected with the foundry practice. One feature of this course is to learn the art of shoveling sand properly, which, of itself, is not an especially interesting operation. To add zest to this exercise, and awaken a suitable amount of interest, and to test the mettle of the men, the class was divided into gangs working in competition, both as to speed and quality of work done. To avoid monotony, this work was carried on in connection with subjects requiring equal time in the class rooms, drawing rooms or laboratories, so that each type of work seemed by contrast a form of recreation when compared with the other. This was kept up every school day for nearly two weeks, at the end of which time the class had not only become proficient in the shoveling and tempering of sand without thinking of it as drudgery, but was also thoroughly drilled in team work. Each student had had opportunity to act as gang foreman and had learned how to take orders from his fellows, and had also learned from the records of successive days that there was a "science" even in shoveling sand. These are items of much value in the handling of men and are requisites in the training of a successful foreman. Compare this with the same work as done by the average apprentice, and note the difference in spirit and in the mental effect upon the two sets of boys. In like manner, time and efficiency tests are made in molding standard patterns, and records are established which every member of the class strives to excel. These methods of stimulation are only employed for first arousing an interest in the work, after which a natural desire for knowledge is developed which is sufficient to maintain the necessary degree of enthusiasm without artificial means.

Another important point in the general scheme of instruction is to make the men feel that they are doing *real work* with tools and machines of latest design, and that all knowledge gained is of actual practical value. This is well illustrated in the machine department, where, as elsewhere, work

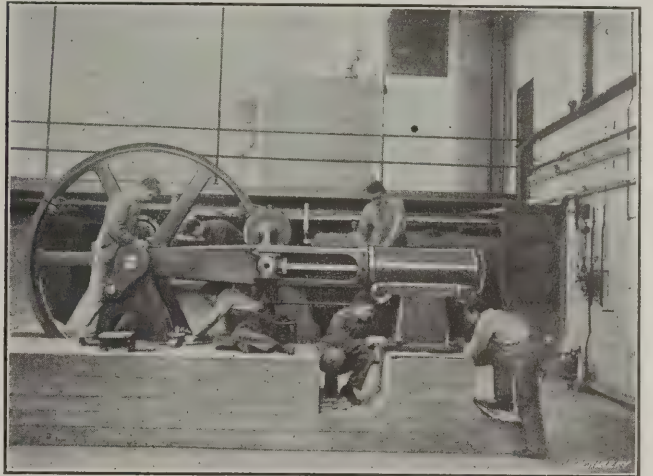

Fig. 10. Students assembling an Experimental Engine in the Steam Engine Laboratory. All Work of this Kind is done by the Students under the Direction of a Foreman

is carried through with the same order and system which would be employed in the most up-to-date shops. The article or machine to be built is first designed in the drafting-room, the patterns made in the pattern shop, and the castings in the foundry. The bench-work and machine-work are then given out to different men in the shop and the work is carried on to completion. In order to give a well balanced course, the men are shifted from machine to machine as fast as

Fig. 11. The Testing Laboratory where Materials entering into the Construction of Buildings and Machinery are tested for Strength

they become proficient in their use, and in this way they have an opportunity to work upon the different parts of any article or machine which is being built in the shop.

No man is held back in his work by another, promotion being dependent upon individual proficiency in each case. Nor is a man kept from using a valuable machine for fear he will damage it, as is often the case with an apprentice in a shop. He is given instruction in the use of each ma-

chine with an opportunity to put it in practice. Until he become thoroughly familiar with it, his work is kept simple. In this way the risk of damage is small.

Another feature of interest is the testing of work after it is finished, to see how it may be improved in design. For example, one of the exercises consisted of the design and construction of an arbor press. After completion, one of these was taken to the testing laboratory and each part tested to the breaking point under the kind of stress to which it would be subjected in actual use. The main casting was broken and the weakest section ascertained; the teeth on the rack of the ram were tested and compared with the teeth on the pinion and the maximum strength of the handle was

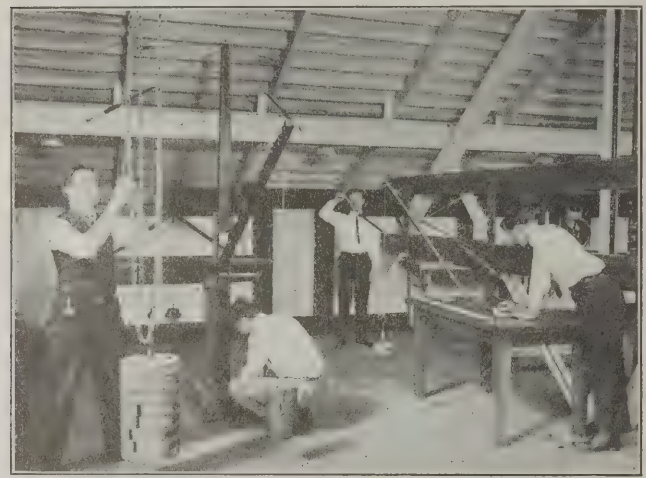

Fig. 12. Determining the Distribution of Load in Derricks and Cranes, using Specially Designed Apparatus

found. In this way the design of the machine may be revised, strengthening some parts and lightening others, to make the whole of uniform strength throughout. It is a noticeable fact that the men, as a rule, get a better grasp of theoretical problems of this kind when they can see their practical application to their particular line of work. The variety introduced into each day's work contributes greatly to its success. The school day is divided into four hours of drawing-room, class-room, laboratory or other theoretical work, and the same length of time is given to practical applications in shops or foundry.

In much that has been described there may appear to be a similarity with other trade schools, but the essential fact which seems to differentiate the Wentworth Institute from others with which the writer is familiar is the perfect blending of the spirit of investigation and open-mindedness of the best schools of science with the spirit of industry and production of the best commercial shops. In every course, theory and practice are carried on together in all the work, and theory is only taught so far as its practical application can be demonstrated.

The objection may be raised that this will have a narrowing effect upon the student, and that the instruction should be more general in its character. It must be remembered, however, that these young men are not university students to whom time and money are not of prime consideration, and who are simply laying a foundation for some special work later. The short length of the course is of the greatest importance to the type of men who enter the Wentworth Institute, and the sacrifice which they make for it is such that it must show practical results in higher wages as soon as it is finished. For these men, later success must come from practical experience obtained in passing upward through the different stages of their chosen trades, and not by passing over it, or dipping into it from the top, as a university student might do. The primary aim of the Wentworth Institute is to so equip its graduates, that with the later experience to be obtained in actual work, they may become superior workmen, foremen, and superintendents. The work done in the school is not intended to take the place of shop experience later on, but is expected to shorten this period at least one-third, and make advancement more rapid and more sure.

In addition to this, if a man develops superior ability as his work progresses, he can broaden his knowledge by further study to better advantage than at an earlier period. While a foundation, if sufficiently broad and deep, will support almost any structure, it is well in this short and busy life not to spend too large a share of it on the foundation alone, before finding out what it may be called upon to carry. The man who avails himself of the advantages of the Wentworth Institute, and subsequently works his way upward to better things, has constructed a foundation of sufficient depth to support almost anything he may wish to place upon it. If he desires to broaden this foundation, it is easily added to without tearing down that which he has already built. When a man has reached the point in his career above alluded to, he knows pretty accurately what his foundation is to support and can finish its construction without waste of time or material.

An advantage of the location of the school is its nearness to the manufacturing district of Roxbury, where various shops and factories are open to the students, thus permitting them to see in practical operation many of the machines and methods employed in the various courses of instruction at the school. A great number of courses are given, in order to meet the requirements of different classes of men. They are briefly outlined below. The one-year day courses include instruction in carpentry, electric wiring, plumbing, machine work, patternmaking, and foundry work. These one year courses are designed especially for apprentices, and aim to give a more thorough foundation than can be obtained in the commercial shop. It is not expected in this short time to turn out finished workmen, but to give the students a thorough understanding of the principles involved, together with sufficient manual skill, so as to enable them to gain a full mastery of their trade in a much shorter time than would otherwise be possible.

The two-year day courses have for their object the training of men to become superior workmen, foremen, and master mechanics. They include instruction in machine construction and tool design, and electrical construction and operation. The general methods of instruction are similar to those already outlined, except that the increased length of time makes it possible to teach the scientific principles in a more thorough manner. It also makes it possible for the student to obtain a greater degree of skill in the use of both hand and machine tools. Evening courses in seventeen practical trades are offered to young men who are employed in mechanical trades or industries during the day.

Fig. 13. Another View of the Mechanical Laboratory showing Students making Friction Tests on Pulleys and Gears

The directors have also inaugurated part-time courses in addition to those noted above. These require the students to attend their classes at the institute every other week, but give them an opportunity to work at some regular employment during the alternate weeks.

* * *

The ribs of a gear should never be made flush with the rim or hub, but should come from 1/8 to 1/4 inch below the rim or hub face; otherwise the rim and hub cannot be finished without making an unsightly appearance.

INDUSTRIAL ADMINISTRATION AND SCIENTIFIC MANAGEMENT*—1

WHAT CONSTITUTES SCIENTIFIC MANAGEMENT

By FORREST E. CARDULLO†

The work of the engineer may be divided into three great departments, since it has to do with the design of machinery, the methods of constructing and operating it, and the administration of the plants in which it is constructed and operated. The first two departments (namely the design of machinery, and its construction and operation) have received the careful attention of trained specialists for more than a century. Even at the beginning of the nineteenth century when engineers first began to apply the resources of modern science to their work, the arts of machine design and construction were in an advanced state, owing to the efforts of many generations of skilled mechanics. The third department of engineering work, however, has lagged far behind the other two, since comparatively little attention has been bestowed upon it. It is doubtful if any substantial advance in industrial administration was made in the thirty centuries preceding the year 1880, and even at the present time only a few men are devoting serious attention to the fundamental problems of management.

Importance of Industrial Administration

At the present time, industrial administration is the most important of the three departments of engineering work. It is not, of course, confined to purely engineering projects, but is an essential part of all commerce and manufacturing. Since the greater part of our working population is engaged in some kind of industrial work, the proper supervision of their efforts is a matter of prime importance to the well-being of the country. Most of the readers of MACHINERY are, or ought to be, interested in the proper administration of the mechanical industries. Hence, this series of articles will discuss more particularly the management of shops and factories engaged in the metal trades.

As has already been intimated, the art of industrial administration was stationary for a long period of time. In spite of tremendous changes in our social, economic and industrial systems, we have been content to adapt or modify methods which originated thousands of years ago. I may liken the system of administration which obtains in most industrial plants to one of those "old homesteads" which dot our New England landscape. They started as a log cabin, to which was successively added a lean-to, a barn, a shed, an ell, an upper story, and other "modern conveniences." As a result, they are roomy—and also inconvenient. The common system of industrial administration is constructed of the surviving remains of Greek slavery, Roman militarism, Saxon serfdom, the medieval guilds, and various other historical oddities, slightly altered to adapt them to the twentieth century conditions, and engrafted on one another in very much the same way as the additions to the old house. This system of management has been a growth in which each manager appropriated those developments of the past which appealed to him. Sometimes methods were adopted as a result of a carefully and properly conducted investigation, but nine times out of ten they were adopted because the manager "guessed" they were the best ones.

Conventional Management

We will designate the system of management described in the preceding paragraph as "conventional management."‡ It must not be inferred from the description the writer has given that conventional management is always and utterly objectionable. When the manager is a good guesser, he will usually choose good methods of work. If his lieutenants are able and energetic, these methods will be well carried out. Of course the system is not perfect, and in many cases it is not even satisfactory. Nevertheless conventional management can be made to work, and to work well, when it is in the hands of capable administrators. Different men will, of course, adopt different methods, and in different shops we will find that the work of administration is carried out in very different ways. In every case, however, the distinguishing feature of conventional management is the acceptance of something already in existence and the choosing, by guess, between methods which have been developed by someone else.

Systematic Management

Within the past thirty years, however, two other systems of management have arisen. One of these may be called "systematic management," while the other has been named by its originators, "scientific management." The systematic system of management is the development of the clerk and the bookkeeper. It aims at the keeping of careful records and the collecting and classification of information. It aims to proceed by continually bettering existing records. It aims to inform the management as to the preferable one of two alternative methods of work, each of which must be tried out in practice. Systematic management is, then, simply the keeping and comparison of records in order to determine the relative value of methods of work.

Scientific Management

Scientific management, on the other hand, has been developed by the engineer. Scientific management aims at the careful investigation of every problem of the industrial world in order to determine its best solution. It is not content to rely upon records, or upon the judgment of the most experienced workman. It brings to its aid all the resources of science. Every possible method of performing a piece of work is carefully analyzed and the best elements of all of the methods combined in order to form a new method. Having established the best methods of work, scientific management then instructs the workman how best to perform his task, and offers an incentive to do it in the prescribed manner. Scientific management is often called the "Taylor System" in honor of its foremost exponent.

Scientific management is not an invention but a discovery. It is the application of the scientific method of research to the problems of the industrial world. Insofar as it is concerned with the investigation of these problems, it is science and nothing else. Insofar as it is concerned with the proper application of the results of these investigations, it is management and nothing else. The combination is therefore correctly termed "scientific management."

Just as in the old days, certain types of machinery reached a very high state of development without the aid of the scientifically trained engineer, so in these days, the administration of certain of our industries has been very highly developed without the aid of scientific management. In some kinds of work, as for instance, watch making, the problems of administration are simple on account of the limited character of the product and the extensive use of automatic machinery. In industries of this class reasonable piece-rates have been established by a series of cuts and after prolonged labor troubles. Such industries have arrived at an efficient system of management by a very strenuous and unpleasant process, and the adoption of scientific management would not always bring notable advantages. On the other hand, most industries are not in this class. The character of the labor employed, the quantity and character of the output, the kind of machinery used, and the kind of material supplied, is continually changing. In the first class of industries a process of evolution extending over two or three generations has established the best methods of management. In the second class of industries the best methods are continually changing as conditions change.

In most industries, the introduction of scientific management promises to effect great gains, and to greatly increase the efficiency of our whole industrial system. Scientific management has been applied to many different kinds of work, and seems to be almost if not quite universal in its applica-

* For articles relating to scientific management previously published in MACHINERY, see "Scientific Management from a Social and Economic Standpoint," June, 1912; "Industrial Efficiency," May, 1912; "Helping a Man to find his Place," May, 1912; "The Efficiency Engineer," February, 1912; "Saving Time in Machine Work," February, 1912; "Scientific Management in the Seventies," January, 1912; "Scientific Management of Arsenals," December, 1911; "Task Work—The Basis of Proper Management," December, 1911; "Scientific Management of Railway Shops," September, 1911; "Scientific Management and Economic Problems," July, 1911; "The Art of Cutting Metals," August, 1907; "The Utilization of Labor," April, 1907; "One Thing at a Time," January, 1907, and the series, "On the Art of Cutting Metals," from January, 1907, to August, 1907.

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‡ Mr. Gilbreth has designated this form by the term "traditional".

tion. It has brought to light many problems in connection with industrial administration of whose very existence we were previously ignorant. Every time it is applied to a new set of conditions, even in the same industry, new problems are presented. If, in the near future, it is extensively applied to all industries or even to any one industry, it will give rise to very serious political, social and economic problems as well as intensify a great many of the problems that are now pressing for a solution. It will be seen, then, that the application of scientific management in industrial administration is not only important to the factory owner, the superintendent, and the workman, but to the law maker, the citizen and, in fact, to every man, woman and child in the country. The field of industrial administration is a very great one, but we cannot appreciate the importance of a right understanding of the problems which will be raised by the extensive introduction of scientific management until we realize how this field is interrelated with our entire political and social system.

An Example of Efficient Management

It is a fact which cannot be controverted, that very few shops in this country produce more than sixty per cent of the work which it would be possible for them to produce with the same wage roll and the same physical equipment. A few of the best managed shops produce probably eighty per cent of the work which it would be possible for them to produce, and occasionally departments in well managed shops reach an efficiency of over ninety-five per cent. On the other hand, there are numerous shops in this country which, without any considerable change in their equipment or increase in their wage roll, could produce from three to five times as much work as they put out at present. This statement, extraordinary as it may seem, is not the result of a wild guess, but may easily be verified by any one who will make a study of conditions in these shops. Some two years ago, the writer made a trip through southern New England inspecting some of the representative industries. The most efficient department that I ever saw was the grinding department of the Norton Grinding Co., Worcester, Mass. I do not know that the engineer, Mr. Norton, made a conscious attempt to install the system developed by Mr. Taylor, but I do know that by a careful study of the work of this department he has raised the standard of efficiency so that every man that I saw was employed continuously in producing a very high class of work with a rapidity that was astonishing, and by methods which the average shop foreman would say were impossible. In conversation, Mr. Norton emphasized the necessity of a careful study of shop problems and stated that such problems were worthy of attention from the most highly trained engineers. Although he never once used the term "scientific," it was quite evident that his study was scientific in the best sense of that term, and that no single problem which had presented itself in his grinding department ever escaped a most thorough and searching investigation. I shall always remember this department of Mr. Norton's works as one of the finest examples I have ever seen of excellent management, and also I shall always remember the type of employe which I saw in that department as a representative of the very finest type of the American mechanic. Every man seemed to be a man of unusual intelligence and skill and seemed to be putting into his work that indefinable something, which for lack of a better term we designate as "brains."

A third matter which attracted my attention was the fact that Mr. Norton seemed to be personally acquainted with every man working in that department; seemed to know their especial abilities and the work for which they were best fitted, and seemed to take great interest in seeing that each man was doing the kind of work for which he could realize the highest pay. So far from adopting the attitude of the average employer, who is inclined to think it a matter of good business policy if he can drive a sharp bargain with his men, and obtain a day's work for a minimum wage, Mr. Norton spoke with pride of the unusual earnings of several of his men who were working under a premium system.

An Example of Inefficient Management

At another time I visited a concern in which it seemed to me that the majority of the men were doing absolutely nothing that was useful. This concern was one of the largest ship building yards of the Atlantic coast. I had no opportunity to talk with any of those responsible for its management and therefore cannot say what attitude they adopted toward various questions of administration. There did, however, seem to be a dearth of foremen, and as in the time of the Judges in Israel, "every man did that which was right in the sight of his own eyes." I remember seeing one man who was engaged in chipping a plate with a pneumatic hammer, and he had two assistants whose duty seemed to be to drag the air hose after them and carry his hammer as he went from place to place. At another place I saw a man measuring a plate and marking upon it an opening which was to be made in a bulkhead, with five or six workmen lounging around him doing nothing. Most of the work of the establishment seemed to be conducted in that manner, and altogether, it was the most disgusting exhibition of shiftless management that I have ever seen in my life. The matter was so apparent that several students who were with me at the time called my attention to it, although they were men unaccustomed to shop administration and most of them were men totally unfamiliar with methods of shop work.

Administration of Average American Shop

The administration of the average American shop is a mean between the slipshod methods of the shipyard and the careful and efficient methods of the Norton Grinding Co. In such a shop, such obvious inefficiency as I have described in the case of the shipyard, would be promptly squelched. On the other hand, in such a shop, careful investigation will usually show very great inefficiency in many departments although such inefficiency is not at first obvious. This inefficiency is due to a variety of causes. It may be that work is slack and the workmen are "nursing their jobs" in order to avoid discharge. It may be that they are prolonging an easy and agreeable task in order to avoid being assigned to a more difficult and disagreeable one. It may be that illness or unsanitary shop conditions have deprived the workman of a measure of his usual energy and ability. In many shops, inefficiency has nothing to do with the workmen, but is entirely chargeable to the management. All of the men appear to be busily employed and the work to be carefully conducted, but at the same time, the type of machines used, the sequence of operations employed, the conduct of the toolroom, or any one of a dozen different things for which the management is or should be directly responsible, greatly reduces the efficiency of the shop.

The writer was once employed by a firm that manufactured small steam engines for the oil trade. Each of these engines was equipped with two flywheels weighing about 600 pounds apiece and the only machine work done upon the wheels consisted in boring the hub, reaming it, and cutting the keyway. I was employed to bore the hubs, which was done upon a homemade machine having a stationary spindle and a revolving table. There was a crane which was used to place the wheels upon the table, but before the wheels could be lifted by the crane, they had to be brought about 500 feet from that part of the yard in which they were stored after being cast. I was instructed to get another apprentice who was named Gus, to help me roll them from the storage yard to a point under the crane. During this time, both my machine and Gus's machine were idle, since they were of a character which required constant attention. This job had to be done several times a day, and I doubt if those two machines were running more than half the time.

As I remember conditions in that shop, I can see that there were endless possibilities of increasing the output by improving the methods of management. Nevertheless, to one who is not in the habit of thinking about the possibilities in this line, the shop appeared to be busy and well managed. It was conducted by a foreman who had an excellent reputation and who was supposed to know "how to get out the work." He was a man of considerable experience and knew about how much time certain work would take when done by the average

machinist in the average way. Most shops would have considered him a valuable acquisition, and in a great many shops he would have introduced notable improvements. The ship building company I have already described would have been fortunate had he taken their affairs in hand, but any department managed by him would have made a sorry showing alongside of the grinding department of the Norton Grinding Co. He employed the usual methods of conventional management, that is, he allowed his men to choose their own methods of doing work, and then eliminated those men or those methods which were obviously incompetent or inefficient. He was not at all versed in the scientific plan of finding the methods of greatest efficiency, and of applying them in the administration of his department.

Misapprehension of Principles of Scientific Management

I have heard a good many men say, in regard to scientific management, that they have managed their affairs scientifically without knowing that they were scientific. However, when I have come to talk over the matter at length with them, I find that what they mean is that some of the inefficiencies not usually obvious had become apparent to them, and that they had adopted some of the methods of scientific management in attempting to eliminate the inefficiences which had come to their attention. This is a very different matter from installing a system of scientific management, although the efficiency of a good many plants has been greatly increased in this manner. However, the men of whom I speak do not understand what scientific management is. They think that scientific management is a collection of best methods, that it necessarily involves the use of certain kinds of blanks and records, or that it is a form of organization, a method of wage payment, or something of that kind. Of course such things are employed in scientific management, but they are only the tools which it uses, and just as a carpenter will change his tools for different kinds of work, so scientific management will adopt different methods, different forms, or different plans of organization, as conditions change.

A great deal of harm is likely to come from the unintelligent employment of some of the methods of scientific management by such men, even when they are acting in the best of faith. The introduction of some of the methods will often cause antagonism among workmen, and they will sometimes prove inefficient under new conditions. In either case scientific management is blamed for the failure, when, as a matter of fact, scientific management would probably have employed other methods under the given conditions. *Scientific management must not be confounded with its forms or its methods*, just as a man must not be confounded with his clothes, or a religious creed with its form of church organization.

Methods under Different Types of Management

It will help us in our consideration of different types of management, if we take a concrete example and note the differences of the several types, as they appear in the example. Let us suppose that a piece of lathe work is to be done, such, for instance, as the turning of a crankshaft. In the conventional type of management the foreman will assign such a job as this to the first man having a vacant machine in which it can be conveniently performed. Systematic management will usually do the same thing. Scientific management, on the other hand, will assign the piece of work to that machine in which it can best be performed.

Having received the work, under conventional management, the workman will determine the plan of procedure, will choose and grind his own tools, and will proceed to work, using those feeds, cuts, and speeds which he thinks will be the most satisfactory. In case the workman is receiving day wages, the pace of the work will depend upon the foreman. As the foreman goes about the shop, he will occasionally take notice of the condition of the work and the way in which it is being performed. If the workman is obviously incompetent or inefficient, the foreman will instruct, reprimand, or discharge him, as his judgment will warrant. On the other hand, if the work appears to the foreman to be going forward at a reasonable pace, nothing will be done.

In case the workman is being paid by some piece-work or premium plan, he will be anxious to earn as large a wage as possible and therefore will attempt to determine the best cuts, feeds, and speeds for the work in hand. There are two methods open to him for doing this. One is to guess at the best conditions and the other is to experiment until he has determined them. The first method, of course, leaves much to be desired. The second method is open to the objection that it takes a considerable number of experiments to determine the best conditions of work, even when the experiments are confined to the performance of a certain job on a certain machine. The workman is rarely, if ever, able to devote the necessary time to such experiments, and he has not the training which would enable him to properly perform and record them. With the facilities which he usually has at hand, it is impossible for the average workman to do any more than gradually improve his performance by careful attention to his methods of work.

Conventional management determines the time required to do a piece of work, or the piece-rate to be paid for it by one of two methods. The first method is for the foreman or some other experienced person to guess at the time required to do the work. The other is to put a capable and conscientious workman at the work and see how long it will take him to do it. Of course the guess of the foreman is about as good as the guess of the average drummer would be if he tried to estimate the population of a village while he was riding through it on a train. The other method of allowing a pace maker to determine the piece-rate is a better one. Since, however, the pace maker usually does not have the opportunity of making a careful study of the best methods of performing the work, his time allowance will usually be too large.

Systematic management, like conventional management, leaves the method of performing the work entirely to the workmen. It does not, however, leave the question of the proper pace to the foreman. The records of previous performances have established a pace and the management can readily determine whether or not the work is being conducted at the best pace of which there is previous record. If it is not, the foreman is notified and the workman is obliged to increase his pace. He may do this in one of two ways. He may experiment in order to determine the possibilities of the work, or he may go to someone who knows more about it than he does for assistance and instructions in regard to feed, cuts, speeds, and methods. In either case he is nagged into bringing up his pace to that of the previous man, and in this way the production is kept up to the best previous record.

Under scientific management, the sequence of operations, the cuts, feeds, and speeds, the tools and appliances, and the methods of work are determined by the management and not by the workman. Before the work is commenced, a specialist considers all the possible methods of doing the work and after carefully analyzing them determines which of these methods are the best. Having fixed upon the methods of work, a time allowance is then established for each operation. A typewritten or blueprinted instruction sheet is then prepared which informs the workman exactly what he must do, and how long it should take him to do it. Instead of grinding his own tools, he receives a supply of properly formed and ground tools. Instead of depending upon the foreman or upon previous records for establishing the pace of work, the time required to perform each of the several operations is exactly known. The whole series of operations has been subjected to a careful analysis, every possible variation has been considered, and the methods developed are not only good ones, but are the best possible ones, considering the limitations of that particular shop.

In order to accomplish the best results, not only must the workman receive an instruction sheet, but he must be shown how to perform many operations. One of the officers of administration is, therefore, the teaching foreman, who makes it his business to instruct the men in the proper ways of doing work and who is always ready to come to the aid of those men who are unable to perform their tasks in the allotted time.

In order to encourage the workman to follow the proper methods of work and to perform his task in the allotted time,

a piece-work, premium, or bonus plan is adopted for the payment of wages. The plan which seems to give the most satisfaction is known as the Gantt bonus plan. This consists in paying the man a certain definite percentage of his daily wages as a premium whenever he performs his task within the allotted time. If his task, for instance, consists of ten pieces a day, and he succeeds in making ten or more pieces, he will receive from twenty to sixty per cent additional wages as a premium. In case he produces less than ten pieces, he receives the regular day wages, but no premium. A man's earnings are computed each day and he knows on the morning of the following day whether or not he has earned the premium. If he has not, it is the duty of the teaching foreman to go over his work with him and instruct him in those points in which he may be deficient. In order to make sure that this teaching is thorough and effective the teacher receives as a bonus a fraction of the bonus earned by his workmen and in case all of his workmen earn bonuses, the teacher receives an extra bonus. It will readily be seen that with such a system of wage payment, thorough instruction and cooperation are the invariable order of the day, and that the foreman as well as the workmen are always on the lookout to see that the tools, machines and stock, are all in perfect condition.

Not only does the man receive adequate instructions, and a reward for obeying these instructions, but he is offered every reasonable facility for doing his work quickly and well. He does not have to spend his time hanging around the smithy or the toolroom getting the things that may be needed for his work. He spends no time repairing his machine, taking up the belts, or fixing the tools supplied to him. The management makes it its duty to see that nothing hinders him in his work so that his entire time and attention may be devoted to the performance of, and not to the preparation for, that work. This requires that certain assistants shall perform tasks which conventional management usually delegates to the workman himself.

Collecting Data Necessary for Scientific Management

It will be apparent from the foregoing, that instead of depending upon judgment, scientific management depends upon knowledge, in its task of administration. Judgment is the instinctive and subconscious association of impressions derived from previous experience. When a man's experiences are wide, his impressions of them are correct, and his memory is good, his judgment will be good. But even the best judgment falls far short of knowledge, and any system of administration based on judgment alone must fall short of scientific management. Judgment will always have its place in any system of administration for two reasons, firstly because knowledge cannot always be obtained, and secondly because it may sometimes cost more to obtain it than the knowledge is worth. In either case judgment is valuable, if not absolutely necessary. But at the best, judgment is only a guess and not to be relied upon if accurate information is available. Not only does scientific management depend upon knowledge, but this knowledge is carefully and systematically collected and the data so obtained are classified and digested until the knowledge is instantly available whenever a problem is presented to the management. Back of the form of organization is a knowledge of the needs and the work of the plant. Back of the plan of wage payment is a knowledge of psychology and sociology. Back of the instruction sheet is a knowledge of the sciences of cutting metals and of handling work. As examples of the way in which such knowledge is obtained, let us take the two subjects last mentioned, and see what scientific management has done to develop the sciences of cutting metals and of handling work.

Most readers of these articles are doubtless familiar with the paper of Mr. F. W. Taylor on the art of cutting metals, which was published in abstract in many of the technical magazines shortly after it was delivered, in 1906. The work described in this paper is probably the best example of the scientific study of methods of manufacture which has ever been made. Mr. Taylor and his associates at the Midvale and Bethlehem steel companies were engaged in the work for nearly twenty-six years, and during that time made many notable discoveries in the line of their work. One of the most important of these was the discovery of high-speed steel; which is, at a very conservative estimate, worth fifty million dollars per year to the machine industry of this country. Other no less important but less spectacular results were the discovery of the best forms for cutting tools, the invention of a slide-rule for the determination of proper cutting speeds, and the resulting developments in the form, rigidity, and power of machine tools.

In making this investigation suitable machines were prepared and after establishing certain standards in regard to the kind of material to be cut, the form and chemical composition of the cutting tools, and the length of time which the tools must run without regrinding, a very elaborate series of tests was made. The object of these tests was to determine the maximum permissible speed of cutting with different feeds, depths of cut, kinds of tool steel, forms of tools, classes of material, and conditions of work. There were in all twelve conditions affecting the cutting speed, each of which could be varied. Some of these could be varied over a very wide range, and every time one of the conditions was altered a large number of experiments was necessary in order to determine the permissible cutting speed. It is obvious that in such a complicated problem as this, thousands of experiments were necessary before it could be solved. As fast as experimental data were collected, the results were worked up in order to determine the mathematical laws governing the cutting of metals. Since these laws were found to be extremely complicated, and since, if the work was to be practical, quick and simple methods of solution had to be devised, a great deal of time and effort was spent in devising methods for determining the proper cutting speeds for any given conditions. Finally after many years of work, a slide-rule was invented which gave a quick and accurate solution of the problem.

This investigation was probably the most important investigation of the kind ever attempted. It was very thorough, requiring a period of twenty-six years for its completion. The total cost is stated to have been $800,000. The results, in which every metal working shop in the country has shared, are unquestionably worth one hundred million dollars a year. Hardly one manager out of one hundred, probably not one mechanic out of a thousand, realizes the immense value and scope of the improvements resulting from this investigation. They rank in importance with the development of the steam engine, the railroad and the printing press. There are equally great opportunities for a dozen, possible one hundred investigations of like character in other industries. It is to be hoped that they will be soon commenced and that they will be prosecuted with the same energy, tenacity and intelligence with which this investigation was so greatly marked.

Motion Study and Analysis

The method employed in determining the best way to handle work is known as "motion study." Motion study is almost a science in itself, and is really a branch of applied psychology. Motion study is not peculiar to scientific management, but has long been utilized by athletes in their endeavor to improve athletic records. A high jumper, for instance, will carefully train himself to do his work in a certain way, taking a certain number of steps in running up to the bar, throwing his limbs and body in a certain position as he jumps over the bar, and endeavoring in every way to develop that smoothness and machine-like precision of action which characterizes what he terms "form." The hurdler does the same thing, day after day making trial of different methods of running and jumping, timing himself by the stop watch, in order to achieve the most perfect form.

The same sort of study can be employed to advantage in training workmen to perform their tasks, when the tasks are repetitive in character. There is, however, one very great difference between motion study for the athlete and for the workman. Whereas the athlete strives to perform a task which taxes his strength and endurance to the limit, the workman strives to develop that form which will enable him to perform his task quickly and with a minimum of fatigue. In the case of the athlete, he is striving to excel for one supreme moment. The workman, on the other hand, must be

trained to repeat his task, day after day, month after month, year after year, without injury to his strength or his health, because only in that manner can the industry in which he is engaged reach its maximum prosperity. It takes a more carefully trained observer and a far better understanding of men and their physical capabilities to train a workman to do a task quickly and well without over-exertion, than it does to train an athlete to perform his task quickly and well, where the question of over-exertion does not come in.

Any one who has ever had anything to do with athletics understands how impossible it is for a man without training to compete with the trained athlete. Just as it would be impossible for the average healthy and vigorous man to enter an athletic contest and do creditable work in competition with trained athletes, so it is impossible for the average workman to go into a shop and accomplish a creditable amount of work, in competition with a workman who has been properly trained after a motion study has been made of his task. In the same way, just as it is impossible for the average man who likes to look at the stars, to predict the time of an eclipse or the future configuration of the heavens, so it is impossible for the average machinist to compete with the trained engineer who has at hand a slide-rule which will tell him exactly the cuts, feeds and speeds, which it is possible to employ with a given class of material and a given machine. We find it advisable to employ designing engineers who have spent years in studying the strength of materials and the sciences upon which engineering depends. It is equally advisable to employ another class of engineers who will study the principles of management, and methods of doing work.

So far we have only touched on two points in regard to the turning of our crankshaft, namely motion study and the science of cutting metals. There are a dozen other branches of science involved in the direction of the shop, all of which are used by scientific management in furthering administration. When we consider these things, it becomes apparent that in many industries the introduction of scientific management will completely revolutionize methods of work, methods of administration, and even methods of selling the product and of financing the industry.

It will be seen from what has just been said that scientific management is by no means a simple matter, that it requires forethought and care in its application, and that, above all things, it requires the scientific spirit in order to make it successful. It will also be apparent to every one, that while scientific management will very probably greatly increase the output per man or per machine, the staff which it requires for the planning of the work, for the conducting of experiments, and for keeping workmen supplied with material and tools, will be quite an expensive one. The question of whether or not scientific management is profitable, and therefore practicable, will hinge upon the question of whether the savings which scientific management will effect, will pay for the staff which it is necessary to maintain. In my opinion, the savings will usually be more than sufficient to pay for the extra cost of scientific management, although sometimes they will not. The application of all of the methods and machinery of scientific management to the pattern-shop, where every job is different and where the principal part of the work consists in planning rather than in executing, will not usually be a success. On the other hand, where scientific management is applied to repetitive work, there is no question but what the cost of maintaining the staff will be but a very small fraction of the savings which will result.

* * *

During the past year 29,353 applications for patents were filed in Great Britain. Of the foreign applications those from Germany and the United States were most numerous; 3304 applications were of German origin, while 2670 were received from residents of the United States. The United Kingdom, of course, contributed the largest number, or 19,579 applications. During the year, five applications were filed for the revocation of patents not worked to an adequate extent in the United Kingdom. Two of these applications were granted; in one case the application was dismissed; in one the patent expired during the proceedings; and the fifth case is pending.

A BALL RACE GAGE

The accompanying illustrations (Figs. 1 and 2) show a ball race gage, which is used in the works of the Cadillac Motor Car Co., Detroit, Mich., for gaging the diameter of the ball race in a ball retaining ring. Two of these rings form a thrust bearing to reduce the thrust on the main drive shaft of an automobile. As shown in Fig. 2, this gage consists of a cast-iron stand *A* in which a hardened and ground steel ring *B* is retained. The top portion of this ring is made a good fit for the inside diameter of the ball-retaining ring *C*, which when being gaged is simply slipped over the top portion of ring *B*. A stud *D* held to the base by a nut, as shown, is slotted to receive the gage frame *E*. Stud *D* is hardened and ground, and the plate *E* has a reinforced piece *F* held to it by rivets, the latter being hardened and ground and made a good fit in the slot in the stud. The fulcrum of the pointer or needle *G* is so disposed that any variation in the work is magnified twenty-five times at the point where the reading is taken. A knurled handle *H* is fastened to the gage for convenience in holding it.

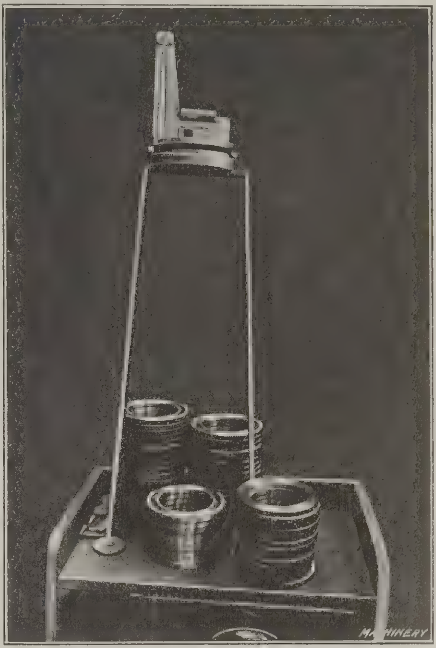


Fig. 1. Ball Race Gage in Use

In operation, the work is slipped over the ring *B* of the gage as shown in Fig. 2; then the gage frame *E* is placed in the slot in stud *D* and the gaging knife-edge rollers *I*, which in this case do not rotate but are held rigidly to the frame, are placed in the ball race. The position of the measuring point

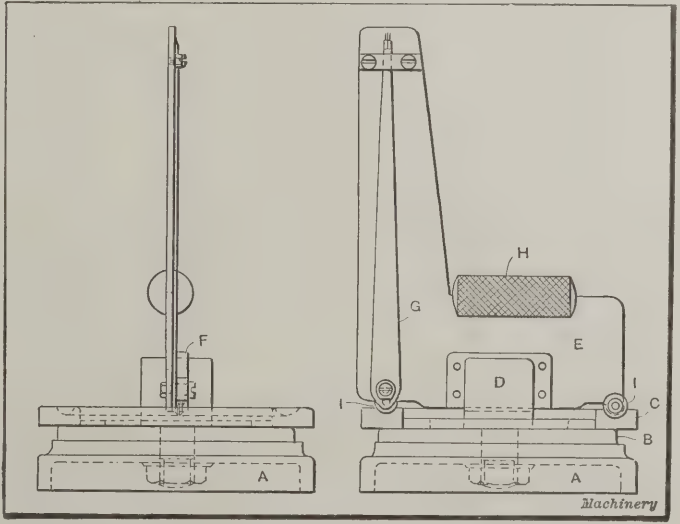


Fig. 2. Construction of the Ball Race Gage shown in Fig. 1

of the needle is then noted to see if the race is of the required diameter. A limit of 0.001 inch is allowed on the diameter of the ball race, the latter being 4.125 inches in diameter. The race is ground on a Brown & Sharpe generating grinder. As shown in Fig. 1, the base of the gage is fastened to a frame which is of sufficient height to bring the ring to be gaged in line with the operator's vision.

* * *

Bolts, cap-screws, or nuts, when used in connection with cored holes, should be supplied with washers for providing sufficient bearing surface for the nut or head.

THE EXTRUSION OF PLASTIC METALS*†

Although it had been found possible as early as 1850 to extrude such metals as lead and tin and thus form pipes and bars, the extrusion process had not, at that time, been successfully applied to the shaping, by means of extrusion, of such metals as copper, delta-metal, etc. It was when Alexander Dick, the inventor of the delta-metal, made some experiments with this material under high pressure and at high temperature, during the latter part of the eighties, that it was first shown that this material could be extruded in a heated state. There were, however, several difficulties to overcome. The extrusion process, as is well known, consists of hot plastic metal being pressed through a form or die at high pressure, so that a continuous bar or pipe of the cross-section of the die or form is produced. Lead and tin can be extruded at comparatively low temperatures (250 degrees F.), but copper and similar metals require temperatures all the way up to 1750 or 1800 degrees F.

The main difficulties to be overcome are to maintain the high temperature and plasticity of the metals during the extrusion, and to make press cylinders and dies which will be able to withstand the effect of the high temperatures and pressures. The first condition was met by Dick by filling

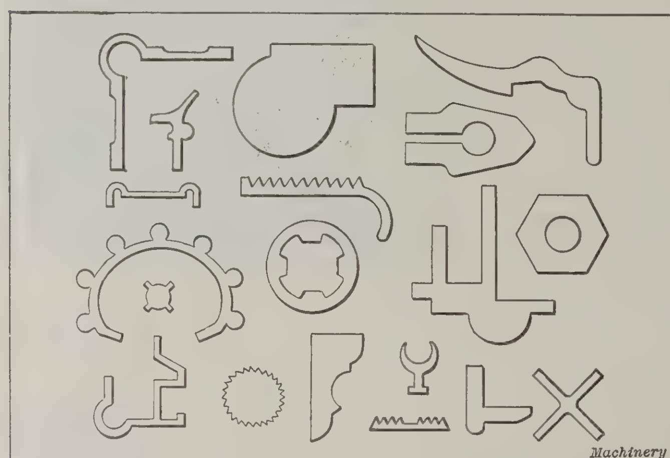


Fig. 1. Some Interesting German Products of the Extrusion Press

the press cylinder with molten metal and by surrounding it with heat insulating material, such as ground granite. In order to prevent the heated metal from forcing itself between the plunger and the cylinder, when the pressure was applied, a spherical steel piston was employed which spread when the pressure was applied, and in this way effectively closed the cylinder behind the metal.

The advantages of the extrusion process, as compared with the ordinary rolling and drawing process, soon became apparent. The extrusion process permitted parts of unusual cross-section to be produced in great quantities. In fact, sections could be extruded which could not be rolled under any circumstances. In Fig. 1 is shown a number of special sections which have been produced by extrusion. On account of the high pressure under which the metal is extruded it becomes more compact and its strength is increased. The extruded shapes, therefore, possess those qualities which make them especially useful in machine design. The surfaces are smooth, and free from flaws and other defects. The dimensions of the extruded shapes can be gaged with great accuracy, so that they may be used either directly or with very little additional finishing. After the advantages of the new method had become known, it was soon adopted and further developed by many different individuals and concerns.

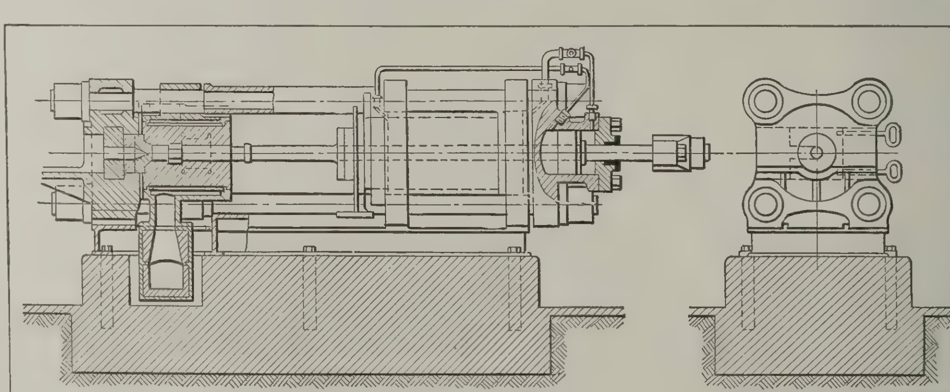


Fig. 3. General Arrangement of Krupp Extrusion Press

Instead of pouring the molten metal into the press cylinder, it was found to be better to have it cast into blocks which were heated to a white heat and inserted in the press. In this way the time required for the setting of the metal in the press cylinder was saved, and the efficiency of the machine considerably increased. Further developments resulted in the perfecting of the press, and the metals used for the cylinders

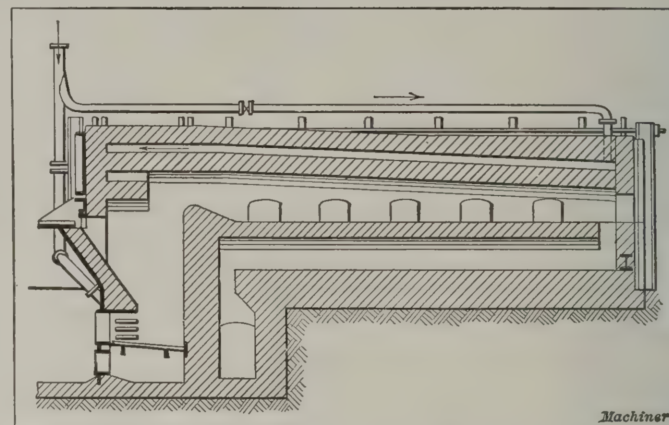


Fig. 2. Section through the Heating Furnace

and the dies. In order to retain the heat within the cylinder it was surrounded by a jacket and heated by special means. Several new presses were brought out, and besides the Dick press, those best known in Germany were built by the firm of Friedr. Krupp A.G., Grusonwerk in Magdeburg-Buckau. The object of this article is to describe the methods and processes used in connection with the machine. The complete installation consists of a foundry for producing the metal blocks, a heating furnace, and a hydraulic press and pumping arrangement.

The Casting of the Metal Blocks

The metal blocks are cast in long sections and are afterwards cut up into pieces of suitable size for the presses. The blocks are cast in permanent molds, and in order that as smooth a surface as possible may be obtained, it is necessary that the inside of the mold be of a close-grained metal, free from flaws. In order to still further insure against blow-holes or porous parts in the cast blocks, the molds are covered on the inside with a preparation, the same as is done in the casting of copper and brass in general.

After the blocks are cast and cut into parts, they are inspected for defects, and any burrs or fins that may be present are removed by chisels or scraping. Special care must be used in producing hollow parts for pipe. In this case, it is especially important that the core be central with the outside, in order that homogeneous walls of uniform thickness may be obtained in the extruded pipe.

Heating the Metal Blocks

The metal blocks are heated in a special furnace which should be placed close to the extrusion press. The important feature about the heating is that the block must be heated clear through to the center, and not be brought to the press when merely the surface has been brought to the required temperature. A furnace used for heating the blocks is illustrated in Fig. 2. The blocks are inserted at the end opposite

* Abstract from an article by Friedr. W. Siepke, of Magdeburg, Germany, in *Werkstattstechnik*, April 15, 1912.
† See also "An Experiment in Extrusion," MACHINERY, June, 1912, engineering edition, and other articles there referred to.

the grate, and roll by gravity down the somewhat inclined surface toward the fire-box. When the required temperature is obtained, they are pulled out through an opening at the side. In order that good results may be obtained in the extrusion process, it is important that the blocks do not come in contact with the brickwork of the furnace. The surface on which the blocks rest is, therefore, covered with a cast-iron plate. The length of the furnace is made to suit the capacity and speed of the action of the press. The width is usually made about three feet. The heated blocks are most conveniently transferred from the furnace to the press by means of an overhead trolley.

The Hydraulic Extrusion Press

The hydraulic extrusion press shown in Fig. 3 is of the horizontal type. The press consists mainly of the hydraulic cylinder, the dies, the pressure chamber or extrusion cylinder, and a head which holds the dies. Four heavy connecting bars tie this head to the hydraulic cylinder. The pressure chamber is located between the head and the hydraulic cylinder and moves on four guide bars.

These presses are built in two sizes, the main dimensions of which are given in Table I. The output of the presses varies according to the size and form of the cross-section of the different extruded shapes. With trained operators and simple cross-sectional shapes, it is possible to extrude about 20,000 pounds of metal in ten hours in the small-size press and 35,000 pounds in the larger press. This output cannot be obtained, however, when tubing of difficult sections is being extruded. The figures given above correspond to two hundred press operations in ten hours. In order to be able to maintain this efficiency the press chamber must be sufficiently heated at the beginning of the work and there must be no interruption in the operation. For the complete installation required for one press, four men are necessary, one of whom works at the furnace.

Details of the Hydraulic Press

The hydraulic cylinder is made of steel casting and lined on the inside with a copper bushing. The pressure chamber is made of so-called "Krupp special" steel which even when heated has a high tensional strength. This chamber or cylinder is forged and is provided with a jacket of steel casting. Between the pressure chamber and jacket an open space is provided through which the heated gases from the fire-place arranged beneath the pressure chamber can pass. By this means the chamber is heated to the required temperature, the gases from the combustion escaping through a pipe

TABLE I. GENERAL DIMENSIONS OF EXTRUSION PRESSES

Dimensions	Smaller Size	Larger Size
Total pressure, pounds	1,430,000	2,200,000
Maximum pressure, pounds per sq. in.	3770	4125
Diam. of hydraulic cyl., inches	22	26
Stroke, inches	$27\frac{1}{2}$	$31\frac{1}{2}$
Diam. of extrusion cyl., inches	$4\frac{5}{8}$	$5\frac{1}{2}$
Max. diam. of extruded bars, inches	2	$2\frac{1}{4}$
Required horsepower	100–150	175–225

above the pressure chamber into the chimney. The required temperature to which the pressure chamber should be heated by external means is about 600 degrees F. This heat is required so that the metal blocks which are heated to some 1650 or 1800 degrees F. may not be suddenly cooled. Should sudden cooling take place, the surface of the metal block may lose its plasticity and the extrusion may either be unduly delayed or be made entirely impossible. The high temperature of the walls of the pressure chamber, while the extrusion takes place, requires an especially high quality of metal, and it has been proved in a number of instances that forged Krupp special steel answers the requirements better than any other known material.

In order to prevent too high a pressure in the hydraulic cylinder, a safety valve is provided on the pump which opens at a pressure of about 4500 pounds per square inch. In order to instantly relieve the pressure in the hydraulic cylinder, a releasing valve is inserted between the pump and the controlling valve on the machine.

The dies containing the shape for the extruded form are held in the head. This latter takes the pressure during the extrusion process. One of the greatest difficulties in the past with machines of this type has been to remove the remainder of the metal block in the pressure chamber when operations are suspended or when practically all the metal has been extruded. Part of the metal would usually be pressed in between the joints, solidify and make the removal of the various parts difficult. In the Krupp press this difficulty is taken care of as follows: As already mentioned the pressure chamber is placed between the head and the hydraulic cylinder, but is movable on four guide rods. A tapered hole is provided in the pressure chamber in the end towards the head, and the dies are formed with a corresponding taper. An auxiliary hydraulic cylinder is provided at the right-hand end of the press in Fig. 3, and the pressure chamber is connected with

TABLE II. INFLUENCE OF THE EXTRUSION PROCESS ON THE PROPERTIES OF METALS

Metal	Cast		Extruded	
	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent
Copper	28,500	35	34,000	38–40
Zinc	27,000*	12	35,000	38
Magnalium	43,000–64,000	5	53,000–71,000	10
Aluminum	14,000–17,000	3	33,000–38,000	4.3
Delta-metal	83,000	11	98,000	21.8
Durana-metal	58,000–74,000	35	60,000–81,000	38

[* The tensile strength of cast zinc is given by several authorities at about 3500 pounds per square inch, and that of rolled zinc at about 16,000 pounds. The strength of cast zinc given in the table is 70 per cent greater than for rolled zinc, which seems to be a very high and doubtful value.—EDITOR.]

the piston of the auxiliary cylinder by means of a cross-head and two connecting-rods. By this means the pressure chamber can be operated. Before the beginning of the extrusion, the pressure chamber is forced against the die by means of this auxiliary cylinder, and due to the tapered hole and the tapered end of the die a very close-fitting joint is provided, so that the metal, during the extrusion process, cannot enter between the two surfaces. At the end of the extrusion, the auxiliary cylinder operates the pressure chamber in the opposite direction, thus opening up a space between the die and the pressure chamber and making it possible to easily remove the remaining metal from the top of the die.

The press can be operated with considerable rapidity. For simple shapes, it is possible to go through the complete cycle of operations for one metal block in three minutes, this time being divided as follows: Putting the metal block into the pressure chamber, 1 minute 25 seconds; extrusion, 50 seconds; opening up the space between the pressure chamber and die, 10 seconds; removing the remaining metal, 15 seconds; and returning to the original position, 20 seconds. The effect of the extrusion process on the tensile strength of various metals is indicated by Table II.

* * *

Franklin H. Wentworth, secretary of the National Fire Protection Association, stated at the meeting of the New England Foundrymen's Association, April 10, that out of more than 11,000 fires under automatic sprinklers, of which the association had records during the past fifteen years, there was not a single instance where the automatic sprinkler, when of standard approved make and installation, had failed to put out or hold in check a fire under it, except in cases where the system had been tampered with, or crippled by an explosion.

* * *

Undoubtedly many (accident) prevention appliances in use in Germany might well be adopted here, but the real and important difference is not in the prevention apparatus—it is in the prevention spirit. In Europe, and especially in Germany, accident prevention is kept constantly before the public, before the legislatures, before the employers, and before the workers.—*F. C. Schwedtman in "Accident Prevention and Relief."*

DETAILING CRANE GIRDERS WITH CURVED LOWER CHORDS*†

By CHARLES B. GILBERT‡

The detailing of crane girders with curved lower chords—that is, of the fish-belly type—sometimes involves considerable labor. The tables given in the accompanying Data Sheet Supplement were, therefore, compiled by the writer about three years ago, and have been used by the structural detailers of the Niles Crane Works, of Philadelphia, Pa. The tables have been carefully checked and have been in use so long that it is assumed that all errors have been eliminated. The tables have proved of great value as time savers when figuring the depth of curved girders, half the span being divided, for convenience, into five or ten equal spaces for spans of different lengths. A glance at the accompanying engraving Fig. 1, will explain the use of the tables, a crane girder having a span of 61 feet 3 inches having been assumed as an example. The curved part has a span of 60 feet; one-half of this distance, or 30 feet, is divided for the convenience of the templet makers into ten spaces of 3 feet each. The end ordinate, assumed here to be 1 foot, will be found at the extreme left of the tables under the heading *H*. The lengths of the remaining nine ordinates follow in order.

For short spans, say about 30 feet, it is most convenient to divide the base of the curve into five spaces, as it is the usual practice to give ordinates about every 3 feet. In this case we would use only every other ordinate in the tables, or, beginning with the left-hand column, the ordinates would be as found in the columns headed *H*, 8, 6, 4, and 2.

The construction of the parabolic curve, while familiar to every student of geometry, may be of interest in this connection. In Fig. 2, divide the base *BO* and the height *H* into the same number of equal parts (ten in the illustration); draw straight lines from *O* to points 1, 2, 3, etc., on line *AB;* then draw vertical lines from points 1, 2, 3, etc., on line *BO*. The points of intersection between the lines 1 and 1, 2 and 2, etc., are points on the curve of the parabola. When the curve is slight, as is frequently the case in plain girder design, it is sufficient, on the drawing, to join the points by straight lines.

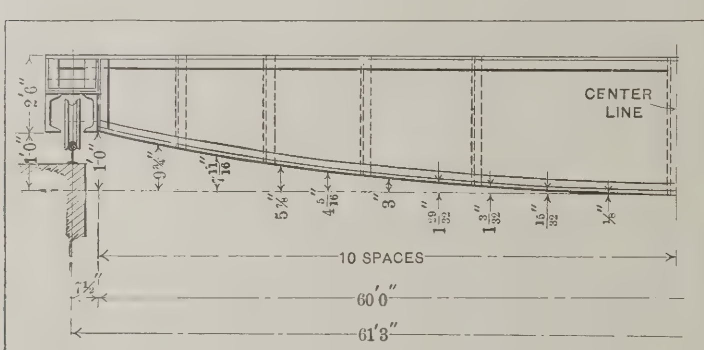


Fig. 1. General Lay-out of Typical Crane Girder

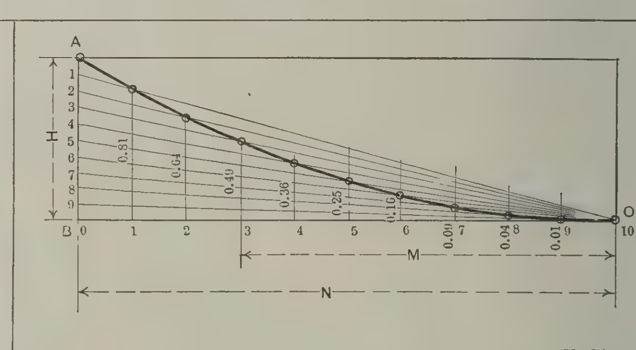


Fig. 2. Lay-out of Parabolic Curve, and Method of Calculating Tables

The tables in the Data Sheet Supplement are calculated as follows. In Fig. 2, let

H = end ordinate,
X = required ordinate,
N = number of equal spaces into which base *BO* is divided,
M = number of spaces from *O* to required ordinate.

Then,

$$X = H \times \frac{M^2}{N^2}$$

When $N = 10$, as in the case for which the tables are calculated, $N^2 = 100$, and

$$X = H \times 0.01\, M^2$$

Hence, ordinate No. 2 equals $H \times 0.01 \times 64 = 0.64\,H$. Ordinate No. 6 equals $H \times 0.01 \times 16 = 0.16\,H$, and so forth.

* With Data Sheet Supplement.
† See also MACHINERY, January, 1912, engineering edition, "Points in Crane Construction and Design," and the articles there referred to.
‡ Address: 1809 N. 16th St., Philadelphia, Pa.

MAKING THE "UNIVERSAL" HACK-SAW BLADE

By CHESTER L. LUCAS*

The steel from which hack-saw blades are made is almost invariably a special grade of crucible steel, each maker having a preference for his own particular brand, the content of which he considers best for hack-saw blades. In making the "Universal" hack-saw blade at the West Haven Mfg. Co., New Haven, Conn., the steel comes to the factory in large sheets, and the first operation consists in cutting these sheets to smaller sections, each of which is wide enough to be cut

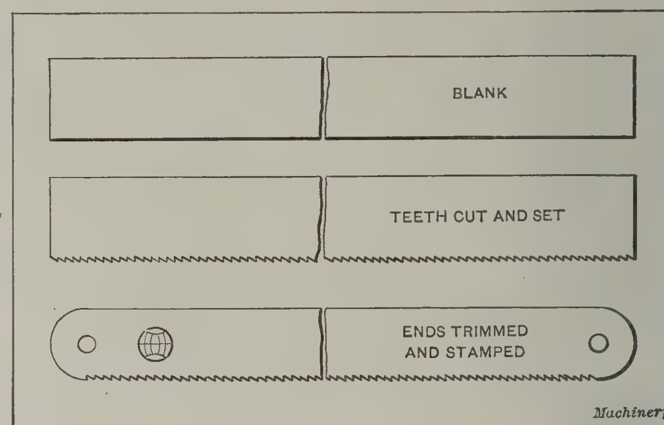


Fig. 1. Order of Operations in Hack-saw Blade Making

into blades of standard lengths, eight, ten or twelve inches. These sections are then cut into blanks for the individual saw-blades. The thickness of the stock and the width of the blank vary, of course, with the different lengths of blades being made. All of this cutting is done on square shears and it is essential that the shear-blades be kept in excellent condition so that the edges of the blanks will be square and free from burrs.

Cutting the Teeth

The blanks for the hack-saw blades are now in the condition shown in the upper view of Fig. 1, being merely blocked to size. Next in order comes the operation of cutting the teeth. Among hack-saw blades makers there are two distinct methods of cutting the teeth; by punching and by milling. The milled tooth is superior to the punched tooth, because milling leaves the sides and faces of the teeth perfectly sharp, while punching rounds one side of the tooth, thus impairing its cutting qualities.

Fig. 2 shows the operation of milling the teeth of "Universal" hack-saw blades. The work is done in plain milling machines, fitted with special vises for holding the thin blades, having "hold-downs" for the front jaws. The vise on the machine shown at the right is but partly filled with blanks, while the one at the left is completely full, and a cut is being taken across the work. The mirror-like appearance of the work is caused by the flooding of the oil over the work. The gang cutters used are made of high-speed steel, and it requires twelve or fourteen of them to make up the width necessary for the average cut. It will be noticed that in

* Associate Editor of MACHINERY.

mounting the cutters on the arbor, they are set one a little ahead of the preceding one, thus effecting a helical arrangement of the faces, the object being to distribute the cut.

These cutters are, of course, made for milling the various sizes of teeth. The number of teeth per inch varies from 14 to 32. Blades intended for cutting solids in iron and steel

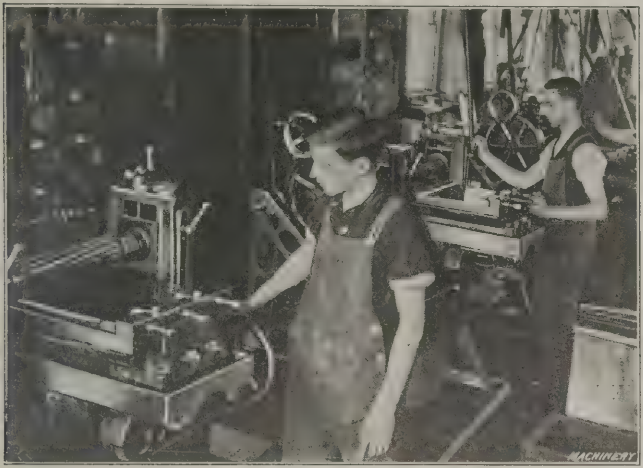


Fig. 2. Milling the Teeth

are usually cut with from 14 to 16 teeth; for general all-around work it is considered advisable to use 20 teeth. For soft brass, 24 teeth has been found better than a smaller number per inch, because there is less tendency to "hog in" and for thin tubing and sheet metal 32 teeth per inch is very satisfactory.

Setting the Teeth

The semi-completed hack-saw blade now appears as shown in the middle view of Fig. 1, and in this condition is ready

Fig. 3. Setting the Teeth

for the setting operation. There are two recognized methods of setting the teeth of hack-saw blades: one is by flat dies having a reciprocating motion, and the other, by rolls having a rotary motion. The machine shown in Fig. 3 is of the rotary type, and as the blades pass between the rolls, projections press the teeth alternately slightly upward and downward, thus giving the teeth the required "set." From the setting machines, the blades are passed to presses that clip the ends, punch the holes, and imprint the trademark upon one end. One of these presses may be seen in the foreground of Fig. 4, and in the background of the same illustration may be seen a battery of the milling machines that cut the teeth.

Hardening and Tempering

The hardening department of the West Haven Mfg Co. is located in a brick addition to the main factory and is exceptionally light and roomy for a department of this kind. The blades are treated by a special process that leaves them as hard as glass, and of extremely uniform hardness throughout.

In order to give them the required toughness, the blades are next tempered by immersing them in hot oil. Previous to this, however, they are packed loosely in an iron frame, similar to the vise used in milling the teeth. This frame has set-screws for applying pressure to the blades, against both the sides and edges. After placing the blades in the frame, and immersing frame and blades in the oil, they are allowed to remain there until the mass of blades has been brought to the temperature of the oil. After this, the screws of the frame are tightened upon the blades, thus bringing any that are bent or warped back into shape. It should be

Fig. 4. Milling and Punching Operations

remembered that this is done while the blades are very hot and still dripping with oil, in which condition they yield readily to the pressure from the clamping screws. The hack-saw blades are allowed to remain in the frame until they are cold, at which time those that were warped will have regained their original straight condition.

In order to reduce the brittleness of the pierced ends of the blades, the ends are dipped into a pot of molten lead. The lead in the pot is of the right depth so that when the bottom is touched, the ends of the blades will be immersed to the right distance. After this operation, the blades are cleaned and brushed free from scale and dirt, at which time they are ready for inspecting and packing.

Inspecting and Packing

Fig. 6 gives a general idea of the way in which "Universal" hack-saw blades are inspected and packed. The in-

Fig. 5. The Testing Room

spectors sit at well-lighted benches and successively try each saw for temper, at the same time inspecting them for poorly cut teeth and for soft spots that may be present. They are then wrapped in packages of twelve each, labeled and boxed for shipment.

From time to time, blades are selected at random from the different lots and tested for cutting qualities, after the manner shown in Fig. 5. They are tested for duration, for speed in cutting and for performances on various hard metals. The

Fig. 6. Inspecting and Packing

results of these tests are carefully recorded and thus the high standard aimed at in making "Universal" hack-saw blades is maintained.

* * *

INDUSTRIAL ADVANTAGES OF THE UNITED STATES

In the United States—a young, growing country—there has been, and still is, an unlimited demand for more highly developed industries. New manufacturing establishments are constantly under construction, and are usually equipped in the most modern manner. In Europe it is, with few exceptions, merely a case of remodeling old establishments. It is very easily understood that an old remodeled factory can never come up to the same standard or offer the same possibilities for manufacturing, as an establishment which from the beginning is planned after modern ideas. The familiarity with old established ways also tends to make difficult departing from old ideas and moving into new fields. The expense account is also a very important factor and should not be overlooked. Whereas a new shop will cost almost as much with an equipment partly copied after old ideas, as it would equipped in the most modern way, the old shop, modernized to the same extent, would have to stand the expense not only of the modern equipment, but of the old superseded one also. New buildings would in most cases have to precede the new equipment, as the facilities offered by old buildings are often so inferior as to make only half a success of the new departure.

The extent and population of the country makes the home market offered in the United States very large, as compared with the market available to the manufacturer in an average European country. This, in turn, makes possible a greater sub-division of labor. Even the smallest article can be manufactured on a large scale without looking for a market outside of the boundaries of the home country. In Europe, on the other hand, most firms of any importance have been, at least until a very recent date, compelled to go into a number of different lines of manufacture, as each line alone has an insufficient market to make the business pay the desired returns. This is a consideration of more than ordinary importance. Not only can an establishment manufacturing one article or one line of articles, secure a greater prestige in this certain line, and enable its responsible heads to gain a much greater experience in the particular line of work they have to direct, but a systematic arrangement of the work can be established, which is not possible in an establishment manufacturing many varied articles. This sub-division of labor, in the whole industrial field, as well as in the individual shops, has been the great cause of the systematic organization peculiar to American factories. This systematic arrangement, again, has made it possible for American shops to turn out, with the same number of men, a much greater amount of work in a given time than is usually turned out by the average European shop.—*From an address by Mr. A. L. Valentine, of Hartford, Conn., before the American Society of Swedish Engineers, Brooklyn, N. Y.*

* * *

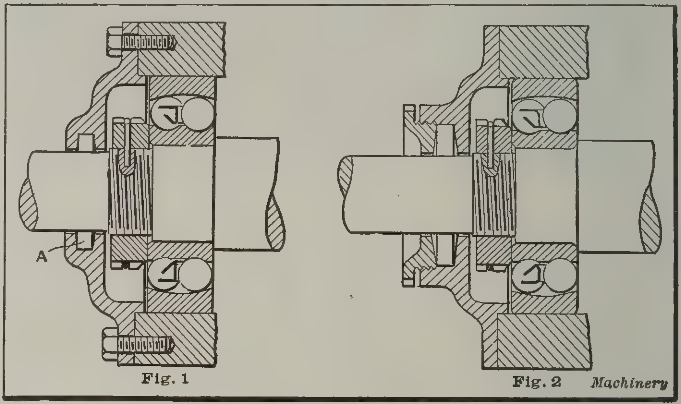
There is a distinction that makes a big difference between a smooth cutting file and a slick one.

THE MOUNTING OF BALL BEARINGS*

By F. H. POOR†

The method used for housing a ball bearing depends largely upon the nature of the machine to which the bearing is applied and the load and speed under which it is operated. One essential should always be kept in mind—ball bearings should in every case be kept clean, in order to give the best service. The selection of bearing caps for any given machine, therefore resolves itself practically into providing for sufficient protection of the bearings against grit or liquids which may be injurious to the bearing, and preventing the escape of the lubricant. The forms of end caps illustrated in the accompanying engravings have been designed for use in connection with the S. K. F. radial ball bearings and have been found satisfactory for general application.

The use of a single groove at *A*, as shown in Fig. 1, is generally sufficient. The grooves are cored to a depth of not less



Figs. 1 and 2. Cap Designs for Ball Bearings with Single Groove

than 3/8 inch and the edges of the lips are bored approximately 1/64 inch larger than the shaft. The width of the grooves and the lips must be determined with a view of providing sufficient strength and protection against abuse when installed. The use of a second groove in the end cap, as shown in Fig. 3, and sometimes a third groove, is recommended where machines are subjected to a great deal of dust, fine grit, moisture, etc. In this case it is customary to pack the outer groove with a felt washer or with a heavy grease, which will provide a frictionless packing. The groove for the felt

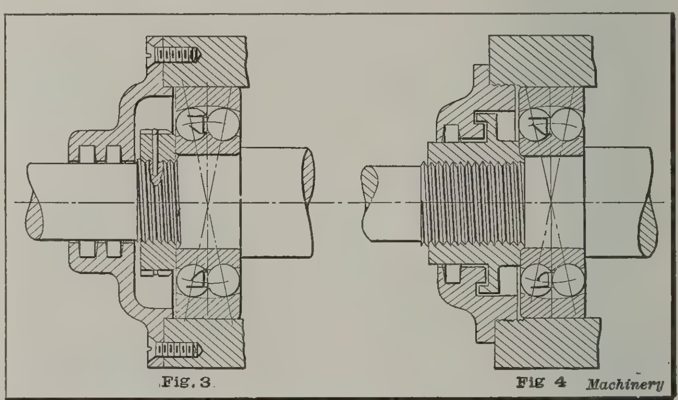


Fig. 3. Cap with Two Grooves. Fig. 4. Cap Design used where Bearing is exposed to Fine Dust

should be machine-finished. The groove adjacent to the bearing may be drained at the bottom to more effectually provide against leakage of the bearing lubricant. The return drain serves to keep the lubricant in circulation behind the sealing groove.

Caps of the type shown in Fig. 4 are too expensive to be considered except for extreme conditions, such as are found in high-speed grinders, cement machinery, etc., where protection against exceedingly fine dust is of importance. Fig. 2 shows a type of end cap, providing for a felt washer only, but

* For further information on ball bearings, see the following articles previously published in MACHINERY: "Some Notes on Ball Bearings," May, 1909, engineering edition, and also the articles there referred to. See also MACHINERY'S Reference Book No. 56, "Ball Bearings."

† Address: Care of SKF Ball Bearing Co., 50 Church St., New York.

having a tightening device to insure a tight fit of the washer on the shaft. This arrangement is applicable to low-speed bearings and is frequently used in automobile transmissions. In Fig. 5 is shown a plain end cap. Numerous means are used for securing the caps to the housings, and also for locking the retaining nut for the inner races. The G-shaped wire shown applied in the engravings, however, is generally considered the simplest form of locking device.

The fitting of bearings to shafts seldom presents any great difficulties. Inasmuch as the bearings are ground to very

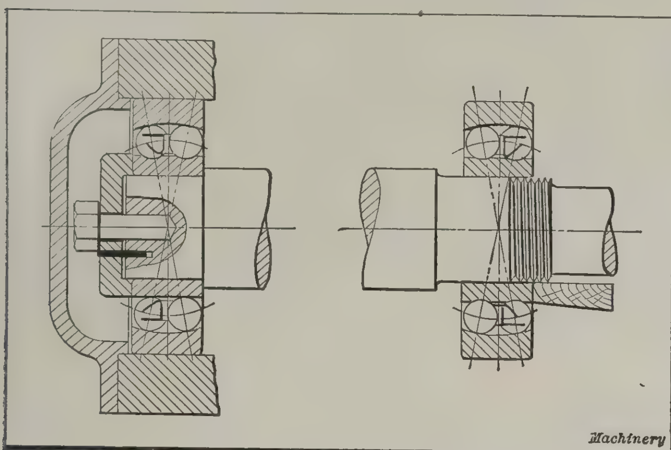


Fig. 5. Plain End Cap. Fig. 6. Using a Piece of Wood to drive Bearing into Place

close limits, the shafts to which they are to be fitted should also be accurately finished to present a smooth uniform seat for the bearing. The inner race should be a tight fit on the shaft and should be permanently seated in a fixed position against a shoulder on the shaft by means of a lock-nut or a distance piece. A driving fit alone should not be depended upon to properly retain the inner race in position, as the continued action of the load on the bearing will tend to peen down the shaft. A positive means for holding the inner race in position prevents creeping on the shaft and materially increases the actual bearing length on the shaft.

In order to obtain a proper light drive fit on the shaft, this should be finished slightly larger than the bore of the bearing, preferably within a maximum limit of 0.001 inch and a minimum limit of 0.0004 inch above the actual size of the hole in the bearing. If the shaft is made smaller, the bearing race will tend to creep and cut into the shaft, and if larger limits than indicated above are allowed, too great a force will be required to properly seat the bearing, with the added danger of cracking the inner race. It is easy to drive the race in place by heating it in oil to about 170 degrees F.

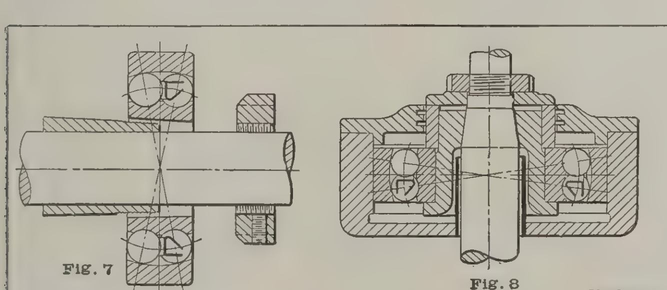


Fig. 7. Adapter Type of Bearing. Fig. 8. Method for Retaining Lubricant in Vertical Bearing Shaft

and driving it into position by light blows of a soft metal hammer. A piece of copper tubing, or a piece of wood in conjunction with an ordinary hammer can also be used for the same purpose, as indicated in Fig. 6. The outer race must under no circumstances be given a blow when fitting the bearing onto the shaft.

The outer race should have a very close sliding fit, but should never be securely fixed in the housing. A slow creeping of the race should at all times be possible under the vibration of the load. This slow intermittent creeping insures a proper distribution of the load over the whole surface of the outer race. Even when it is desired to prevent end motion of the shaft, a slight clearance of 0.010 inch should be provided on each side. Without this lateral clearance—*i. e.*, if the race is securely fixed in the housing—the load will always bear on one position in the race. When there are several radial bearings on the same shaft, one bearing only should be used to hold the shaft against end motion; the outer races of the other bearings should be free to locate themselves.

In cases where it is impossible to make the inner ball race a driving fit on the shaft or to secure it by means of a lock-nut or distance piece, the adapter type of bearing shown in Fig. 7 should be used. This bearing is provided with a conical split sleeve and lock-nut which clamps the bearing on the shaft in any desired position.

The shaft and housing should be turned as true as possible to insure concentric running of the races, and in case split housings are found desirable, great care should be taken to see that the housing sections do not bind the outer races and distort them. The application of radial bearings to vertical shafts occasionally makes lubrication difficult. A practical method of meeting these conditions—as they are sometimes to be found in the upper bearings of sugar centrifugals, vacuum cleaners, side cutters on wood planers, vertical pumps, etc.—is shown in Fig. 8, the retention of the lubricant being amply provided for by the tubular cup between the shaft and the seat for the inner race. This mounting is also made in a modified form with a lock-nut below the bearing, in which case the upper face of the inner race is held against a shoulder on the bearing support.

When it is necessary to use a thrust bearing to take the weight of a vertical shaft, a combination of radial and thrust bearings, as shown in Fig. 9, provides an ideal method of

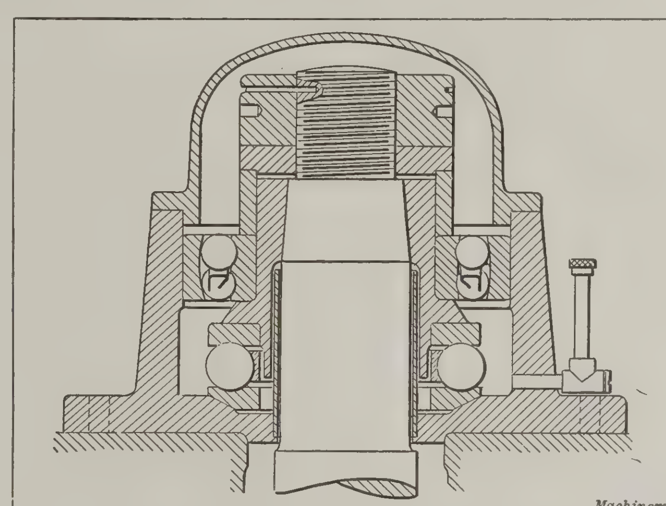


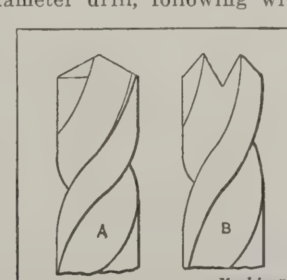
Fig. 9. Combined Radial and Thrust Bearing

mounting. The center of the radial bearing coincides here with the center of the spherical surface of the thrust disk. This provides a combination which is self-aligning about one point.

* * *

THE DRILLING OF MARBLE OR SLATE SLABS

Anyone who has had to drill marble or slate knows of the difficulties met with. Frequently holes are produced by drilling through with a small diameter drill, following with one of the full diameter of the hole required. A better method, says the *Practical Engineer* (London), is to mark out the center of the hole required and start it with an ordinary ¼ inch twist drill, as shown at *A* in the accompanying illustration, replacing this tool by a special tool, as shown at *B* (of the same diameter as that at *A*), as soon as the cavity is deep enough to permit of changing with safety. Then, to obtain the full diameter hole, a drill of the full size required is used as before. This method is more rapid than to drill a small hole right through the marble by an ordinary twist drill.



Drills for Marble or Slate

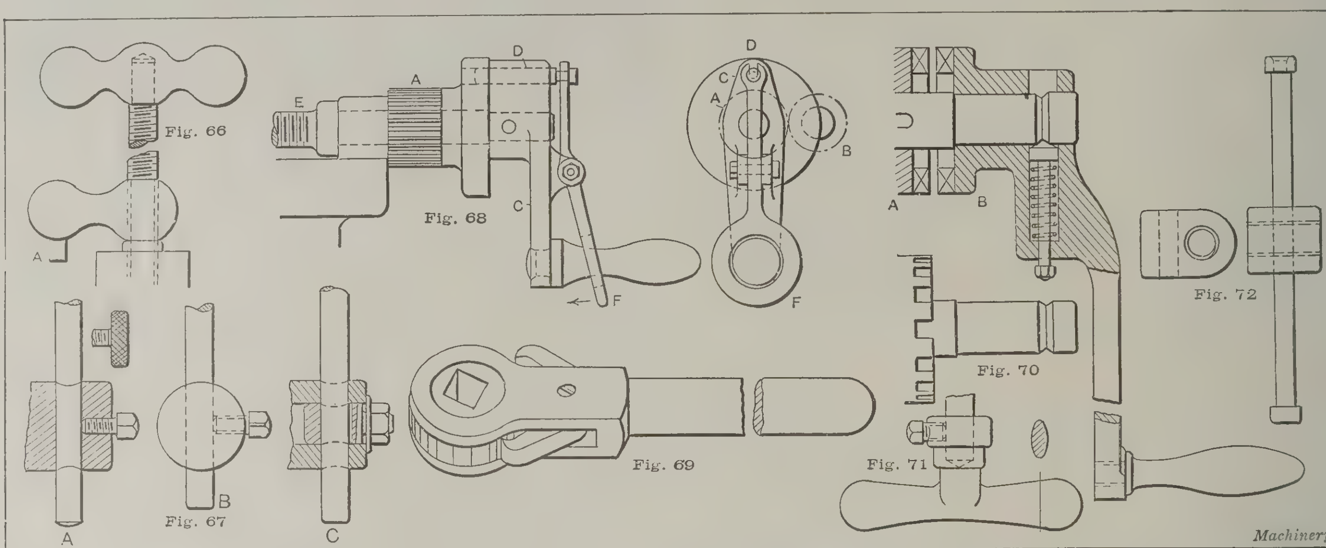
MACHINE HANDLES—2

A STUDY OF THE VARIOUS TYPES OF HANDLES AND HANDWHEELS USED ON MACHINE TOOLS

By FRED HORNER*

The handles and handwheels illustrated and described in the previous installment of this article were, in general, of a simple nature. In the present installment some of the handles and mechanisms described will be of a more complicated nature, including combinations of handles, handwheels, ratchets, indexes, and other similar mechanisms.

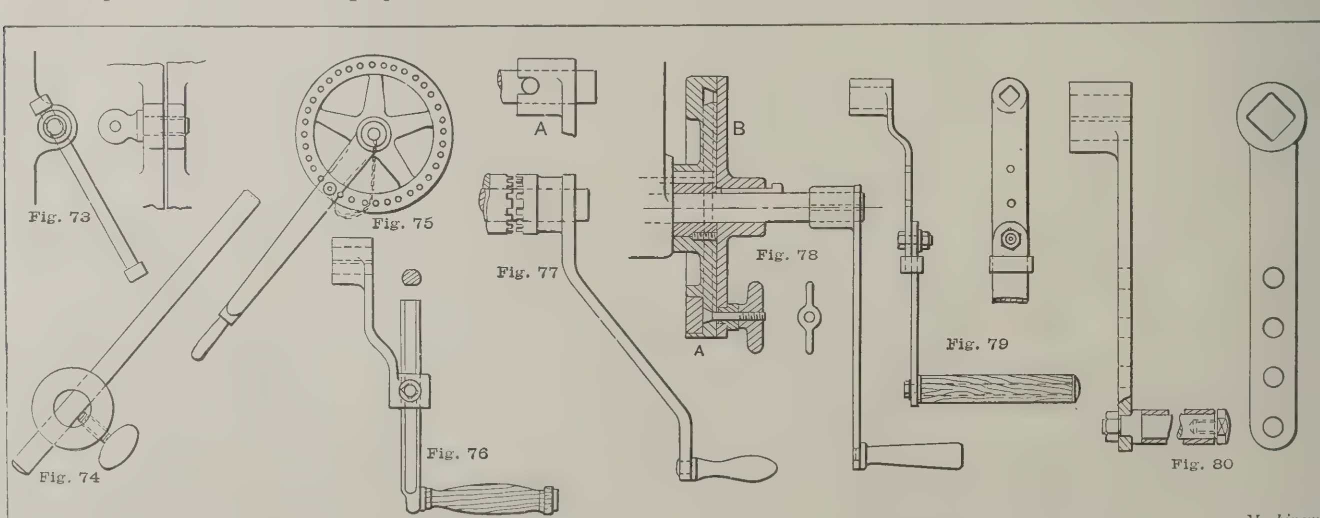
on the boss or hub of the handle and on the sleeve of the spindle, as shown in Fig. 77, thus permitting of disengagement when desired. Ratchet teeth are occasionally required. As an alternative design, a pin may be driven through the spindle and the hub of the handle may be provided with slots on either side as shown in the detail view at *A* in Fig. 77. Often the handle is kept out of engagement by a weak spring. A washer may be held on the end of the spindle by a set-screw to prevent the handle from falling off, while, in other instances, the washer is omitted in order that the handle may be slipped off and placed on another



Figs. 66 to 72. Types of Handles used in Machine Tool Construction

In Fig. 66 is shown an example of a handle combining the double and single types, one being used for adjusting the raising screw and the other for locking it. The latter has a small pin *A* which catches against the bearing cap and prevents the handle from swinging into contact with the revolving spur gears on the other side of the cap. A handle attached to the end of a spindle for operating a belt-shifting mechanism for a small countershaft, is shown in Fig. 71. This handle is made of cast iron.

In a few instances, it is not desirable or may be impracticable to permit the handle to project out on one side or adjacent screw or spindle. An example of this type of handle is shown in Fig. 70, where two screws or spindles on a boring mill are shown placed close together, and one handle serves for both. The clutch arrangement, in this case, differs somewhat from the ordinary type. The clutch *A* is double-ended, one end only being shown in the engraving, and slides along a feather key on the spindle. When moved to the left it engages with a power-driven clutch gear, but when moved to the right it meshes with the teeth of handle *B*, and the turning of the latter rotates the spindle when an adjustment is desired. The spring plunger in the handle engages with



Figs. 73 to 80. Types of Handles used in Machine Tool Construction

the other of its boss. In such a case, a sliding handle of the type shown in Fig. 73 is used; the same kind of handle, passing through a nut on one side of the threaded hole, is shown in Fig. 72. This example is taken from a brass finisher's lathe and is used for tightening the screw of the hand-rest underneath the bed.

Handles provided with clutches, apart from the friction devices already described in the previous installment, are sometimes required to prevent their being operated when the power feed is in and the shaft is rotating. Teeth are cut

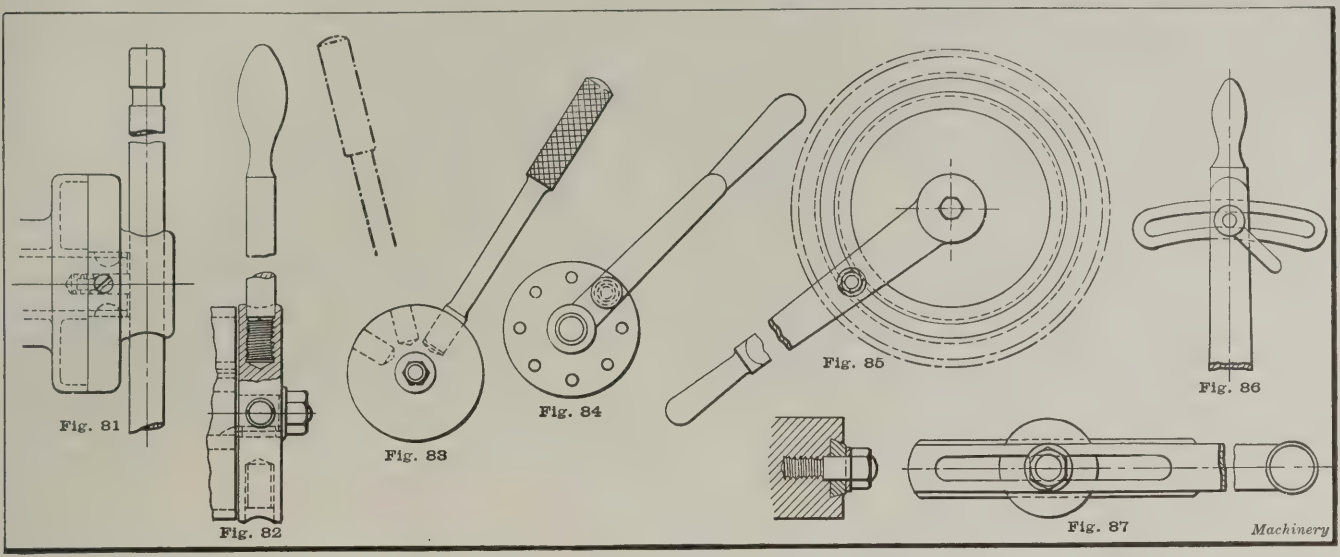
the V-groove in the spindle and prevents the handle from falling off endwise. The spring, however, is not strong enough to prevent the pulling off of the handle when it is desired to remove it.

Pilot or star handles, of the types shown in the previous installment, are generally so designed that they can be disconnected so that when the power feed is in action the star handle does not rotate. Some form of friction clutch is usually provided, or a spring plunger is fitted to the hub of the star wheel handle, the plunger passing through into a hole in the sleeve which rotates with the operating spindle

* Address: 13 Forester Ave., Bath. England.

or shaft. The friction-disk device is also a favored type of connecting medium for many mechanisms of this description. The Lang disk device was one of the first to be applied extensively in turret lathes. One of these applications is seen in Fig. 78, in which the power-driven plate A is coupled to the disk B on the shaft when the wing-nut is tightened. boring and drilling machines. The ratchet is usually double-acting, as shown in Fig. 69, so as to admit of adjustment in either direction without removing it from the square on the end of the screw or spindle.

Another class of handles is designed to enable two or more rates of speed to be obtained, this being accomplished by the

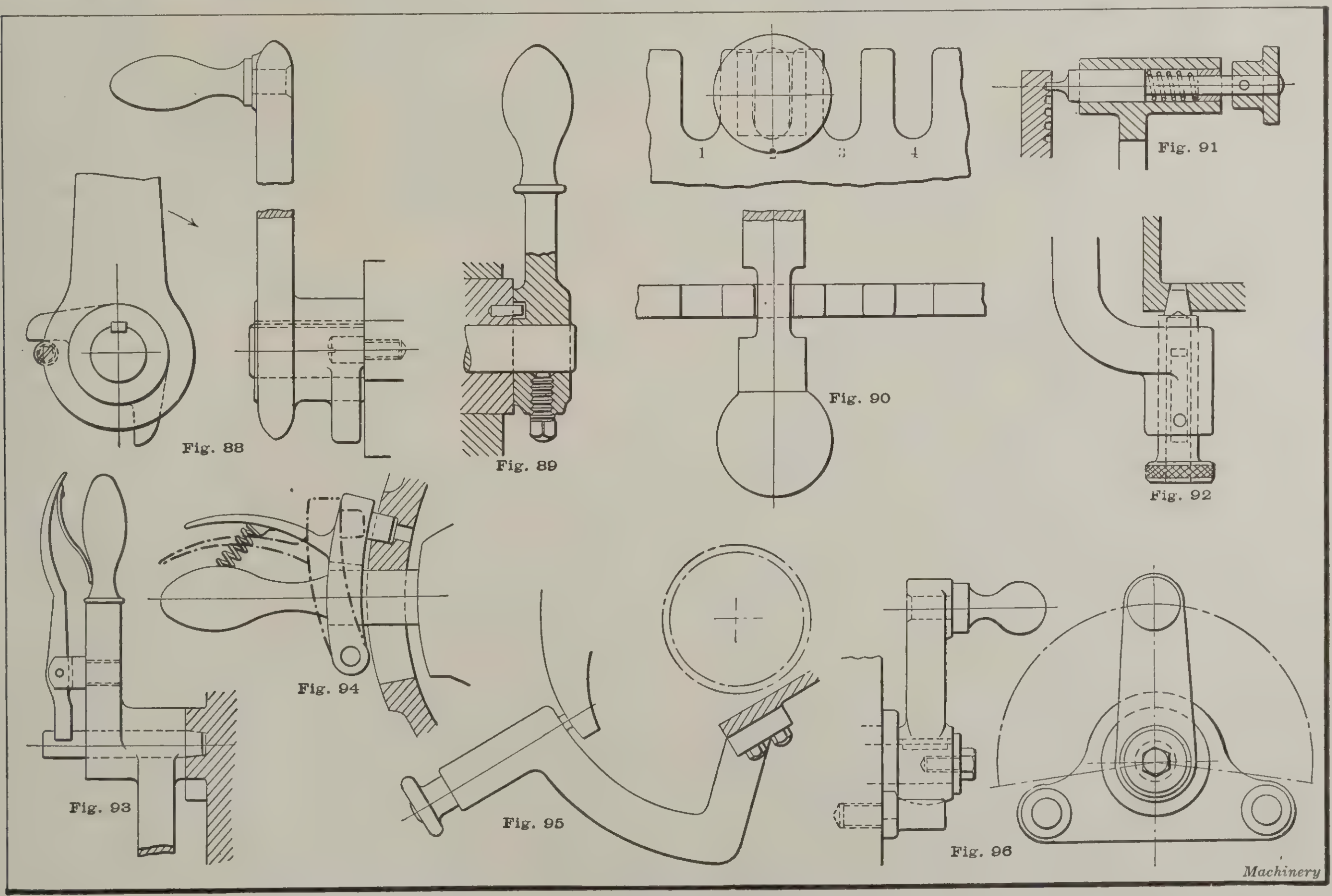


Figs. 81 to 87. Types of Handles used in Machine Tool Construction

Two of these nuts are used when the drive is heavy. Many variations in the details are found in different designs.

Ratchet handles are employed principally for two reasons: either because there is insufficient space for a complete turn of the handle, or because the power required cannot be conveniently applied by a full circular motion of the hand. Most cases of this kind relate to movements where only occasional adjustments are required, such as the adjustment

withdrawal of a pin or other means of coupling. Many feeds on drilling machines are constructed in this manner so that by a slight movement of a pivoted handle the rapid lever movement is changed into a slow one, by means of a worm or other mechanism for fine adjustment or feed. The application of this device is illustrated in Fig. 68, this being applied to a shaper and actuating the saddle screw. When the parts are in the position indicated, gear A, driven by



Figs. 88 to 96. Types of Handles used in Machine Tool Construction

of a slide at infrequent intervals, etc. Such cases occur when the setting lasts for a long period of machining, or when a power feed is usually applied, and the handle is required only to give a small adjustment for exact position. Heavy lathe carriages, for instances, are sometimes operated in this manner and also the saddles and slides for heavy

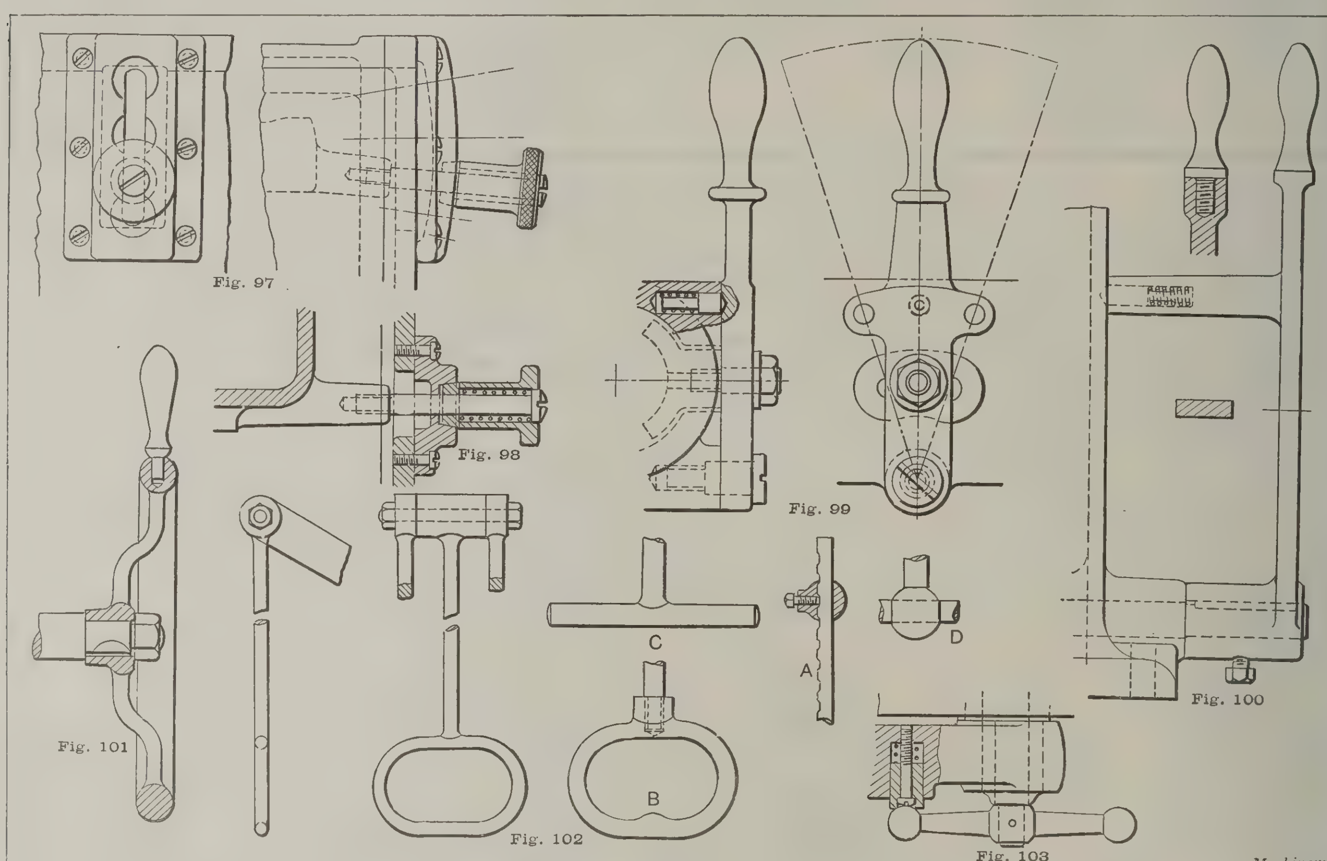
gear B, is coupled to the handle C by means of the plunger D, and screw E is rotated by power; but when the hand is applied to the handle, pushing the pivoted lever F in the direction of the arrow, the pin D is withdrawn and screw E may be revolved rapidly by hand.

Certain types of machines, especially for tapping, are pro-

vided with a simple means for obtaining two speeds, by having two squared spindles for receiving the operating handle. When the handle is applied to one, the drive is at a rapid rate, but when operating upon the other, the drive is through two spur gears at the slow speed. Then there is another common type, that adjustable for radius to suit different powers and speeds. Hand screw machines are very commonly provided with adjustable handles, and so are certain types of portable machines for drilling, planing, shaping, etc. Adjustment for radius is necessary in many handles for feed motions, principally in drilling machines, where a light pressure is more easily applied with a short handle, and a heavy pressure when the handle is drawn out to its full length. The lengths of handles are varied in different ways. A common method is to slide a loose handle through the socket portion which fits on the shaft, as indicated in Fig. 76. This loose portion is then tightened with a set-screw. Occasionally, a split hub is employed instead, and clamped with a set-screw. Another way is that shown in Fig. 79, where flat arms are used, provided with holes for the reception of a tightening bolt. The two parts are also kept together by a loop as indicated. Instead of the separate holes, a slot is sometimes made so that the readjustment may be effected without removing the bolt. In Fig. 87 is shown an instance of an adjustable handle applied to a keyway cutter of the portable type. The dovetail section of the lever prevents it from falling out when the nut is loosened. The handle in Fig. 80, from a portable cylinder boring machine, shows a case where the handle proper is adjusted along the web by a series of holes drilled at different radii. A continuous slot forms an alternative to the separate holes, if more rapid changes are desirable.

The handles for feeding spindles of small drilling machines, etc., are usually of plain bar section and can slide through the boss of the rack spindle. The method of clamping these handles and the means for adjustment are shown in Fig. 67. At *A* and *B* are shown arrangements with set-screws, with either square or knurled heads, and at *C* a grip-bolt design. A wing-screw, as shown in Fig. 74, is also often used. In some sensitive drilling machines the lever is self-locking in any position, through the medium of a spring plunger, as indicated in Fig. 81. The plunger presses against the handle with sufficient force to hold it by friction.

Another class of designs requires that a lever may be adjusted for radial direction so as to bring it in the most convenient angle for the operator's hand. Handles with split hubs, as already described, are used for this purpose in certain instances, but are not always desirable. A type suitable for small drills is that shown in Fig. 82, where the handle can be screwed into either one of three or four holes in the disk on the pinion spindle. Sometimes the handles fit into a tapered hole, as shown in Fig. 83. Among other methods for obtaining the same ends may be mentioned a circle of holes in a disk, into one of which the spring plunger of the pivoted handle can enter, as shown in Fig. 84. A similar method is adopted in the design shown in Fig. 75, where a large wheel is provided with holes for receiving the locking pin of the handle in any position which happens to be most convenient for feeding the spindle. This design is applied to a special vertical hole grinder. An alternative design is that in Fig. 85, where a T-groove is cut in a circular disk so that the handle can be locked in any position by means of a T-bolt and nut. This design is applied to a multi-spindle drilling machine in which each spindle is fed down independently with its own lever, or, if desired, simultaneously by a shaft (common to all) on one end of which is the wheel seen in Fig. 85. The ratchet lever is used on many drilling machines, the engagement of the pawl with any particular tooth governing the radial setting of the lever.



Figs. 97 to 103. Types of Handles used in Machine Tool Construction

In many cases it is important that means be provided for locking or retaining the handle in a certain position after the movement has been made, so as to keep the adjustment unaltered until a change is again made. This requirement is present in nearly all machine tools. Sometimes the range of movement of the lever is small, and, in such a case, the arrangement shown in Fig. 86 may be used, where the handle is clamped to a quadrant with a wing-nut after the handle is adjusted. A stop arrangement is shown in Fig. 96, where two stop-pins are used to arrest the motion of the small handle at each extreme of its movements. In Fig. 88 is shown another example of preventing a movement beyond a certain point. Here two lugs are provided which come in contact with the head of a screw. Still a different arrangement is shown in Fig. 89, where an annular groove is provided, fitting over the stop-pin, so that the latter arrests the motion of the handle at each end of the slot. Another means

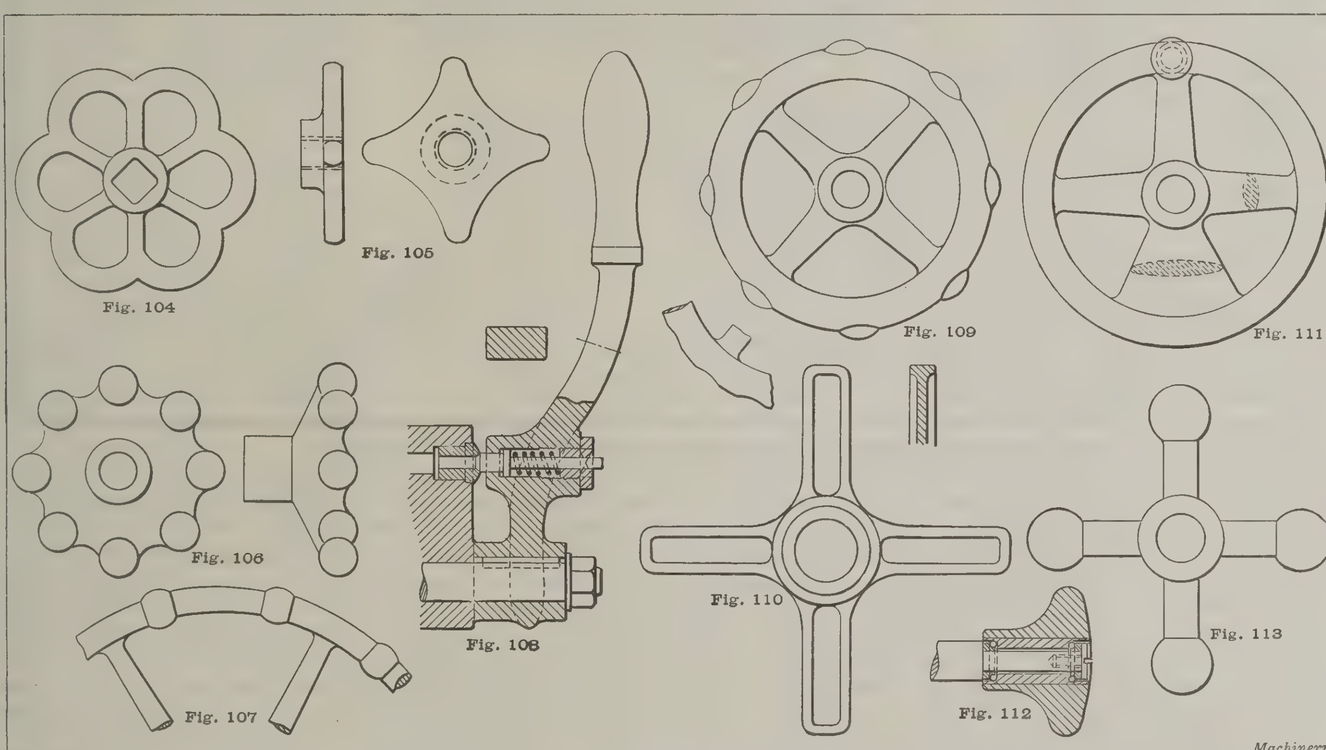
of control is indicated in Fig. 90, where the heavy knob end of a lever is raised, moved to one side and brought into the next notch of the disk.

By far the greater majority of locked handles, however, are retained by some form of spring catch. The spring is combined with a plunger which either acts automatically or is pulled out by hand when making changes, and which maintains the handle steadily in one place and eliminates the vibration which is liable to occur in a locking device without spring action. An example of a hand-operated plunger is shown in Fig. 91, this design being frequently met with on the indexing arm of milling machine dividing heads. Another example, from a milling machine gear-box, is shown in Fig. 92. Here the plunger has a tapered end dropping into a series of holes in the edge of the gear-box. A plunger is often withdrawn by a lever arrangement as shown in Fig. 93. A great many handles are also modeled after the steam-engine reversing lever, with a plunger fitting into notches on the rim of a quadrant or into ratchet teeth on the side of a disk. In Fig. 94 is shown an arrangement used for changing the gears in a gear-box, a pivoted clasp lever being used for withdrawing the plunger, and in Fig. 95 is another example of a handle used for operating gear-box change gears. In Figs. 97 and 98 are shown the elevation, end view and section, respectively, of a handle, the stem of which is screwed into the lug of a tumbler bracket carrying the change gears, and which is locked by the tapered end of the spring handle which enters into the counterbored recesses indicated. The same principle is applied to cases when gears have to be moved laterally, in which case the handles are attached to a forked piece embracing the gear.

The trouble of pulling back the plunger at each change is avoided in a great many handles, by making the plunger end of a pointed or slightly rounded shape, so that it will easily slide out of the countersink provided for it. In Fig. 99 an example of this kind is shown, where a handle can be locked in three positions by a spring plunger. A variation of the design, with the plunger placed in the handle, is shown in Fig. 108. The plunger here slides into a series of hardened steel bushings forced into the casting of the bed of the machine.

If two levers happen to come close to each other, as in the front of a drilling machine gear-box, it is often the practice to carry one handle out further than the other, in order to prevent the handle ends from interfering. The boss of one handle is then lengthened, as shown in Fig. 100, this requiring also the lengthening of the boss that receives the spring plunger. In some cases, the convenience of being able to machine the shaped handle portion separately prompts a design as illustrated in the detail in Fig. 100, where the handle is screwed into the main forged lever. Provision is sometimes incorporated for holding a spring plunger out of engagement with the locking holes, this being usually accomplished by a partial twist which engages a pin in a slot and prevents the forward movement of the plunger. A method of locking a handle in two positions is illustrated in Fig. 103. This method is applied to some milling machine back-gears. The ball ends of the handle are prevented from moving by the hollow spring plunger shown.

Mechanisms which cannot be easily reached by the attendant standing on the ground are either operated by long shafts or chains, or, if circumstances permit, a hanging pull-rod is used, the rod being provided with a loop or handle for the hand. Fig. 102 shows some details used on designs of this kind. The pull-rod is usually made with a boss fitting on the bolt or pin at the end of the levers to which it is attached, and is either of fixed length or adjustable, as indicated at *A*, in which the rod has a series of flats to receive the point of the clamping screw. The handle ends may be designed as shown at *B*, *C* and *D*. If there are two pull-rods close together they are often connected by a loose horizontal link to prevent their clashing with each other, and if a pull-rod comes close to a bearing or spindle, a light bracket is often carried out from the frame to embrace the rod and prevent it from coming into contact with the moving parts.



Figs. 104 to 113. Types of Handwheels and Handles used in Machine Tool Construction

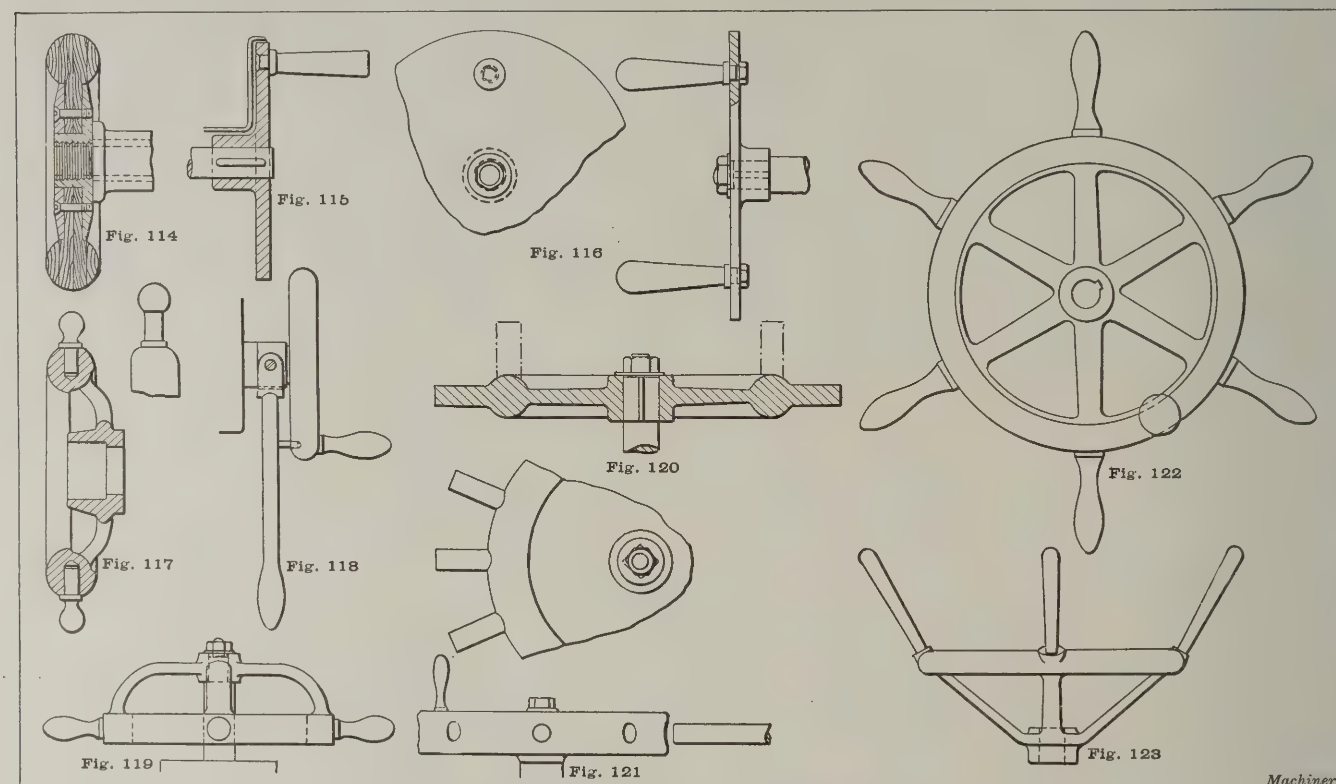
Handwheels

Handwheels are merely a special design of handles; on modern designs the use of handwheels is undoubtedly increasing. The continuous rim of the wheel possesses some advantages which are not present in handles even when made of the star or spider types. The continuous rim always presents something for the operator to grasp without feeling blindly for it in the air, as is often necessary when he has to keep his eye on the work or tools. It also permits of a more delicate feed motion. Micrometer graduations can be placed on a large diameter of the rim. The weight of the rim and its flywheel action are of great advantage when rapidly rotating the wheel for quick adjustments. It is well balanced and does not have a tendency to alter adjustments because of vibration. It can be provided with special fittings, such as dogs, ratchet teeth, feeding devices, and other details. The principal objection to a handwheel is that

it takes up more room than a handle and may, therefore, be in the way. In such cases, it either must be made removable or be discarded for some other design.

On the boundary line between star wheels and handwheels are a number of knobs, cross-handles or disks used chiefly for tightening or clamping where no great power is to be exerted. In Fig. 110 is shown a good example of a cross-handle, and in Fig. 113 another of the ball type. The plain star-shaped knob is often used as shown in Fig. 105, or

enable increased power to be exerted. An example of a wheel provided with a single handle is shown in Fig. 101. The accurate balancing of a handwheel with one handle is often neglected, but sometimes the arm opposite the handle is increased in size so as to balance the wheel properly, as shown in Fig. 111. Wheels of solid disk type, with one or two handles, as shown in Figs. 115 and 116, are easily manufactured and very convenient for certain applications; the edge is often graduated. An increase in the number of



Figs. 114 to 123. Types of Handwheels used in Machine Tool Construction

a small disk with a series of knobs on its periphery, to give a firm grasp, as shown in Fig. 106. The looped type of wheel shown in Fig. 104 is also very popular. Fig. 112 shows a special type of knob fitted with ball-bearings, its function being to control and feed endwise the grinding-wheel spindle of a small grinder. When it is desired to increase the grip of the hands on a handwheel, knobs or projections are often cast on it, as shown in Fig. 109, or the rim may be hollowed out with a series of transverse grooves, as in the small detail shown in the same illustration. Large

radial handles is often necessitated for reasons of convenience, because when provided with two or more handles, one will always be within easy reach. In Fig. 122 is shown a wheel with six radial handles, and one transverse handle on the rim. A peculiar specimen from a German turret lathe is shown in Fig. 124, in which a comparatively small handwheel has handles bolted into it and these handles again have lateral handles riveted to them.

A compromise between the radial and the transverse positions of the handles has sometimes been made, when the

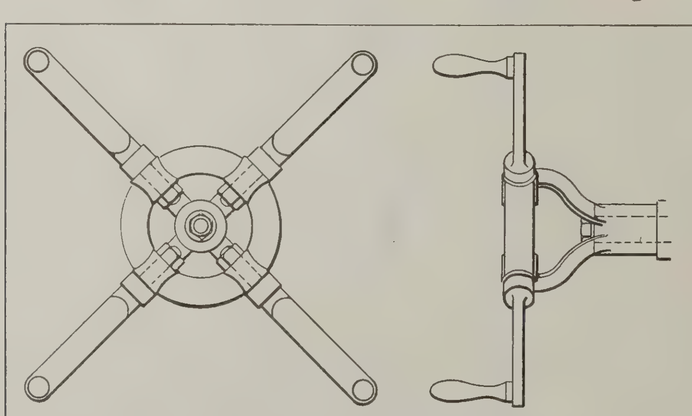


Fig. 124. Handwheel with Radial and Lateral Handles

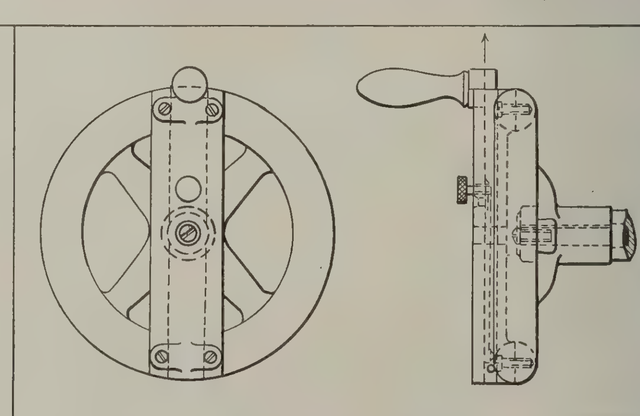


Fig. 125. Handwheel with Handle Adjustable Radially

handwheels are often cast with the rim as shown in Fig. 107. A wooden wheel made in segments as shown in Fig. 114 is very suitable for operating the draw-in chucks on bench and other small lathes.

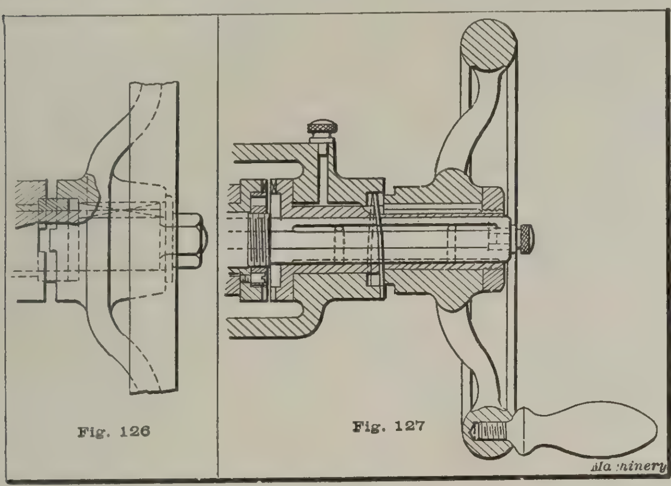
Handwheels are divisible into two main classes, those which are grasped by the rim only, and those that are fitted with one or more handles projecting either radially or laterally from them. The lateral extending handle is used for rapid rotation, and the radial handle chiefly to

conditions prevent a strictly radial setting. Fig. 123 shows an extreme case of this. This wheel is placed horizontally on the bed of a cold-sawing machine so that the operator would have to bend down to reach it. For this reason, the rim is carried upwards by the arms, and handles inserted into it in an angular direction. Another arrangement, with the rim and the handles in a different plane from the boss, is shown in Fig. 119, this being the operating wheel for a vertical forming-slide, where the inside of the wheel can

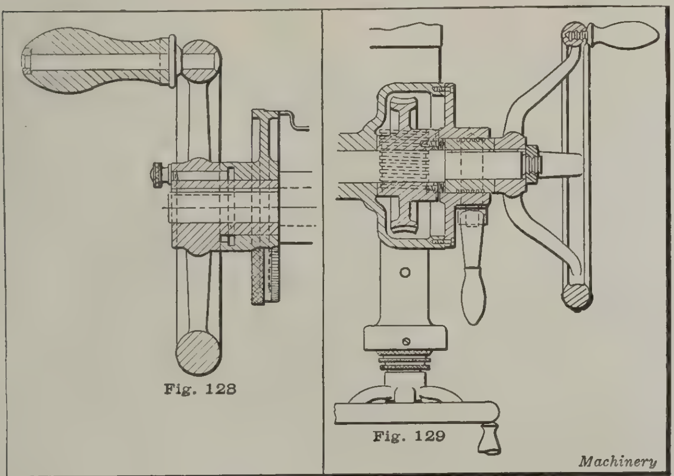
pass over the outside of the slide. Sometimes small knobs are fitted to the rim of the handwheel as shown in Fig. 117.

In some cases a considerable increase of power over that ordinarily required may be necessary at intervals. This condition is met in a German turret lathe by the arrangement shown in Fig. 118, where a lever pivoted on a boss adjacent to the hub on the handwheel is provided. This lever can be moved up against the handwheel so that a pin in it engages with the wheel, and a more powerful turning moment is thus obtained at the end of the lever than would be possible at the handle of the wheel.

Certain classes of handwheels made with solid webs instead of arms are provided with a set of holes around the periphery for the insertion of bars for turning them, as shown in Fig. 121. Another method of attaining the same object is to forge the wheel with a series of short pins or arms extending out from the rim and slip a piece of pipe on either of these for getting the increased leverage. A design of this kind is shown in Fig. 120. Sometimes the pins project out in the direction indicated by the dotted lines, in which case a bar can be laid across the wheel to engage with these pins. Fig. 125 illustrates a more complicated method of design for increasing the leverage of the handwheel, this being applied to certain milling machine table handwheels and cam-cutting attachments. The handle is formed with a sliding piece moving in ways screwed onto the wheel, and is pulled out when required.



Figs. 126 and 127. Handwheels with Clutch Arrangement



Figs. 128 and 129. Means for Connecting and Disconnecting Handwheels

A great number of devices for coupling and disconnecting handwheels have been designed. A plain clutch hub, as shown in Fig. 126, may have only a couple of teeth on opposite sides of the periphery, although it is more convenient if a greater number of teeth are used, so that the wheel may be slipped into engagement at almost any point. A spring may or may not be incorporated to keep the wheel out of mesh. In Fig. 127 the spring is placed in front of the boss and the resistance of this has to be overcome when the wheel is pushed forward to engage the teeth inside of the casing. Sometimes clutch teeth are provided in both faces of the hub so as to engage different mechanisms when moved toward the right or left.

Friction locks frequently are used in connection with micrometer dials when the dial must be released to turn it to the zero position for a new setting. This is accomplished, as shown in Fig. 128, by a bolt working in a circular T-slot by means of which the micrometer disk can be clamped to the wheel hub. Another method is to use a central threaded pin and let this force a transverse pin upward against the bore of the disk.

In the case of many handle mechanisms, it is necessary to provide for rapid and slow feeds or adjustments, which cannot be done by a single handle or handwheel. The most commonly used method is to use a worm and worm-wheel, the wheel being on the shaft of the rapid handwheel and the worm being turned by another handwheel at right angles to the first, as shown in Fig. 129. Some kind of clutch is incorporated to connect or disconnect the two movements. In the example shown, the rapid handwheel has a clutch moved along by a circular rack in order to engage the worm-wheel.

* * *

PATTERNS FOR THE FOUNDRY

In an address before the Superintendents' and Foremen's Club at Oakley, Cincinnati, Ohio, Mr. H. M. Ramp, superintendent of the Modern Foundry Co., called attention to the difficulties the foundryman has to meet because of the fact that patterns are poorly made or in poor condition. In the course of his address he said that many concerns have inspectors who check up every piece of work done in the factory; some have inspectors who check up every gage and templet at stated periods to discover errors and prevent mistakes; but he knew of no concern that employed an inspector to periodically check up the patterns to find out if they were true. Usually such checking is first done after a lot of castings have been rejected, and only then is the pattern found to be at fault. There seems to be a tendency today to save on pattern cost, although a great deal of money is spent for improved machinery in the machine shop to improve the quality and cheapen the cost of the finished product. The average patterns in the average foundry today are not made as well as they were ten years ago, and still there is a reason why the foundry ought to be supplied with better patterns than formerly. The trend of the times is to reduce the skill of the workers by putting more dependence on improved machinery; hence, the molders of today are not as skilled as they were years ago, and, for that reason, better patterns rather than poorer ought to be the rule.

Mr. Ramp also called attention to the lack of understanding of the requirements of the foundry on the part of many machine designers. The castings designed may be perfectly fitted for the purpose for which they are made, but the design is such that the molder cannot make a perfect casting on account of the excessive strains produced by the unequal proportions of the different parts, and it is impossible to prevent these castings from cracking or warping. It is easy enough to say that no more metal is required at this or that point; it may be very creditable to be able to design a machine with a maximum of utility and a minimum of weight, but, nevertheless, there are unalterable laws in the shrinkage or contraction of cast iron that the designer cannot be permitted to overlook. Many castings are designed with a view to saving metal, which, as a matter of fact, will have a higher ultimate cost than if no specific effort to save metal had been made. The extra labor cost in the foundry in such cases outweighs the saving in the cost of the metal.

* * *

Fernand Forest is credited in France as being the first mechanic to construct a multiple-cylinder explosion motor. Forest claims that he built the first four-cylinder motor in 1889, and the first gasoline launch in 1885. He developed magneto ignition in 1883, thirteen years before it was adopted by any automobile manufacturer. A movement is on foot in France to reward Forest for his inventions which are the foundation of the modern internal combustion motor, and for which he received little or no financial benefit.

TABLE OF RADII FOR TOOLS TO TURN SPHERICAL ENDS

Diameter (d) in 32nds — Radius (r)

(h) in 64ths	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{9}{32}$	$\frac{5}{16}$	$\frac{11}{32}$	$\frac{3}{8}$	$\frac{13}{32}$	$\frac{7}{16}$	$\frac{15}{32}$	$\frac{1}{2}$	$\frac{17}{32}$
$\frac{1}{64}$	0.039	$\frac{5}{64}$	0.133													
$\frac{1}{32}$	$\frac{1}{32}$	0.051	$\frac{5}{64}$	0.113	$\frac{5}{32}$	0.207	$\frac{17}{64}$	0.332	$\frac{13}{32}$	0.488	$\frac{37}{64}$	0.676	$\frac{25}{32}$	0.894	$1\frac{1}{64}$	1.144
$\frac{3}{64}$		$\frac{3}{64}$	0.065	0.089	0.117	0.151	0.190	$\frac{15}{64}$	0.284	0.339	0.398	0.464	0.534	$\frac{39}{64}$	0.690	0.776
$\frac{1}{16}$			$\frac{1}{16}$	0.080	0.102	0.127	$\frac{5}{32}$	0.189	0.227	0.268	$\frac{5}{16}$	0.361	0.414	0.471	$\frac{17}{32}$	0.596
$\frac{5}{64}$				$\frac{5}{64}$	0.095	0.116	0.139	0.166	0.195	0.228	0.264	0.303	0.345	$\frac{25}{64}$	0.439	0.491
$\frac{3}{32}$					$\frac{3}{32}$	0.111	0.130	0.152	0.177	0.204	$\frac{15}{64}$	0.267	0.302	0.340	0.380	0.423
$\frac{7}{64}$						$\frac{7}{64}$	0.126	0.145	0.166	0.190	0.215	0.243	0.273	0.306	0.340	0.377
$\frac{1}{8}$							$\frac{1}{8}$	0.142	0.160	0.181	$\frac{13}{64}$	0.227	0.254	0.282	$\frac{5}{16}$	0.345
$\frac{9}{64}$								$\frac{9}{64}$	0.157	0.175	0.195	0.217	0.240	$\frac{17}{64}$	0.292	0.321
$\frac{5}{32}$									$\frac{5}{32}$	0.173	0.191	0.210	0.231	0.254	0.278	0.304
$\frac{11}{64}$										$\frac{11}{64}$	0.188	0.206	0.225	0.246	0.268	0.291
$\frac{3}{16}$											$\frac{3}{16}$	0.204	0.221	0.240	0.260	0.282
$\frac{13}{64}$												$\frac{13}{64}$	0.219	0.237	0.255	0.275
$\frac{7}{32}$													$\frac{7}{32}$	0.235	0.252	0.271
$\frac{15}{64}$														$\frac{15}{64}$	$\frac{1}{4}$	0.268
$\frac{1}{4}$															$\frac{1}{4}$	0.266
$\frac{17}{64}$																$\frac{17}{64}$
$\frac{9}{32}$																
$\frac{19}{64}$																
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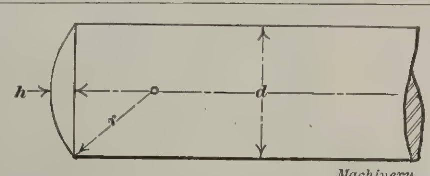
(h) in 64ths	$\frac{9}{16}$	$\frac{19}{32}$	$\frac{5}{8}$	$\frac{21}{32}$	$\frac{11}{16}$	$\frac{23}{32}$	$\frac{3}{4}$	$\frac{25}{32}$	$\frac{13}{16}$	$\frac{27}{32}$	$\frac{7}{8}$	$\frac{29}{32}$	$\frac{15}{16}$	$\frac{31}{32}$	1
$\frac{1}{64}$															
$\frac{1}{32}$	$1\frac{19}{32}$	1.426	$1\frac{37}{64}$	1.738	$1\frac{29}{32}$	2.082	$2\frac{17}{64}$	2.457	$2\frac{21}{32}$	2.863	$3\frac{5}{64}$	3.301	$3\frac{17}{32}$	3.769	$4\frac{1}{64}$
$\frac{3}{64}$	0.867	0.964	1.065	$1\frac{11}{64}$	1.284	1.401	1.523	1.651	1.784	$1\frac{59}{64}$	2.065	2.214	2.367	2.526	2.690
$\frac{1}{16}$	0.664	0.736	$\frac{13}{16}$	0.893	0.977	1.064	$1\frac{5}{32}$	1.252	1.352	1.455	$1\frac{9}{16}$	1.674	1.789	1.908	$2\frac{1}{32}$
$\frac{5}{64}$	0.545	0.603	0.664	0.728	0.795	0.866	0.939	$1\frac{1}{64}$	1.095	1.178	1.264	1.353	1.445	1.541	1.639
$\frac{3}{32}$	$\frac{15}{32}$	0.517	0.568	0.621	0.677	0.736	$\frac{51}{64}$	0.861	0.927	0.996	1.068	1.142	$1\frac{7}{32}$	1.298	1.380
$\frac{7}{64}$	0.417	0.458	0.501	$\frac{35}{64}$	0.595	0.645	0.698	0.752	0.809	0.868	0.930	0.993	1.059	1.127	1.180
$\frac{1}{8}$	0.379	0.415	$\frac{29}{64}$	0.493	0.535	0.579	$\frac{5}{8}$	0.673	0.723	0.774	$\frac{53}{64}$	0.884	0.941	1.001	$1\frac{1}{16}$
$\frac{9}{64}$	0.352	0.384	0.417	$\frac{29}{64}$	0.490	0.529	0.570	0.613	0.657	$\frac{45}{64}$	0.751	0.800	0.852	0.904	0.959
$\frac{5}{32}$	0.331	0.360	$\frac{25}{64}$	0.423	0.456	0.491	0.528	0.566	0.606	0.648	0.691	0.735	$\frac{25}{32}$	0.829	0.878
$\frac{11}{64}$	0.316	0.342	0.370	0.399	0.430	0.462	0.495	0.530	0.566	0.604	0.643	0.683	0.725	0.768	0.813
$\frac{3}{16}$	0.305	0.329	0.354	0.381	0.409	0.438	$\frac{15}{32}$	0.501	0.534	0.568	0.604	0.641	0.680	0.719	0.760
$\frac{13}{64}$	0.296	0.318	0.342	0.367	0.392	0.419	0.448	0.477	0.508	0.540	0.573	0.607	0.642	0.679	0.717
$\frac{7}{32}$	0.290	0.311	0.333	0.355	0.379	0.405	0.431	0.458	0.487	0.516	$\frac{35}{64}$	0.579	0.612	0.646	0.681
$\frac{15}{64}$	0.286	0.305	0.325	0.347	0.369	0.393	0.417	0.443	0.469	0.497	0.525	0.555	0.586	0.618	0.651
$\frac{1}{4}$	0.283	0.301	0.320	0.340	0.361	0.383	$\frac{13}{32}$	0.430	0.455	0.481	0.508	0.536	0.564	0.594	$\frac{5}{8}$
$\frac{17}{64}$	0.282	0.299	0.317	0.335	0.355	0.376	0.397	0.420	0.443	0.468	0.493	0.519	0.546	0.574	0.603
$\frac{9}{32}$	$\frac{9}{32}$	0.297	0.314	0.332	0.351	0.370	$\frac{25}{64}$	0.412	0.434	0.457	0.481	0.506	$\frac{17}{32}$	0.558	0.585
$\frac{19}{64}$		$\frac{19}{64}$	0.313	0.330	0.347	0.366	0.385	0.405	0.421	0.448	0.471	0.494	0.518	0.544	0.569
$\frac{5}{16}$			$\frac{5}{16}$	0.328	0.345	0.363	0.381	0.400	0.420	0.441	0.463	0.485	0.508	0.532	0.556
$\frac{21}{64}$				$\frac{21}{64}$	0.344	0.361	0.378	0.397	0.416	0.435	0.456	0.477	0.499	0.522	0.545
$\frac{11}{32}$					$\frac{11}{32}$	0.360	0.376	0.394	0.412	0.431	0.450	0.470	0.491	0.513	0.536
$\frac{23}{64}$						$\frac{23}{64}$	$\frac{3}{8}$	0.392	0.409	0.427	0.446	0.465	0.485	0.506	0.527
$\frac{3}{8}$							$\frac{3}{8}$	0.390	0.407	0.425	0.443	0.461	0.480	$\frac{1}{2}$	0.521
$\frac{25}{64}$								$\frac{25}{64}$	0.406	0.423	0.440	0.458	0.477	0.496	0.515
$\frac{13}{32}$									$\frac{13}{32}$	0.422	0.439	0.456	0.473	0.492	0.510
$\frac{27}{64}$										$\frac{27}{64}$	0.438	0.454	0.471	0.489	0.507
$\frac{7}{16}$											$\frac{7}{16}$	0.453	0.470	0.487	0.504
$\frac{29}{64}$												$\frac{29}{64}$	0.469	0.485	0.502
$\frac{15}{32}$													$\frac{15}{32}$	0.485	0.501
$\frac{31}{64}$														$\frac{31}{64}$	$\frac{1}{2}$
$\frac{1}{2}$															$\frac{1}{2}$



RADII FOR TOOLS TO TURN SPHERICAL ENDS

BY WILLIAM W. JOHNSON*

The method of arriving at the results given in the accompanying table of radii may be of interest. The work was reduced to a minimum in the following manner. The general formula for r in terms of h and d is

$$r = \frac{1}{2}\left(\frac{d^2}{4h} + h\right) \qquad (1)$$

Let $d = \frac{m}{32}$, and $h = \frac{n}{64}$; where

m = the number of 32nds in d, and
n = the number of 64ths in h.

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Then,

$$r = \frac{m^2 + n^2}{128\,n} \text{ or } r = \frac{n}{128} + \frac{1}{n}\left(\frac{m^2}{128}\right) \qquad (2)$$

By means of a table of 1/128ths of an inch, and a table of squares, each column of figures is calculated as follows:

Take for example the column for $\frac{3}{8}$ inch diameter.

$\frac{3}{8} = \frac{12}{32}$, then $m = 12$ and $m^2 = 144$.

Giving n the values 2, 3, 4, 5 and so on, in (2), we have

$$\frac{2}{128} + \frac{1}{2}\left(\frac{144}{128}\right) = \frac{74}{128} = \frac{37}{64} = r.$$

$$\frac{3}{128} + \frac{1}{3}\left(\frac{144}{128}\right) = \frac{51}{128} = 0.3985 = r.$$

$$\frac{4}{128} + \frac{1}{4}\left(\frac{144}{128}\right) = \frac{40}{128} = \frac{5}{16} = r.$$

$$\frac{5}{128} + \frac{1}{5}\left(\frac{144}{128}\right) = 0.0391 + \tfrac{1}{5}\,(1.1250) = 0.0391 + 0.2250 = 0.2641 = r$$

and so on, until $n = 11$.

Then $n = m$, $h = \frac{d}{2} = r$.

* * *

One good way to spend some of your stray thinking moments is in digesting the question of just exactly what it is you are aiming at in the world anyway.

ELECTRIC CONTROLLING DEVICES

By G. J. KIRCHGASSER*

Electric controlling devices for electric motors include such apparatus as starting rheostats, speed regulating or controlling rheostats (referred to as speed regulators and controllers), and such devices as compensator or auto-transformer types of motor starting apparatus, which are used for alternating current motors. Besides these, there are special types of switches, such as float and tank switches, magnetically operated switches, star-delta switches used with squirrel cage induction motors, and various other styles used for controlling the motor or the circuit to it. Automatically operated motor starters, regulators and controllers are also included under this heading.

The motor with its controlling device can be compared to the human body. The muscles, representing the power, correspond to the motor, and the brain which controls or regulates the working of the muscles, corresponds to the controlling device. Work done by the muscles can be disastrous unless properly controlled, and an electric motor supplied with power is also very apt to cause trouble unless provided with a controlling device of some kind. The wires connecting the controlling device and motor are comparable to the nerves emanating from the brain and passing to the muscles.

A motor of very small power can be started without the need of a starting rheostat, but for most motors used in manufacturing or industrial plants starting or regulating devices of some kind are required.

Action of Motors

Current is passed through the armature conductors of a motor (which are parallel to the shaft) at right angles to the magnetic lines which pass from the motor field poles. The electrical energy transmitted to a motor meets with several losses in changing to mechanical action. If the resistance of the armature conductors is high, there will be a correspondingly high loss in this part of the motor. As the motor armature revolves in a magnetic field, a current is set up in the armature conductors just as in the case of a dynamo. This flows in a direction opposite to the current being fed to the motor and is greater at full speed than at half speed, while at a standstill, of course, no counter current is generated, because the conductors are not moving through a magnetic field. Because of the absence of this counter current or counter electromotive force when a motor is being started, there is nothing to check the inrush of current.

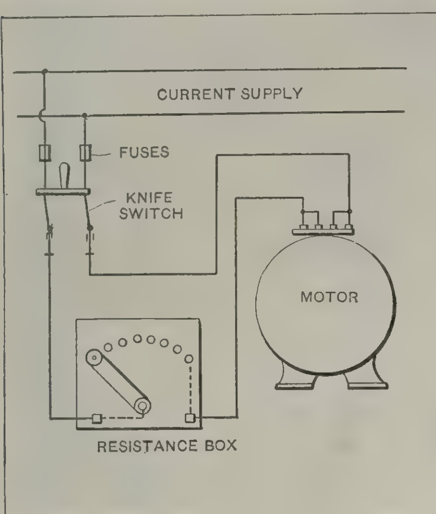

Fig. 1. Resistance Box in Armature Circuit arranged to be cut out by moving Lever over Successive Contact Button Terminals

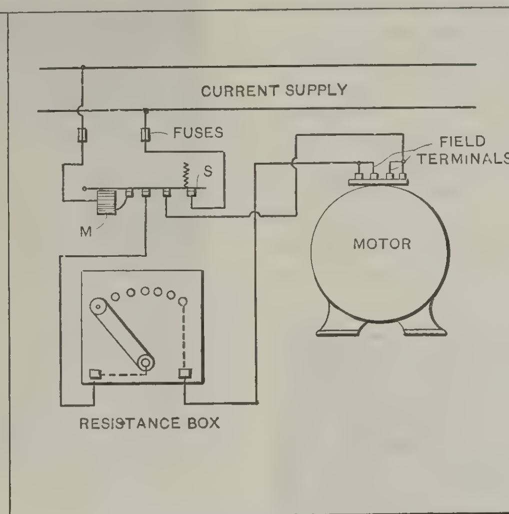

Fig. 2. Diagrammatic View of the Main Features of Shepardson's Patent Magnetically closed Main Line Switch

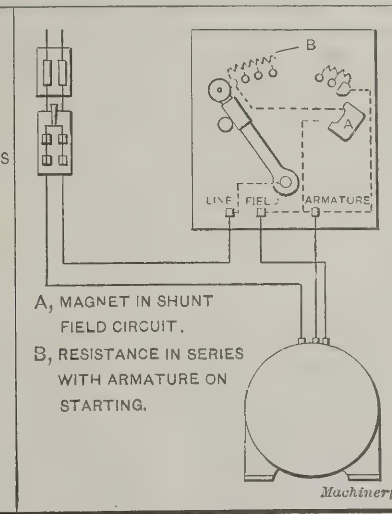

Fig. 3. Blades' Patent Controlling Device having Magnet incorporated with Starting Device and connected in Shunt-field Circuit

The necessity for controlling devices (of which the motor starter is the pioneer) for use with motors was recognized even before the first commercially efficient motors were put on the market for industrial purposes, which was about 1885. Early motors caused trouble, becasue it was found that when the switch connecting them to the line was closed, a very large current inrush took place. Controlling devices were not made then, so the armature was built with a high resistance, which served to retard the current inrush during starting; but as this high resistance was in circuit at all times, it resulted in the motor being very inefficient during normal running, and its speed varied considerably under varying load conditions.

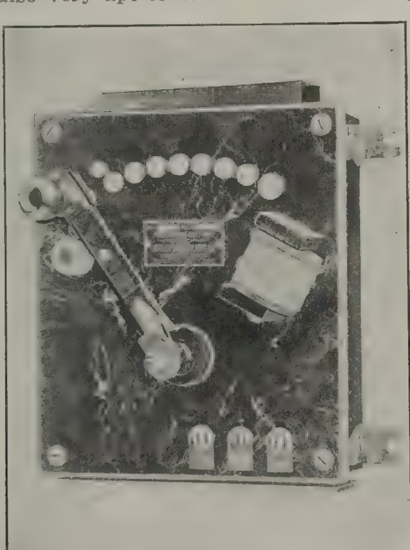

Fig. 4. Simple Hand-operated Motor Starting Rheostat with No-voltage Release

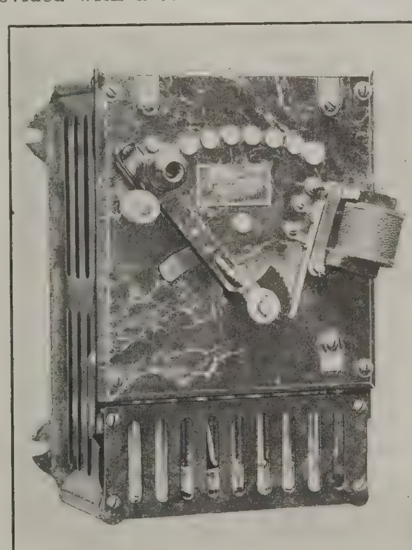

Fig. 5. Small Hand-operated Speed Regulator

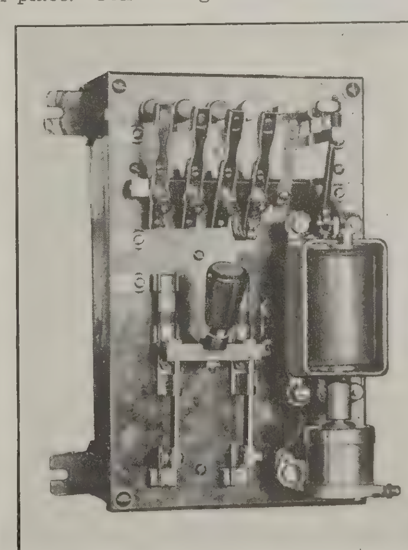

Fig. 6. Simple Automatic Motor Starter, Single Solenoid Type

One of the chief advantages of the shunt-wound motor is its ability to run at about constant speed even though it be driving two lathes or five, for instance, but the high resistance armature destroys this self-regulating feature, and, therefore, early electrical men tried to invent and design devices or methods for regulating the high resistance armature motor.

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No commercially practicable results followed until the armature with low resistance was developed. To avoid the large inrush of current mentioned, a resistance connected so as to be inserted during the starting period and cut out when running was employed. This was set up outside of the motor itself and really was the first controlling device of any value. The low resistance armature motor runs at practically constant speed, and with the arrangement of an outside starting resistance for cutting down the current, it put the high resistance armature motor and the various regulating devices into the scrap heap at one sweep. The diagrammatic sketch, Fig. 1, illustrates the method of inserting the resistance by means of a now obsolete type of starting-box. The lever for cutting out the resistance or returning it to the "off" position had to be moved by hand.

Motor manufacturers began using the shunt motor and this starting-box in which the starting arm was moved from the "off" to the "on," and *vice versa*, by hand. This arrangement, which marked the highest type that the most capable men in the electrical industry at that time were able to devise and place on the market, involved several great dangers: first, due to accidental breaking of the shunt field circuit, resulting in running away and destruction of motor and excessive

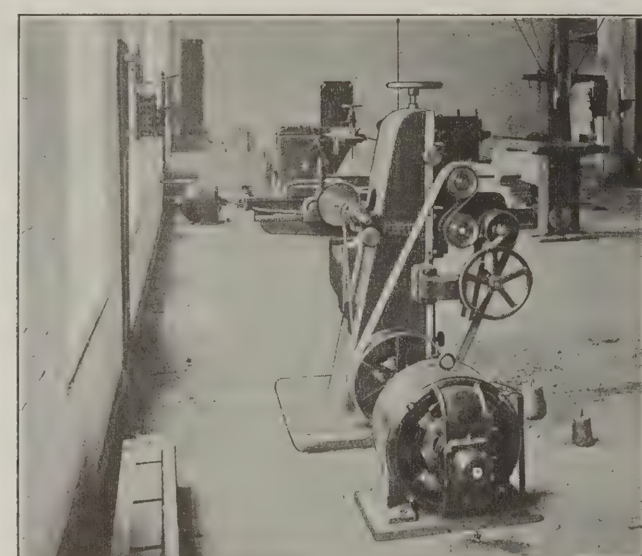


Fig. 7. Motor Starting-box, mounted on Wall for Starting Motor installed on Floor

current in the armature caused by the decreased counter electromotive force generated; second, due to the contact lever not being returned to the "off" position when shutting down, resulting in destructive current when the main switch was thrown in again and in sudden jerk instead of gradual acceleration (just as though no starting rheostat were installed); and third, due to leaving the contact arm on intermediate contacts, resulting in burning out the resistance of the starter.

Besides this, the blowing of the fuse, the cutting off of the current supply, the sudden drop of voltage—all left the motor unprotected, no starting resistance being in circuit when the current was again supplied. It meant that every motor would have to have an attendant to push the operating lever to the starting position when trouble arose, and it should be remembered that in the early days interruptions in current supply, drops in voltage, etc., were of more frequent occurrence than now. The dangers arising from the re-establishment of the current supply after the same had been cut off were a serious menace to the commercial operation of the electric motor. There was a crying need for a controlling device to overcome these dangers.

Shepardson's Main Line Magnetic Switch

Shepardson's main line magnetic switch was an effort to solve the problem, but it did not take care of all requirements. The switch lever *S*, Fig. 2, is held back by a spring so that when the current supply is cut off the magnet *M* is demagnetized, and the switch springs up and opens the circuit to the motor. The motor was not left connected to the line, but an attendant was just as necessary to push the starting lever back, and nothing prevented leaving the lever on an intermediate contact. Also, if the connection to the shunt field opened, there was no provision for opening the circuit automatically to prevent destruction of the motor.

Blades' Controlling Device

The device required, however, was finally invented. It marked the greatest step in the commercial application and operation of the electric motor. The invention, application for patent on which was filed Nov. 30, 1888, by Mr. Harry H. Blades, comprised a shunt motor connected to a constant po-

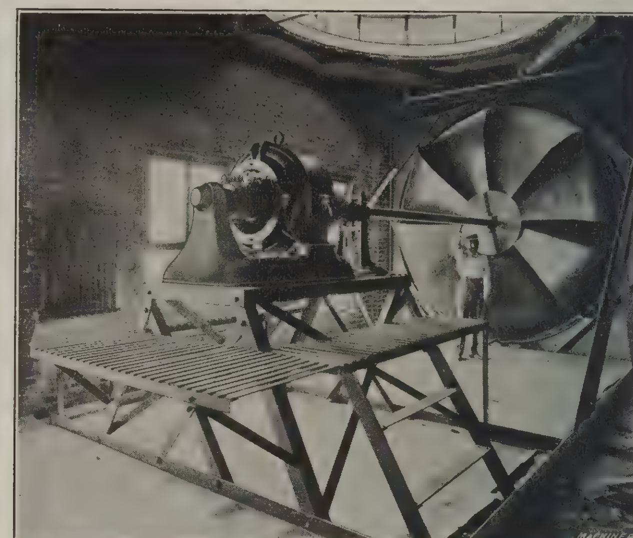


Fig. 8. Ten-foot Fan driven by a 25 H. P., C. & C. Direct-current Motor regulated by a Cutler-Hammer Speed Regulator

tential circuit; a starting-box consisting of a series of resistance steps; a contact arm adapted to be moved by hand over the terminals of the resistance associated with the motor, whereby the resistance may be included in series with the armature of the motor when the contact arm is in the "off"

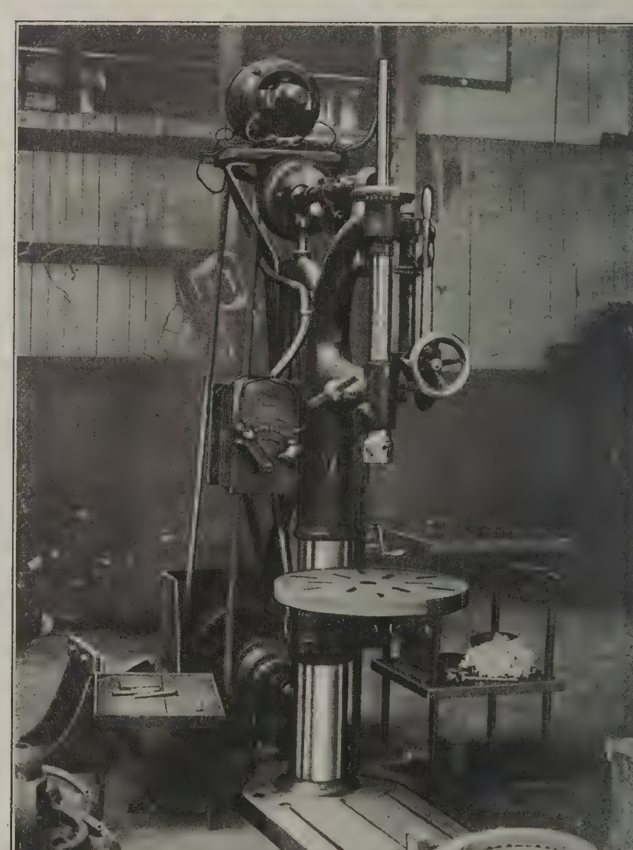


Fig. 8A. Drill Press equipped with Combination Starting and Regulating Rheostat

position, and may be removed entirely from the circuit when the contact arm is in the "on" position; and a magnet which is adapted to grasp and hold the contact arm in the "on" position after it has been moved to the "on" position by hand. This magnet is connected in the shunt field circuit so that it

will not be influenced by varying currents flowing through the armature, but will be influenced only by the current flowing through the shunt field circuit. Fig. 3 illustrates Blades' original structure, patent for which was issued January 7, 1890. Mr. Blades was at that time electrical engineer for the Detroit Motor Co., which company has long since been out of business.

Blades had produced a novel combination for overcoming the dangers incident to the employment of the shunt motor and hand starting-box. If the shunt field were broken, the current supply interrupted or the fuse blown, the motor would shut down with the lever of the starting-box in position for starting properly; if the voltage dropped a trifle and only temporarily, the motor would not be disconnected, but if the drop were prolonged, the motor would be shut down and the rheostat lever returned to the starting position automatically. As there are only two rest positions of the starting lever, "off" and "on," and a strong spring is provided, the danger incident to leaving the lever on an intermediate contact was obviated. About 1892 and 1893 the Blades patent began to be used to a great extent, and by 1896 the use of the automatic release of the operating lever was considered essential to the successful operation of motors.

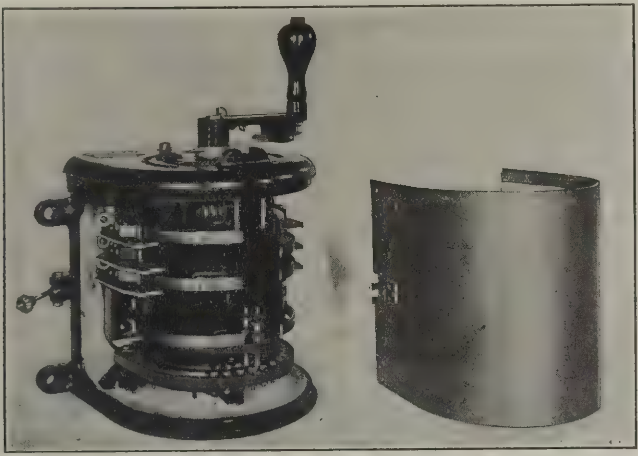


Fig. 9. Drum Type Machine Tool Controller

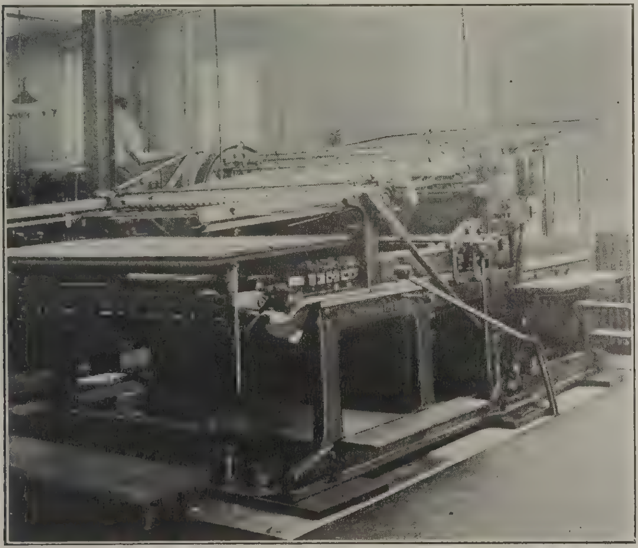


Fig. 10. Drum Controller installed for Controlling Motor-driven Printing Press

Modern Motor Starters

The present standard motor starter of the manually-operated type illustrated in Figs. 4 and 7 is built on the same principle as the first Blades structure. This device has, however, led to the development of innumerable kinds of motor controlling devices. The recognition of the value of the Blades patent by a Milwaukee electrical manufacturing company has been the means of the establishment of the largest plant devoted to the designing and building of motor controlling devices in the world.

Motor starters, starting rheostats, or "starting-boxes," as they are sometimes called, are used, as already stated, for starting an electric motor without excessive current inrush and bringing it gradually up to its normal speed. Some types of speed regulators are similar in appearance to starting rheostats, but the resistance employed is designed for carrying the full current constantly.

A starting rheostat used with the ordinary shunt or compound motor cuts out steps of resistance in succession as the lever is passed over the contacts. When the lever is held in contact with the magnet of the no-voltage release, no resistance is in circuit, but the current passes directly to the motor. Five to fifteen seconds is the usual period for starting a motor under ordinary load. Where the motor is driving a machine which requires very heavy starting torque, a starting rheostat having resistance designed for a longer starting period should be selected. A motor heavily loaded should be started slower, allowing the handle to rest for longer periods on successive contacts. This prevents large current inrushes and blowing of fuses, and takes from thirty seconds to one minute for the whole operation, depending upon the load.

Speed regulators for machine tool motors, fans, pumps, printing presses, controllers for hoists, cranes, elevators, etc., are made in types for every application, each providing special features, as required. In all cases the character of the drive and the motor data must be considered. For instance, a controller for a printing press must be differently proportioned from a controller for a lathe. With a printing press, the torque is about the same whether running with paper or without, and the vital requirement is to bring the motor up to speed smoothly and quickly.

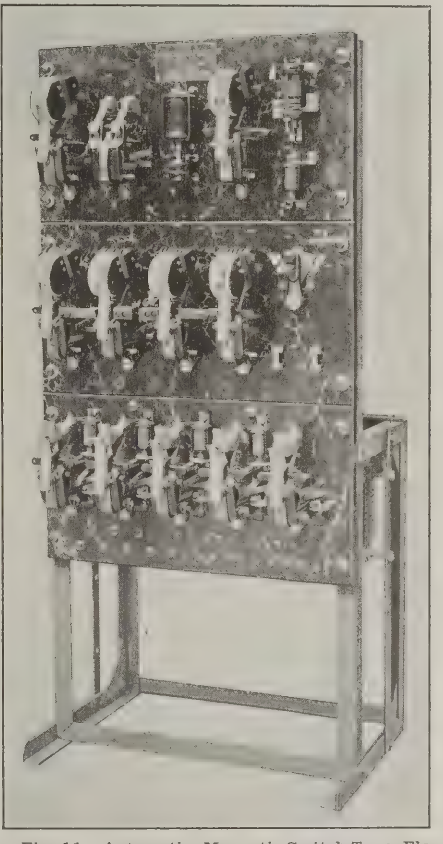


Fig. 11. Automatic, Magnetic Switch Type, Elevator Control Panel, for High-speed Electric Passenger Elevators, Multiple Solenoid Type

A motor speed regulator, such as used considerably for regulating ventilating fans, illustrated in Fig. 5, is practically a motor starter with resistance designed to be capable of being in circuit all the time the motor is in operation, instead of just five to ten seconds, as required in starters. The resistance must be ample to carry the full load motor current for long periods of time, so that the operating lever can be left on any contact segment. Fig. 8 shows a 10-foot fan driven by a 25 H. P. C. & C. direct current motor regulated by a Cutler-Hammer regulator mounted against the wall.

Speed regulation of shunt-wound and compound-wound motors may be effected by inserting resistance in the armature circuit of the motor, or by inserting resistance in the shunt-field circuit. The first method reduces the speed of the motor below its normal rated speed. The second method increases the speed of the motor above normal. Fig. 8A is an example of the latter type of control. The drill press shown is driven by a ½-horsepower Watson motor and a speed variation above normal is obtained by the combination starting and regulating rheostat within easy reach of the operator. By a combination of the two methods the speed of a motor may be both decreased below and increased above normal speed, thus affording a wide range of speed variation.

Speed regulation by armature resistance is open to two ob-

jections: first, the difficulty of maintaining constant speed under varying load conditions, and, second, the necessity of wasting energy to secure speed reduction. These objections are in part offset by the fact that speed reduction by armature resistance may be applied to any motor of standard design and requires nothing more than the simplest (and, therefore, least expensive) speed-regulating rheostat. In cases where the motor will be operated nearly always at full speed, and only occasionally at less than its normal speed, the difference in first cost of the installation may justify the use of the armature resistance method of control. When the speed is changed frequently regulation by shunt-field resistance is preferred.

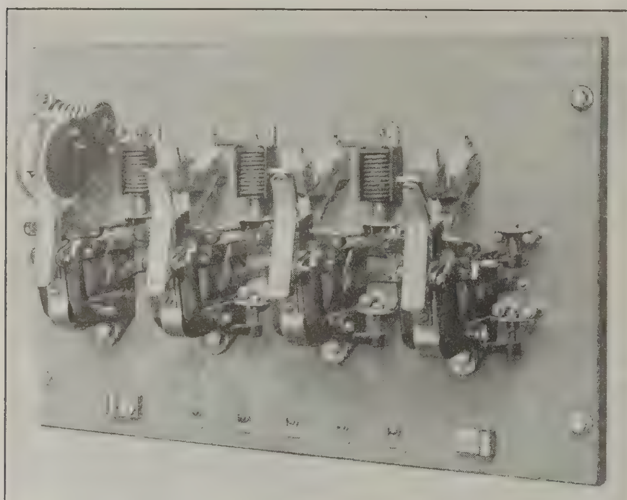


Fig. 12. Series Relay Multiple Solenoid Type Self-starter

One of the most common errors is that of selecting a regulating rheostat of insufficient capacity. If the current required to operate the motor at full speed with no resistance in circuit is greater than the rated capacity of the rheostat, overheating of the resistance will result. An increase in temperature even to a point where the hand cannot be held on the enclosing case need cause no apprehension, but should the resistance become red-hot, the regulator is being worked beyond its capacity and the load on the motor should be reduced or a regulator of greater capacity substituted. If the current required to operate the motor at full speed with no resistance in circuit is less than the rated capacity of the regulator no over-heating will occur, but it will not be possible to secure the full fifty per cent speed reduction which the rheostat is designed to give with all resistance in circuit.

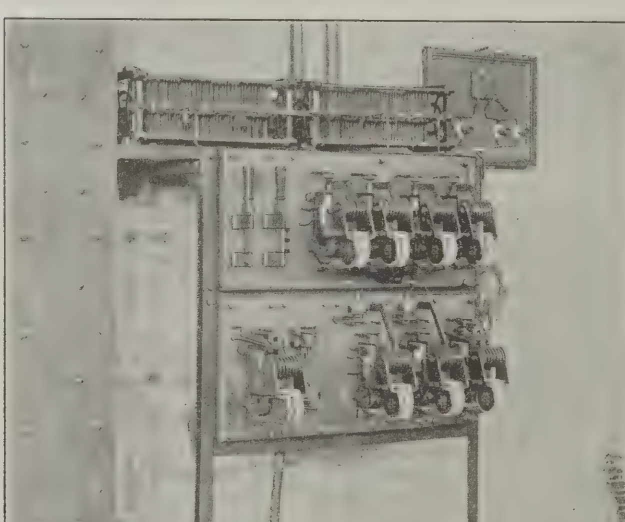


Fig. 13. Control Panel for Steel Mill Service. Magnetic Switches on the Panel are operated by Small Control Master Switch on Rolling Mill

The power required by some kinds of motor-driven machines when running at slow speed is less in proportion to the reduction in speed than in other classes of machines, some of which take almost as much current when operating at one-half speed as at full speed. Typical examples of the two classes of machines referred to are furnished by a ventilating fan and a hydraulic pump, the current required to operate the fan becoming less and less as the speed of the fan is diminished, while in the case of the pump practically the same amount of current is required to operate it at half speed as at full speed. In other classes of service, such, for instance, as the speed regulation of ice cream freezers, several ventilating fans driven by one motor, line-shafting subject to variable loads, etc., the current requirements can only be determined by tests made at various speeds.

Drum type controllers, such as are used for machine tools, printing presses, cranes, etc., operated by a revolving handle at the top, are built on the same principle. They vary the speed by inserting resistance in the armature circuit and in the shunt-field circuit, and provide several reverse speeds or full reverse operation of the motor, as desired. A revolving drum carries segments, as shown in Fig. 9, so arranged as to make contact in a predetermined order with contact fingers. By means of accurate control the output of a machine can be increased, because for the various operations the most efficient speed can be employed. The method of mounting a drum type controller is illustrated in Fig. 10, which shows a flat bed printing press.

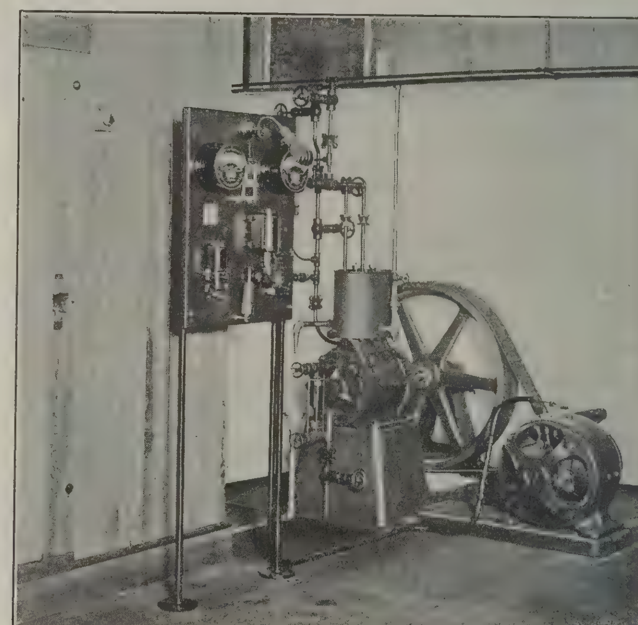


Fig. 14. Automatic or Remote-controlled Self-starters, used in Connection with Motors operating a Refrigeration System

On the simple regulator, Fig. 5, it may be noted that contact to cut in or out the various steps of resistance is made by moving a handle or lever by hand. On automatic starters, regulators or controllers, the cutting out of the resistance is accomplished by magnetically operated switches. The principle is exactly the same. A simple automatic starter is illustrated in Fig. 6. The solenoid at the right side, when energized, closes the fingers at the top in succession and starts the motor with which it is used in the same manner as if the operation were by hand. In the "off" position all resistance is in circuit so that on starting there will be no current inrush. As each finger closes, a step of resistance is cut out. The last finger cuts out all the resistance.

An automatic control panel for varying the speed may consist of a number of magnetically operated switches, the closing and opening of which may be accomplished by pushing buttons connected in the switch magnetic circuit. Assuming that a motor is running at its normal speed and that it is desired to increase this, a control button connected so as to magnetize a switch, the closing of which would connect a resistance in the shunt field, is one means. The button may be located at any location

remote from the motor and control panel. Several typical control panels are illustrated in Figs. 11, 12 and 13.

For some motor applications it is now desirable to have the starting-box automatically operated, or capable of being started by pushing a button or closing a switch at some remote point. The "self-starter" or automatic starting device is one of the most interesting devices employed in connection with motors. Unless one has been able to keep in close touch with the development of electrical apparatus in recent years, one is likely to be astonished at the results accomplished by the various applications of the solenoid. This coil of wire which "sucks" in its iron plunger or core when energized by the passage of current through it, is used in what is called the dashpot-controlled self-starter and in the multiple solenoid current relay type.

In some plants automatic motor starters are installed solely for the purpose of preventing careless employes from starting up the motors too suddenly, but the value of the self-starter consists chiefly in the fact that when combined with suitable energizing devices, such as float switches, pressure regulators, limit switches, or even a push button switch, it dispenses altogether with the need of employing someone to start and stop the motor at the proper time, or else enables the one charged with this duty to control the motor from a distance.

In connection with motor-driven pumps and air compressors the self-starter finds one of its widest fields of usefulness. By means of a switch operated by a copper float in the tank, the circuit to the motor is automatically opened and closed through the self-starter whenever the water in the tank reaches a predetermined high or low level. The same device may be used in sump pits or, indeed, wherever there is sufficient change in water level to operate a float switch. In compression tank systems, and when used with air compressors, a pressure gage is substituted for the float switch, the circuit being made and broken as the needle, or indicator, moves back and forth between two fixed points.

A good example of the advantage of remote control is found in mining work where (in mines employing manually-operated starting-boxes) it is oftentimes necessary to send a man down the shaft to start a motor. In mines where self-starters are installed, every motor can be controlled by switches located in the power house, or at any other convenient point. In connection with electrically operated elevators, hoists, etc., the self-starter insures a smooth start and gradual acceleration to full speed, since by means of the dash-pot referred to the starting period is predetermined and is not affected by carelessness on the part of the operator.

In connection with refrigeration systems, automatic motor starters are frequently used for various purposes. The panel shown in Fig. 14 carries a main line knife switch, fuses, voltmeter and ammeter at the top, with an automatic starting rheostat and pilot switch for the motor driving the brine pump. By running control wires to several points in the building it is possible to start or stop the motor as desired from any of these locations. The starting is accomplished in the same manner each time, and the time of acceleration can be regulated to suit each particular requirement.

In short, practically every motor installation requires a controlling device. The choice of control is equally as important as the choice of a motor. All conditions should be considered in selecting the controlling device. Will the ordinary type of hand-operated starter be most economical or convenient, or would an automatic starter be better in the long run? Is speed regulation required? Is the device to be located where dust, lint, etc., are present in excessive quantities? Is the motor to be reversed? Is the motor of direct-current—series, shunt or compound type? Or of alternating current—single phase, or, squirrel cage or slip ring polyphase type? What duty will the motor be required to do? These are all questions concerning which information is required when considering the installation of the controlling apparatus.

* * *

In all places where bolts, studs, cap-screws, etc., are used, care should be taken to allow enough room for the use of a standard wrench.

CASEHARDENING TEMPERATURES

In an article in *Le Genie Civil*, Dr. L. Guillet gives some interesting information relating to casehardening methods and temperatures to be used in casehardening processes. In general, the regular carbon steels should be carbonized at a temperature of about 1560 degrees F. After carbonizing, the objects should be permitted to cool to about 1100 degrees F. or lower. They are then again heated and quenched from a temperature of about 1875 degrees F. for refining the core, after which they are again heated and quenched from a temperature of 1380 degrees F. for the final hardening. The quenching in both cases is done in water.

The carbon contents in ordinary carbon steel for casehardening should, in general, be from 0.10 to 0.15 per cent, and in no case should it exceed 0.20 per cent. In alloy steels the carbon contents may be as high as 0.30 per cent. The manganese contents should not exceed 0.40 per cent if a single quenching only is employed, but can be somewhat higher if two quenchings are used. Silicon increases the brittleness in all cases, and should not exceed 0.30 per cent. Tungsten and molybdenum also increase the brittleness of the core.

Nickel steels are very suitable for casehardening, but have, however, both advantages and disadvantages. Among the latter are that nickel seems to retard the process somewhat and the hardness of the case is somewhat lower than that obtainable in ordinary carbon steels. On the other hand, nickel tends to oppose the crystallization of the steel at high temperatures and to eliminate the consequent brittleness. Because of this, the first quenching for refining the core is not always necessary, although it noticeably increases the tenacity of the core. With a 2 per cent nickel steel the following temperatures are recommended: The first quenching should be from a temperature of 1830 degrees F. The second heating should be to 1380 degrees F., after which the quenching should take place after the objects have cooled off to about 1290 degrees F. A single quenching from 1290 degrees F. gives the greatest hardness in the case but not the greatest tenacity in the core. Quenching from 1380 degrees F. gives a somewhat higher tenacity but a slightly lower hardness in the case. A 6 per cent nickel steel should be quenched in the first instance from 1560 degrees F., and after reheating from 1245 degrees F. Since this high nickel percentage almost completely prevents the brittleness of the core, one quenching from about 1290 degrees F. is in most cases sufficient.

Steels with from 1 to 1.2 per cent chromium are sometimes used when an especially hard case is required. This element, however, aids the crystallization of the core and the double quenching is, therefore, absolutely necessary. Chrome-nickel steels with a low chromium content require about the same heat treatment as pure nickel steels.

The author does not recommend charred leather for a casehardening mixture, as he considers that it works too actively, but, instead, believes that a mixture of 60 parts wood charcoal and 40 parts of barium carbonate is the best to use. It is easy to obtain, is not expensive, and can be used over again for a number of times.

* * *

A combination of the moving picture machine and the phonograph has been recently demonstrated in London. The invention is of French origin and its development has been under way for a couple of years. Two electric motors are used, one for the moving picture machine and one for the phonograph. These are kept in synchronism by a special arrangement which makes it possible to instantly remedy any defects in the relative speeds of the two instruments. The combination machine is called "chronophone." At the demonstration, prominent actors could be seen reciting monologues. The sounds and the movements on the screen were in perfect harmony. One remarkable picture was that of a lion tamer in the cage of the animals. The mixture of sounds—those of the man speaking, the crack of the whip, the thud of an iron bar falling on the floor of the cage, and the growls of the lions—harmonized perfectly with the pictures. As these are also shown in natural colors, the illusion seems perfect.

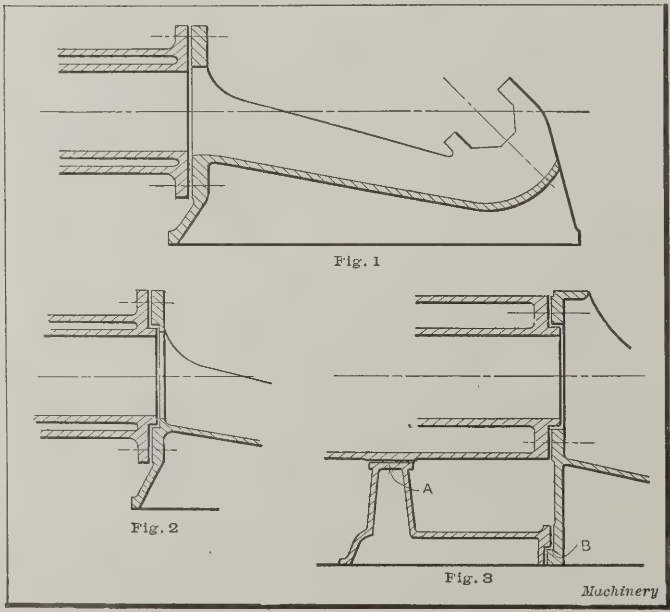
DESIRABLE IMPROVEMENTS IN AMERICAN GAS ENGINE DESIGN*

By C. F. HIRSHFELD†

The designer of gas engines has a double problem to solve. He must not only develop an apparatus which will function properly through a long life, but he must also, in general, design it in such a way that it can be built at a cost which will make it possible to meet competition. In criticizing commercial designs one must, therefore, bear in mind that manufacturing costs limit the refinement of design; but manufacturing costs do not excuse poor designs which a resourceful designer could improve without making the machine more expensive; nor do they excuse designs which make it difficult or impossible for an engine to function properly through a reasonably long life. Such design may give a manufacturer a temporary advantage, but it can never result in giving him a permanent share of the engine business. In the following paragraphs, some of the faulty constructions which are more or less common in small and medium sizes, will be pointed out, and better methods suggested.

One of the most glaring faults still found in many American gas engines of the horizontal type is the unsupported, overhung cylinder shown in Fig. 1. In very small sizes this construction would be justifiable if it were not more expensive than other and better designs which can be used for small engines; in medium and large sizes it is well-nigh inexcusable. The studs or bolts which hold the cylinder to the frame, and which often pass through unfinished, cored holes, cannot be depended on to keep the cylinder in proper alignment. These fastenings are, moreover, not well adapted for taking care of the normal pressure of the piston and of the weight of the cylinder and piston. In the case of large engines constructed in this way it is sometimes possible to notice a measurable deflection of the cylinder during the expansion stroke.

If this general type of design is deemed necessary because of the present investment in drawings, patterns, etc., it should at least be modified as shown in Fig. 2, so that a generous

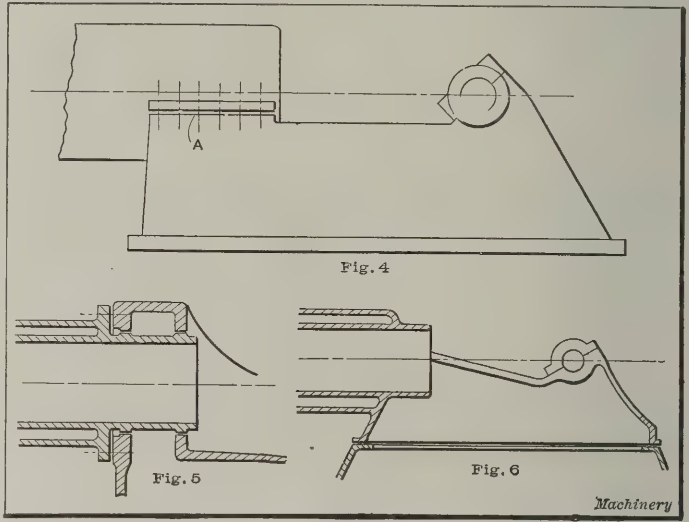


Figs. 1 to 3. Methods of Attaching and Supporting Cylinders

counterbore serves to locate the cylinder and to prevent motion of the crank-end with respect to the frame. The next simplest improvement is to slightly modify the patterns, using a support such as that shown in Fig. 3. This should be cast with, or bolted to, the frame, and should be so arranged that the cylinder can slide back and forth upon it at the point of support *A*. To secure accurate alignment when this auxiliary support is bolted to the frame, some kind of shoulder bearing, such as that shown at *B*, should be provided. Another solution, but a more expensive one, is to allow the cylinder barrel to extend into the frame for a considerable distance, as shown in Fig. 5.

One of the most satisfactory designs, so far as locating and supporting the cylinder is concerned, is that shown in Fig. 4. By making the bench at *A* short in the smaller sizes, the necessary support can be given the cylinder without necessitating the use of an excessive amount of metal in the frame. As the size of engine increases, this bench can be made relatively longer, thus giving the more perfect support required in higher powers. This design is particularly desirable from the manufacturing point of view, because the machine work is simple in character, and because, if properly designed, one frame can be used with several sizes of cylinders.

For very small single-cylinder engines some makers have developed designs similiar to those in Figs. 6 and 7, in which the working bore, jacket and frame are all cast in one. For small sizes this is a satisfactory solution; for larger engines



Figs. 4 to 6. Methods of Attaching Cylinders to the Frames

it should be so modified as to permit of the use of a separate cylinder liner, as shown in Fig. 8.

In tandem engines the front cylinder should be supported in much the same way as in the single-cylinder type. The rear cylinder should be located with respect to the front cylinder by counterbored flanges which are finished when the cylinders are bored. These flanges should not, however, be called upon to resist bending moments caused by the weight of the cylinder, the thrust of valve mechanisms, etc. This bending moment should be taken care of by a simple support. A modification of the support shown in Fig. 3 is adapted to this case. The use of a support entirely separated from the main frame, a common practice in tandem constructions, is not to be recommended. The accuracy of its location depends entirely upon the care exercised by the erector, and is beyond the control of the manufacturer.

There seems to be a difference of opinion as to the necessity of a crosshead in single-acting tandems. From the viewpoint of rational design, there can be no question: a crosshead should be used. A piston cannot perform the functions of a crosshead without impairing the perfection of its action as a piston. From the viewpoint of the designer, however, the case is different. However desirable a crosshead may be, financial considerations may not be neglected. Although the crosshead itself is not necessarily a very expensive piece, it involves the use of a piston-rod and guides; but many manufacturers increase the cost of crosshead constructions very considerably by using an unnecessarily complicated crosshead. With proper slipper surfaces, no wedge adjustment is required on this member. A simple construction so arranged that the lower slipper can be moved down by the insertion of shims, if it should become necessary, is all that is required. As a result of the balance between cost and desirability, trunk-piston designs are generally used in smaller sizes, and crossheads in larger engines. The split might well be made at about 100 horsepower per crank. The reboring and ultimate replacement of 50 horsepower cylinders will, in general, about

* For additional information on this and kindred subjects, see MACHINERY, February, 1912, engineering edition, "Points in the Design of Two-stroke Cycle Engines," and the articles there referred to.

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balance the interest on the additional investment involved in a crosshead engine.

The cylinders of single-acting engines of American design are often open to considerable criticism. One of the most common faults is the use of a working barrel and jacket of too nearly the same diameter, giving inadequate jacket space. Faults that generally accompany this are the entire omission of openings through which this space can be cleaned, or the use of openings so small and so distributed that they are of little practical use. Builders of what may be called "stock" engines can seldom be sure that their engines will not be used in places where the only available water is muddy or carries large quantities of mineral matter in solution. If designers would regard the jacket as a water heater as well as a cylinder cooler, fewer designs of the kind mentioned would appear. Openings into the jacket space should be of such size and number that all parts of the interior can be easily reached, so that mud and scale can be cleaned out.

It is not good practice to make provision for cleaning by combining the jackets of the cylinder and of a separate cylinder head, that is, making them continous, as shown in Fig. 9. Experience has shown that joints of this kind are very difficult to pack. Leakage of water into the cylinder is apt to occur, causing irregular operation, or, if this can be prevented, water is apt to leak to the outside of the engine. If such cored passages are deemed necessary by the designer for the support of cores or for simplicity of construction, the head should be made to fit into the end of the cylinder with a metal-to-metal contact at some point in the counterbore, in order that the gas pressure acting on the inner edge of the gasket may be reduced to a minimum. It is, however, far better to cast the abutting faces solid and to carry the water around from jacket to jacket by means of a U-shaped connection. Even in this case many troubles will be eliminated if the counterbored construction is adopted. This method of protecting the gasket against blowout is well worth while.

Vertical engines have many head joints which are difficult to properly care for in operation. Whenever valves are placed

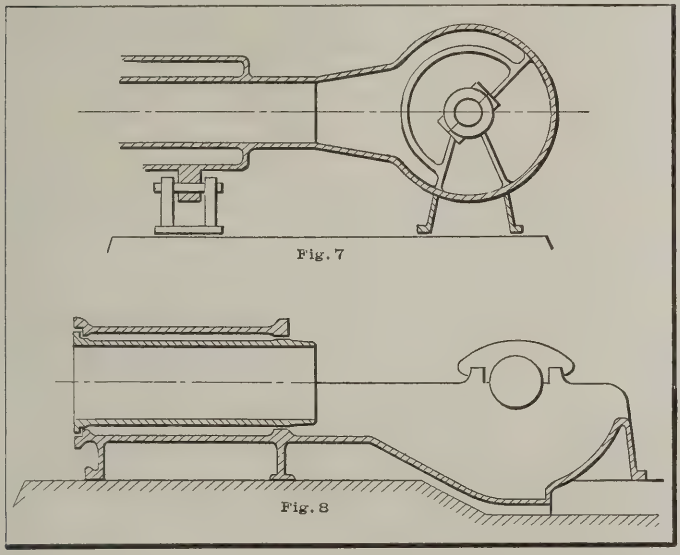
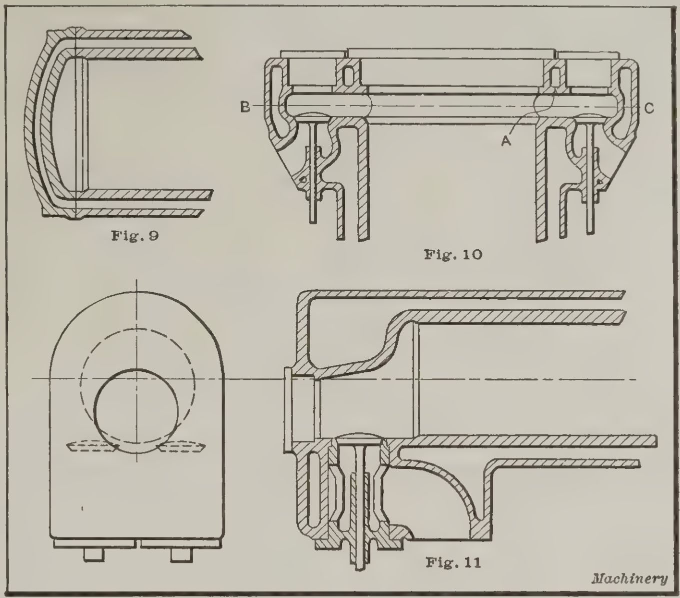


Fig. 7. Arrangement for Small Single-cylinder Engines. Fig. 8. Frame for Heavy Engine

in side chambers or pockets in high-compression engines of this type, it becomes difficult to design proper covers for the cylinder and valve chambers. The ideal arrangement would be the use of circular covers for each part, with each cover fitting into a counterbore, as shown in Fig. 10. When high compression and large valve diameter are desired, it becomes necessary to decrease the distance between the center line of the cylinder and the center lines of the valves. This generally makes it impossible to leave enough metal at point *A* to make it feasible to use separate covers, and there is a tendency to split along the line *BC*, move the valve toward the cylinder, and use non-circular covers. Not only does this construction require non-circular gaskets and prevent the use of counterbores, but it also often makes it impossible to finish the abutting surfaces with circular cuts which do not run off the edge of the casting. The satisfactory packing of a joint of this kind is often a matter of great difficulty. If, in addition to the disadvantages already enumerated, the gasket is called upon to take care of a continuous jacket, such as that previously mentioned, it will require both skillful manufacture and attendance, to keep the engine in successful operation.

These considerations and others to follow form strong arguments in favor of the location of valves in the head in high-compression vertical engines, if not in all engines with a vertical center line. Other advantages are simple cylinder castings, better shape of combustion space, and general accessibility of valve operating mechanism. The advantages accruing from valves in the head are particularly noticeable in



Figs. 9 to 11. Cylinder and Valve Arrangements

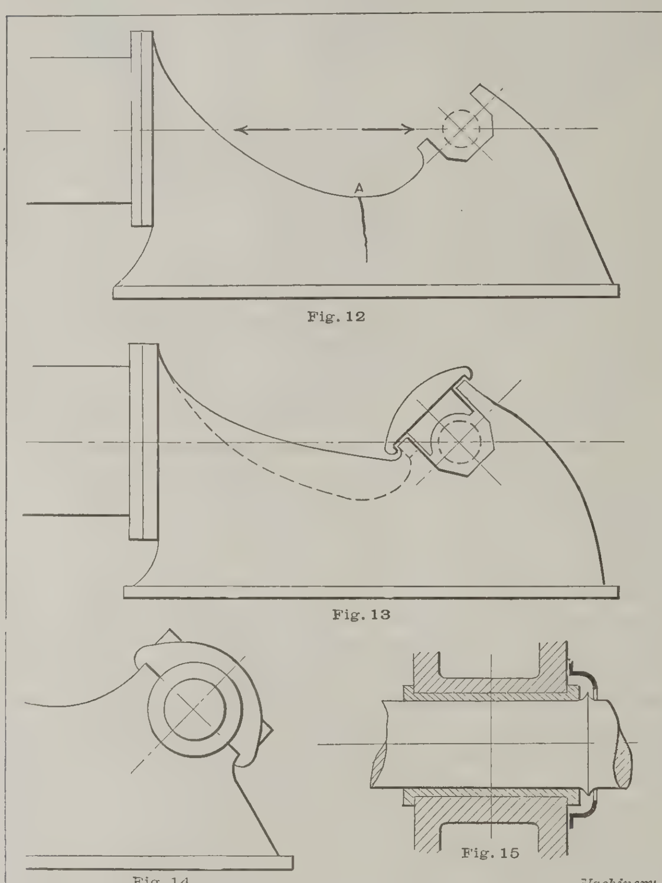
Diesel engines, which are almost universally constructed in this way.

While speaking of valves and valve gear, it will not be amiss to consider some of the designs used in horizontal constructions. There are still a large number of these engines constructed with horizontal valves, that is, valves with their longitudinal axis horizontal. It needs no theoretical discussion to prove that such an arrangement is incorrect; the engines themselves prove that. Such valves are bound to wear their guides and seats out of round at a comparatively rapid rate. It is no more expensive to use vertical valves, and it is no more difficult to devise the operating mechanism for such valves.

In small types of horizontal engines with vertical valves, these members are located at the top and bottom in the cylinder or head, in chambers at the side or sides, and side by side in the bottom of the combustion space. The last-named location is generally preferable on the grounds of cheap construction and simple operating mechanism. An arrangement of this kind is shown in Fig. 11. This design is open to the objection that the volumetric efficiency of the cylinder is decreased by the heating of the incoming charge, which must pass in close proximity to the hot exhaust valve. The thermal efficiency is also apt to be slightly decreased by the loss of unburned mixture, if any considerable overlap of valve events is permitted. For small engines, however, these considerations are insignificant in comparison with the advantages to be gained by this construction.

Valves in pockets cast or bolted to the walls of the cylinder are open to criticism because of the poor shape of the combustion space, the complication of the cylinder end and its jackets, and the more complicated mechanism generally found necessary; but these pockets have the advantage of making it possible to remove the valves through plugged openings, so that valve cages are not necessary. In this sense the construction is cheaper than that just recommended; but on the other hand the advantages of valve cages are so great and the difference in cost so small, that cost can hardly be urged as a justification for valves in pockets.

Such seemingly simple things as frames are often incorrectly designed, particularly in the smaller sizes of horizontal engines. It is evident that the end of the frame to which the cylinder is fastened and the end which supports the bearings tend to separate during each combustion and expansion. To prevent this they are tied together by the metal in the frame. The most effective way to tie two pieces together against the action of separating forces is to put the tie member in such a position that its gravity axis coincides with the line of action of these forces. If this is not done there must be a bending moment on the binding member. A common type of frame is shown in Fig. 12. The two arrows in the center line show the line of action and the directions of the separating forces. It is evident that the upper surface of the frame will tend to separate at some such point as *A*. The result will be a crack extending downward. The trouble can be remedied by raising the upper lines of the frame as shown in Fig. 13, in which the dotted lines indicate the construction of Fig. 12. This results in bringing the gravity axis of the frame section nearer to the center line of the engine and thus reduces the bending moment.



Figs. 12 to 15. Frame and Bearing Design

Many designers deem it desirable to use a bearing split at an angle as shown in Fig. 13, in order to take up the maximum thrust with the strong, cantilever-like piece which backs up the bearing. With this design it is difficult, although not impossible, to carry the top line of the frame as high as desirable, and as a result many of the engines now built in this way have abnormally strong bearings in proportion to the strength of their frames. In all but the smaller sizes it is better to use a design such as that shown in Fig. 8; it gives more nearly the same strength in different parts of the frame. Some makers are still using the type of bearing shown in Fig. 14. For this type there can be no justification. The maximum thrust must be taken largely by the cap and transmitted to the frame through the studs which hold that cap in place.

Another fault in some frames as now built in this country is to be found in the footings or surfaces on the lower side of the frame which are to rest on the foundation. In large engines, which may reasonably be expected to receive proper care in erection, it is good practice, when necessary, to use transverse footings within the walls of the frame, as shown in Fig. 8. In small engines there is no need for such supporting surfaces. The support furnished by the feet on the walls at side and end, is amply sufficient, and bearing surfaces inside of the walls may do more harm than good in the hands of a careless erector.

The downwardly projecting crank-case is a weak point in many engines of the smaller type. In large engines it is often necessary, if the shaft is to be at a convenient height above the floor, but this argument does not hold for the smaller sizes. Where small engines are designed as stock types, it is far better to protect the bulge of the crank-case with slightly deeper frame walls.

Many designers have not yet realized the desirability of an oil groove or channel on the outside of the frame at the bottom. Such a groove adds little to the molding cost, but adds materially to the ease with which the engine and foundation can be kept clean and free from oil. The channel should be properly sloped to insure drainage, and a drain provided at the lowest point, preferably at the front of the engine. It should also be noted that oil channels which are broken up into several undrained or imperfectly drained parts by bosses for foundation bolts are little better than no channels at all.

In the same class with these oil channels are oil guards over the crank-case in horizontal engines, and oil drains at the lowest point of the crank-case in all types. Unfortunately these are often ignored through ignorance, or as a foolish means of cutting down costs. Many of the larger engines in which oil channels, crank-case guards and oil drains are provided as a matter of course, are still faulty in that no provision is made for taking care of the oil which works out of the bearings and along the shaft. Splash rings and guards, such as those shown in Fig. 15, are not very expensive, and they materially assist in maintaining cleanliness.

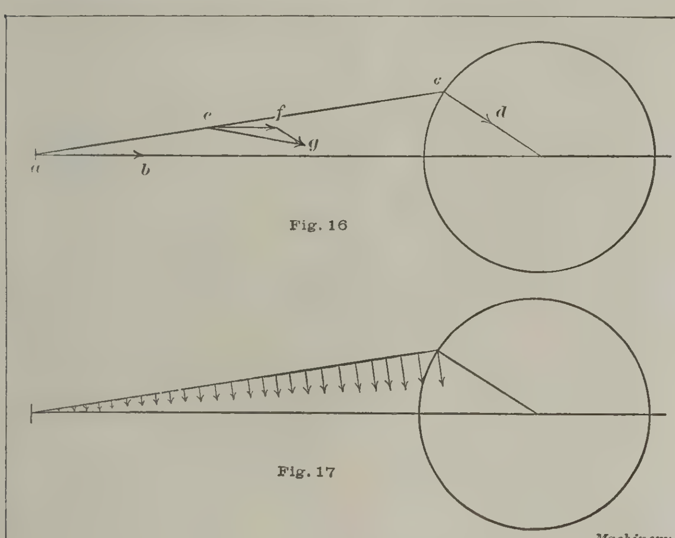
A very weak point, characteristic of American design, is the exposed or partly exposed gear. When possible, cam shaft and similar gearing should run in an oil bath and be entirely enclosed. There are, however, many types in which such an arrangement would be very expensive, but this should not be used as an excuse for leaving these gears poorly protected or not protected at all. Danger of injuring the attendant is not the only thing to guard against; it is also necessary to prevent accidental damage to the gears. There are many engines now on the market in which the gears are so protected that it would be practically impossible for an attendant to get caught in them, but which have the guards arranged in such a way that tools can easily be dropped onto or between the meshing teeth. Several engines which were temporarily disabled in just this way within a few weeks after installation have recently come to the attention of the writer.

Another weak point in American design, which fortunately is now being rapidly eliminated, is the use of a malleable iron connecting-rod. It is generally conceded that the proper material for connecting-rods is steel, forged or cast in the smaller sizes, and forged in the larger. It is true that malleable rods are used only on single-acting engines, in which the maximum load puts the rod in compression, but these rods are too weak and are liable to fracture. The compression loading is only part of the story. Every connecting-rod, in operation, is also loaded like a beam, and iron is notably not the proper material for use in a beam. This beam loading is illustrated in Figs. 16 and 17. The acceleration at the wrist-pin end of the rod is shown in Fig. 16 by the arrow *ab*, and the normal acceleration at the crankpin end by *cd*. Any point between these two is subject to an acceleration which may be regarded as made up of two components, one parallel to and smaller than *ab*, the other parallel to and smaller than *cd*. These components and their resultant are shown for one point in the length of the rod by *ef*, *fg* and *eg*. If the normal accelerations of all the points be found, they will be about as represented in Fig. 17. Since there can be no acceleration without an accelerating force, there must be forces acting along the length of the rod in the same general way as do the accelerations in the illustration. It will be observed that these forces load the rod as a beam. The existence of these forces also shows the folly of using an H-section as is done by some makers. An I-section is rigid in the plane of rotation and

is well able to care for the beam loading; an H-section is not sufficiently rigid in this direction.

While on the subject of connecting-rods, it would be well to speak of the methods provided for taking up wear at the two ends. In normal operation the wear at the crankpin end will be far in excess of that at the wrist-pin. The design of adjustments which will leave the distance between the pins the same is, therefore, practically impossible. The designer must decide whether the rod is to grow shorter with age, giving decreasing compression and efficiency, or whether it is to grow longer with the opposite results, and with the possibility of causing preignitions because of high pressures. The former is generally preferable as being safer, although the kind of fuel, the compression pressure for which the engine is designed, the kind of attendance which may reasonably be assumed, and a number of other considerations should also be given due weight in arriving at a conclusion. One case has come to the writer's attention which is interesting as illustrating what extreme conditions may be attained in practice. Wear was taken up in such a way as to lengthen the rod to such an extent that the first piston ring was driven into the counterbore of the cylinder and effectually locked the piston. This is, of course, a most exceptional case, but serves to show what is possible with some engines in some hands.

It has become recognized as desirable to provide means for adjusting the time of ignition while the engine is in operation. There are still many engines built in which such adjustment cannot be made. It may surprise some, but it is nevertheless a fact, that several large engines which are commonly recognized as "standard designs" have no such provision. The convenience of being able to adjust the time of ignition during operation can hardly be questioned, and it is absolutely necessary with producer gas engines.



Figs. 16 and 17. Forces acting on Connecting-rod

Another weak point in many ignition systems is the lack of proper provision for taking up wear. The parts are of necessity rather small, and rub across one another millions of times per year. Adequate lubrication is difficult, and wear is certain. Such systems should always be so arranged that the effect of wear upon the timing can be compensated for in a simple manner, and that considerable wear can occur before it is necessary to replace parts of the apparatus. It is rather remarkable that more manufacturers have not deemed it advisable to adopt the high-tension system which has proved its worth under the severe operating conditions pertaining in automobile practice. This type combined with careful construction can be relied upon to give most satisfactory results.

* * *

The methods of Russian high finance are startling, if we can accept the report current in regard to the use of certain die-casting machines recently bought. It is alleged that ten die-casting machines were lately bought by the Russian Government from a New England concern, for making certain Russian coins. The price was the mere bagatelle of $40,000 each.

THE INFLUENCE OF HEAT ON HARDENED TOOL STEELS*

By testing various samples of carbon steel in the tool steel testing machine designed by the author, it was found that carbon tool steels have a very low durability at a low cutting speed; that there is an increase of durability as the cutting speed increases; and that a maximum durability of cutting speed is obtained at about 50 to 80 feet per minute. There is then a decline of durability to a very low value if the cutting speed is further increased. These general characteristics are common to all tool steels that have been tested, whether of the carbon or high-speed steel type (tungsten or tungsten-vanadium varieties). All of these give, when the durability is recorded in diagrammatic form, a single- or double-peaked curve, according to the heat-treatment they have received. All show a low durability at low cutting speed, this characteristic being especially marked in the case of some high-speed steels, which latter often retain their durability at very high speeds.

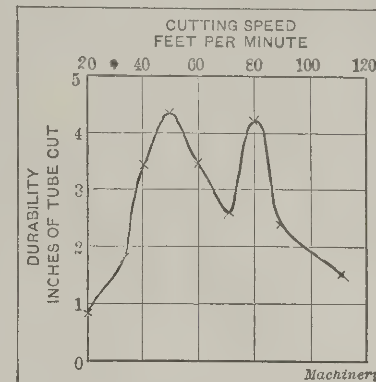


Fig. 1. Example of Double-peaked Durability Curve

The author, at a previous occasion, has pointed out that the observed changes in the durability of cutting tools are mainly caused by the changes in the temperature of the cutting edge, due to the heat generated at different cutting speeds. This heat theory has been confirmed by experiments showing that changes of durability corresponding to those which occur under varying cutting speeds can be produced by varying the temperature of the tool in other ways, while the cutting speed remains constant—for instance, by varying the temperature of the water with which the tool is flooded, or by varying the depth of the cut (a heavy cut generating more heat than a light one), or by dispensing entirely with the cooling water.

The various problems that were dealt with in the experiments were as follows:

1.—It has been found by experiments on the tool steel testing machine that all tool steels, without exception, have a very low durability, and are very quickly blunted when cutting under water at low speeds and fine cuts, that is, under conditions which preclude any considerable heating of the cutting edge; and it has been found that any alteration in the cutting conditions which tends to increase the temperature of the cutting edge results in an increased durability of the tool. What, if any, are then the correlative changes in the physical properties (strength, hardness, toughness, etc.) of hardened steel which occur when it is raised from a low to a higher temperature?

2.—All varieties of tool steel have been found to be capable when suitably hardened, of producing double-peaked speed-durability curves (see Fig. 1), the characteristics of such steels being that at a certain speed they are less durable than at either a higher or lower speed. Is it possible to correlate this low durability at a certain speed with a particular physical condition at a certain temperature?

3.—All tool steels are found to lose their durability when the cutting speed is raised above a certain limit. Is there any corresponding change in their physical properties when they are heated above a certain temperature?

4.—Assuming that each cutting speed corresponds to a definite temperature of the cutting edge (the weight of cut and all other conditions remaining constant), what are the actual temperatures of the cutting edge corresponding to the various cutting speeds, and corresponding to the various changes in the durability and physical properties of the steel?

Before dealing with these problems, it is necessary briefly to consider the nature of the actions tending to wear or blunt a cutting tool, and the correlative physical properties constituting durability, which the tool must possess in order to withstand these actions. The principal action to which a tool is subjected in cutting is one of friction under heavy pressure. This tends to rub away the surface of the steel, by causing

* Abstract of a paper read by Mr. Edward G. Herbert before the Iron and Steel Institute, Great Britain, at the May, 1912, meeting.

the particles of steel to slide over one another. To resist blunting by this action a tool must possess hardness. But the stress on the tool point is not constant: as the chip is detached it breaks up into a series of short segments (more or less completely separated), and this process subjects the tool to a succession of changes of pressure, amounting almost to blows, and tending to chip off portions of the cutting edge. To withstand this action the tool must possess toughness.

If we make a tool of glass and another of copper, and use them to turn a cylinder of soft material such as lead in the lathe, we shall find that both are very soon blunted, but from totally different causes. The glass tool, though extremely hard, is brittle, and is blunted by the chipping away of minute particles of the cutting edge. The copper tool, though very tough, is soft, and is blunted by the rubbing away of the cutting edge. If now we imagine that by some subtle alchemy we can gradually change the tool of glass into one of copper, it will probably pass through some intermediate stages where it will retain some of the hardness of glass without all its brittleness, and will have attained some of the toughness of copper without all its softness. The tool in this intermediate state will probably keep its sharp cutting edge much better than either the glass or the copper tool.

In order then to measure, throughout a range of temperatures, those physical properties of steel which constitute its durability, it is necessary to test it at each temperature for hardness and for toughness. Experiments with suitable apparatus were, therefore, carried out for measuring the hardness and toughness at various temperatures, taking into consideration such factors as different methods of grinding the tools, etc. The experiments made it possible to answer the questions propounded above, as follows:

1.—The low durability of all tool steels, cutting under water at low speeds and light cuts, seems to be completely explained by the low values of hardness and toughness which always occur at cutting temperatures of 50 to 100 degrees C. (122 to 212 degrees F.). The breaking tests have shown in every case the product, hardness times toughness, increases in value as the temperature is raised above 100 degrees C. The cutting tests have shown in every case that the durability increases when the cutting speed is raised above 20 feet per minute. These cutting tests have also shown that the durability always increases when a tool working at 20 feet per minute is allowed to cut dry instead of with water, or with hot water instead of cold. It is impossible to doubt that these are different manifestations of the same physical change in the steel.

A clear recognition of this phenomenon is of great practical importance. A great deal of the metal cutting in every machine shop consists in taking fine finishing cuts, often with water on the tool. If such cuts are taken at a slow speed, the temperature of the cutting edge may not rise above 100 degrees C., in which case the tool will be quickly blunted. Its durability can be increased by increasing the speed or by cutting dry. Many cases are known to have occurred in ordinary workshop practice, where an increase in cutting speed has actually resulted in increased durability of the tool. Low durability at low cutting temperatures (on, for example, finishing cuts) is a familiar characteristic of high-speed steels, and is most marked in tools which have been suitably hardened for very high temperature work. High-speed steel can be so hardened as to retain its durability at fairly low temperatures, and there are now on the market tungsten steels specially adapted for low temperature work, such as finishing very heavy forgings; but every description of steel known to the author loses its durability if the cutting temperature is low enough. It should be noted that a low cutting temperature can only occur when there is a combination of low speed with light cut. A heavy or moderate cut raises the temperature of the cutting edge above 100 degrees C., even at very slow speeds.

2.—The phenomenon of the double-peaked curve is not completely elucidated, though the evidence goes some way to explain it. The variations of hardness and toughness with temperature are of a complicated character, and the cleft between the two peaks of a durability curve appears to be caused by the conjunction of depressions in the hardness and toughness curves at a particular temperature. The relative heights of the two peaks are found to vary with the conditions of cutting, and this variation may be due to a change in the relative importance of the hardness and toughness factors, according to the quality of the material cut, or the shape of the tool.

3.—The decline in durability which takes place when a certain limiting speed is exceeded, is evidently caused by an actual softening of the cutting edge by the heat generated in cutting. This softening, which is extremely local, takes place even when the tool and the work are practically immersed in running water. The speeds and temperatures at which the softening occurs depend largely on the particular hardening process which has been applied to the tool, and are generally highest in high-speed steel.

4.—It is not yet possible to establish an exact scale of cutting temperatures corresponding to the scale of cutting speeds, but a comparison of the temperature-durability tests with the speed-durability tests enables us to make an approximation, as in Fig. 2.

To establish the relation between the speeds of cutting with and without water, a comparison was made between the various results obtained in the tests, from which it appears that the effect of using water is approximately to double the cutting speed; in other words, the edge of a tool flooded with water attains about the same temperature as the edge of a tool cutting dry at half the speed. This must not be taken as a general statement applicable to all cutting operations. The dry cutting temperature depends largely on the volume of metal operated upon. The tube used in the tool steel testing machine is small in diameter and light in section; it becomes considerably heated under a dry cut. In machining a large forging, the body of metal absorbs a great deal of heat, with only a slight rise in temperature, and the use of water has less effect on the cutting speed.

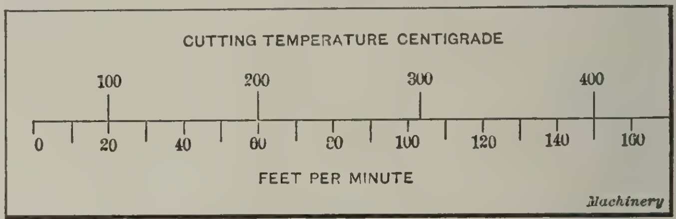


Fig. 2. Approximate Scale of Cutting Temperatures and Cutting Speeds, when Testing in Tool Steel Testing Machine

Considerable interest attaches to a comparison of the durabilities of carbon and high-speed steels. It appears that the high-speed steel has two distinct features of superiority. The speeds at which it attains its maximum durability are not very different from those at which carbon steel is most durable, but the high-speed steel is several times as durable at these speeds. Quite distinct from its superior durability at moderate cutting temperatures is the property possessed by high-speed steel of retaining some durability at temperatures high enough to soften carbon steel, but its actual durability under such conditions is much less than under conditions which do not unduly heat it. In other words, its abrasive quality appears to be more important than its heat-resisting quality.

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ERRORS IN JUNE DATA SHEET

We have been advised by the Society of Automobile Engineers that a few errors appear in the specifications for heat-treatment of carbon and nickel alloy steels reported by its Iron and Steel Division, January, 1912. The data of this report which was condensed into the June Data Sheet also contains the errors which are as follows: In Table I, reduction in area for annealed 0.10 carbon steel should be 55 to 65 per cent instead of 60 per cent; elongation of 0.50 heat-treated carbon steel should be 5 to 20 per cent instead of 0 to 20 per cent. In Table III, elongation of 0.40 carbon high nickel-chromium steel should be 2 to 15 per cent instead of 0 to 15 per cent; same for 0.45 carbon high nickel-chromium steel; and 150,000 to 225,000 pounds elastic limit for heat-treated 0.50 carbon chromium-vanadium steel instead of 150,000 to 200,000 pounds.

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A few years ago engineers considered that 8, 10 or 12 square feet of heat transmitting surface per boiler horsepower was good practice, but improvements in the circulation system of steam boilers have made possible great increases in efficiency and now the ratios have been cut down to 4, 5 or 6 square feet per boiler horsepower.

THE RIVETT INTERNAL GRINDING MACHINE IN THE AUTOMOBILE FACTORY*

By CHESTER L. LUCAS†

The manufacture of automobiles has done much to develop general machine shop practice, and the necessity for mechanisms requiring hardened and ground parts has created a demand for the best that can be produced in grinding machinery. In internal grinding of the smaller variety, considerable trouble was met with at first in securing a suitable quill-spindle that would maintain its accurate adjustment and still run at the high speeds required in the grinding of holes of small diameter. A second difficulty was encountered in grinding holes perfectly straight, without tapering or "bell-mouthing." Grinding machine builders soon recognized the fact that before internal grinding could become of great value as an accurate machining operation, these two primary troubles must be overcome.

One of the first persons to recognize the possibilities of internal grinding, as well as the limitations of the machines in

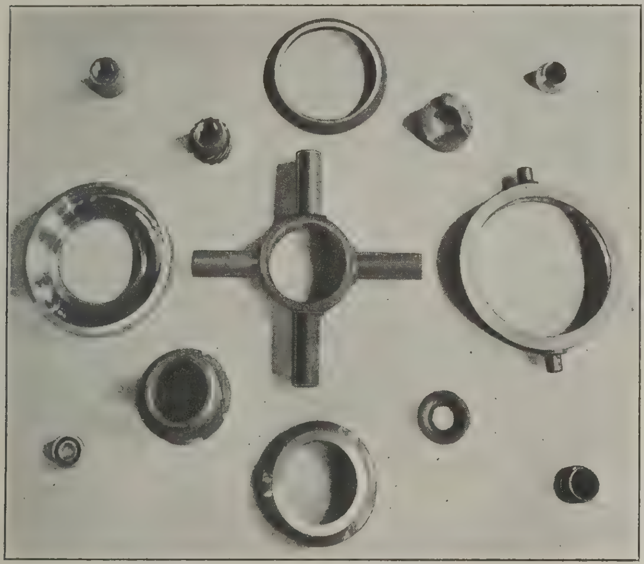

Fig. 1. Some of the Automobile Parts ground on Rivett Grinding Machine at the Stevens-Duryea Co.'s Factory

use, was Mr. Edward Rivett of the Rivett Lathe Mfg. Co., Boston, Mass., who, in 1900, took out a patent on an improved form of grinding machine quill-spindle. This spindle was designed to run at the high speed required for internal grinding and was designed particularly to overcome the end shake of the spindle, as well as to insure the proper fit of the spindle in the bearings. Essentially, this spindle consists of a centrally located shaft upon which is a fixed collar. Against this collar, sleeves are fitted which may be adjusted laterally

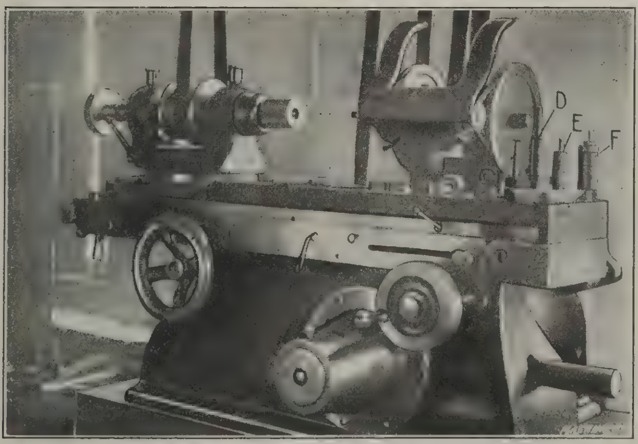

Fig. 2. Grinding the Bores of Tappet Rolls

against suitable washers which bear against the sides of the collar, thus effectively taking up the end thrust. The spindle itself runs in two split bushings, one on each side of the collar. These bushings are adjusted to the spindle by means of two sets of tapered wedges fitted in holders placed about these bushings. With this spindle, which is driven by belts passing from pulleys at both ends of the quill-spindle, speeds as high as 100,000 revolutions per minute can be obtained, although the usual speed employed is far less.

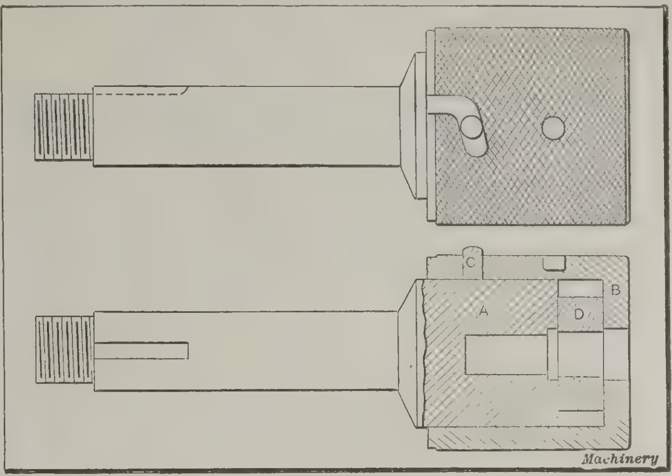

Fig. 3. Method of holding Tappet Rolls for Grinding

This style of spindle was used successfully for several years, until in 1907 Mr. Rivett brought out the new high-speed ball bearing spindle, which has superseded the former one. This spindle has specially designed ball races, made of a high grade of steel, and ground and lapped on Rivett ball grinding machines, which makes it a most rigid and durable type. The adjustment of these spindles is very simple, as there is but one screw, which governs both the end and side shake simultaneously.

In meeting the second obstacle in the path of successful internal grinding, that is eliminating the tendency toward grinding tapering or bell-mouthing, an important problem was solved. It was generally conceded that this tendency toward

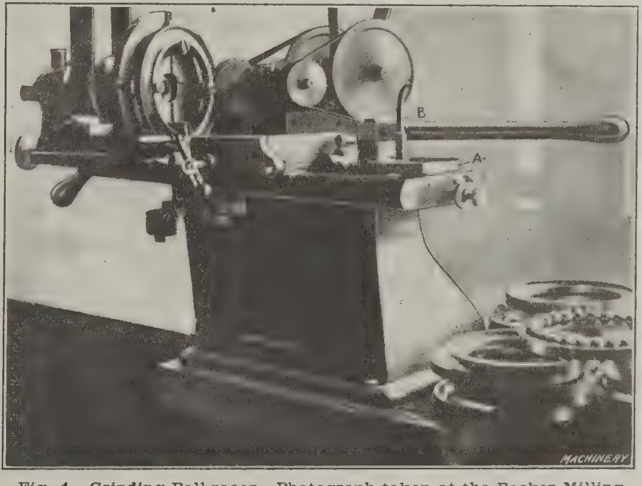

Fig. 4. Grinding Ball-races. Photograph taken at the Becker Milling Machine Co.'s Shops, Hyde Park, Mass.

bell-mouthing in internal grinding was due to the fact that in reciprocating the table of the grinding machine in the ordinary way, the table moved with varying speed throughout the whole distance of travel. Thus, at the extreme ends of the stroke the table was moving more slowly than at the central portion; consequently more stock was removed from the ends of the hole than from the central portion, as the wheel was in contact with the work longer at these sections. In 1904, Mr. Rivett patented a mechanism for changing rotary into reciprocating motion, and applied the principle to his grinding machines. In brief, this mechanism consists of a lever mounted on the base of the grinding machine and fulcrumed near its central point. The upper end of this lever is connected to the table by means of a link, and the lower end carries a roller whose position is adjustable in relation to the fulcrum. This roll serves as a means of contact with a conical heart-shaped cam.

The object of this special table traversing motion is to pro-

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Holding Work for Grinding," March, 1912; and "Internal Grinding Practice in the Hardinge Bros. Shop," May, 1912.

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vide a slight retardation at the middle of the stroke. The gradually accelerated traverse of the table towards the ends of the stroke gives less cutting time on the ends than at the center, thereby producing a hole which is about one ten-thousandth of an inch larger in the center than at the ends. In order to provide for the traversing of the table on long and short strokes, the heart-shaped cylinder cam is made conical, and by moving the roll upon the lever to a suitable position along the cam, the stroke can be reduced to any desired length.

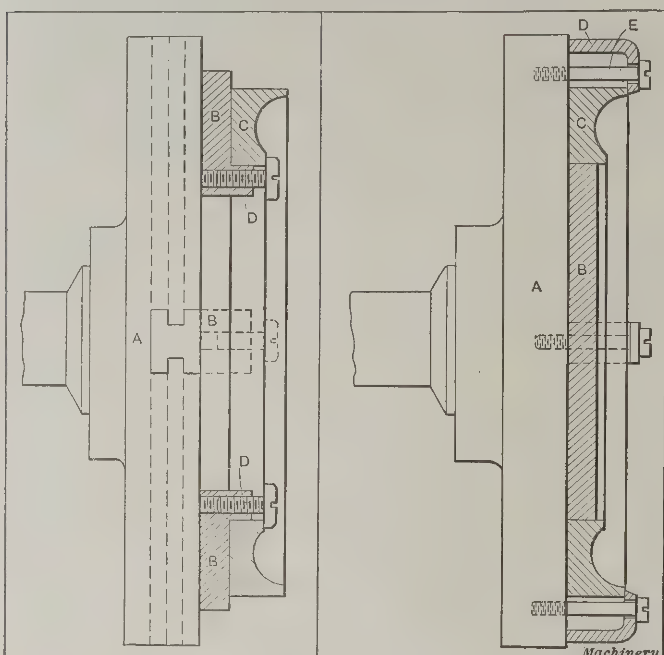


Fig. 5. Special Chuck used for the Grinding Operation shown in Fig. 4   Fig. 6. Another Method of holding this Class of Work

By thus securing an even table travel, an important improvement in internal grinding was made which enables these machines to grind internally without tapering or bell-mouthing.

Special Grinding Operations and Chucking Devices

In order to illustrate some of the possibilities of internal grinding and to show some of the chucking devices used in performing these operations, the accompanying illustrations and descriptions of modern internal grinding operations have been secured from leading automobile factories. Fig. 1 shows various automobile parts that are regularly ground in the Stevens-Duryea Co.'s factory in Chicopee Falls, Mass.

Grinding Tappet Rolls

Small tappet rolls like those shown on the end of the table of the grinding machine in Fig. 2, one of which is also shown in Fig. 1, are ground in an interesting manner on the Rivett No. 3 grinding machine. These rolls are used on the ends of the tappet rods and, when in use, are in constant contact with

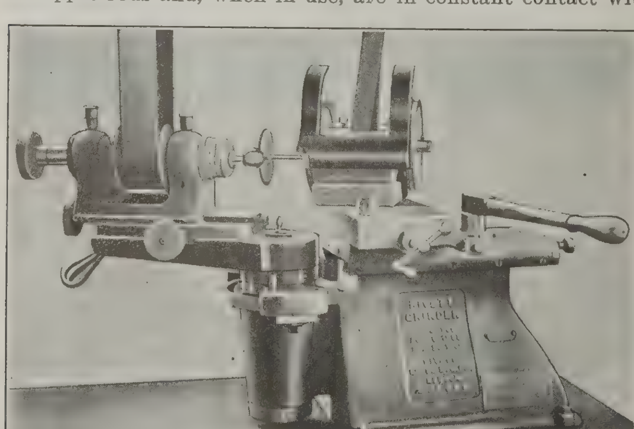


Fig. 7. Ball-grinding on the Rivett No. 5 Grinding Machine

the cams on the camshaft that operate the valves. In order to obtain satisfactory action of the valves it is necessary that the holes in these rolls be ground true with the end-faces. The rolls are first ground on these faces on ordinary surface grinding machines, and come to the Rivett grinding machines with their faces ground true and parallel.

By means of the special chucking fixture shown in Fig. 3, the rolls are chucked for the grinding of the bores, being held by their faces. This chucking device consists of a central shank *A* which fits into the spindle of a grinding machine after the manner of an ordinary draw-in collet. Over this shank, a sleeve *B* is fitted. A hole is bored in the end of this sleeve slightly larger than the hole in the tappet roll. By means of an inclined slot in the wall of the sleeve, acting in conjunction with a pin *C* driven into the shank, it is possible to hold the tappet rolls securely by the faces. This method of clamping is of the bayonet-lock order. Previous to clamping the tappet rolls in position, however, they are centrally located by means of a locating plug shown on the end of the table of the grinding machine at *D*, Fig. 2. The end of this plug is fitted to a central hole in the shank *A* of the chuck, and being a close fit for the hole in the tappet roll, the latter is thus located in a central position ready to be clamped and ground.

In grinding these holes, the grinding wheels used are of Norton make, J grade and No. 38 grit. The wheel spindle is operated at a speed of 17,500 revolutions per minute and the work spindle travels at the rate of 200 revolutions per minute. Limit gages are used for testing the work; these are shown at *E* and *F* on the end of the table of the grinding machine. The holes in these rolls are 0.4375 inch diameter and limits of but 0.0005 inch above or below are allowed. The thickness of the rolls is 7/16 inch. It will be noticed that the table and slides of the grinding machine are protected with

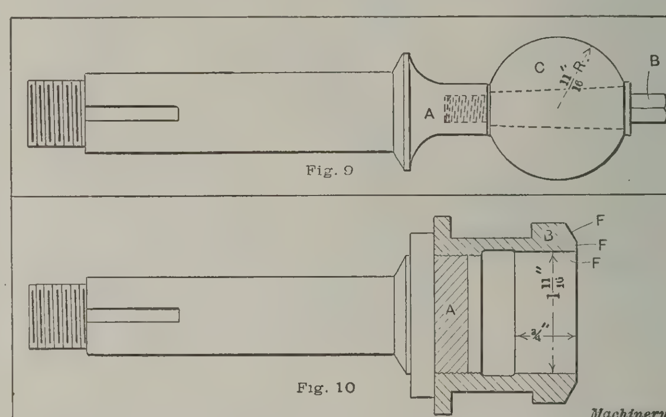


Fig. 9. How the Balls are held for Grinding. Fig. 10. Method of holding Steering Post Cones on the Grinding Machine

a wooden guard which keeps out a great deal of the emery and saves the bed from the wear occasioned by contact with wrenches and pieces of work.

Grinding the Races of Large Ball Bearings

In the shop of the Becker Milling Machine Co., Hyde Park, Mass., the races of large ball-bearings are ground on the No. 5 Rivett grinder. Some finished work is shown at the right of the machine in Fig. 4, and one of the pieces is shown mounted

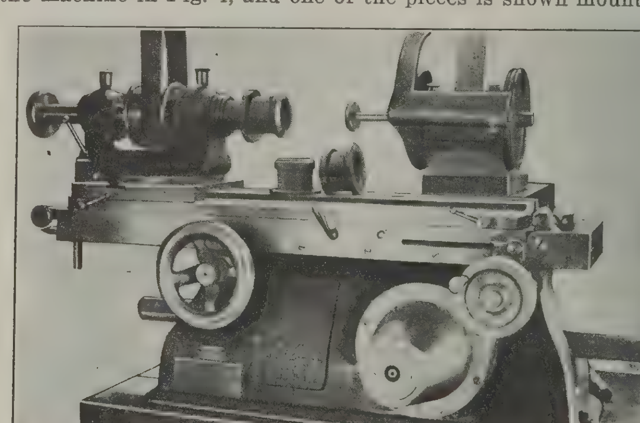


Fig. 8. Grinding Steering-post Cones

in the chuck of the machine. The method of holding the work is shown in Fig. 5. The rings are held in a chuck *A*, being gripped from the inside by means of chuck jaws *B* and held back against the jaws by means of four screws *D* whose heads extend over the inside edge of the work. In setting up the machine for this job the locating fixture shown on the end of

the machine in Fig. 4 is used. This locating fixture consists of a base *A* having, on its under side, a projecting stud that fits into a recess over the swiveling point of the work slide. At the top of arm *B* a thin steel disk of the proper radius is located, it also being at the correct distance from the center. By inserting the stud of this gage in the recess in the grinder bed, the chuck may be moved the proper distance from the swiveling point, thus insuring that the work will be ground at the right radius and to the proper diameter.

Fig. 6 is an illustration of the method used by the Stevens-Duryea Co., for holding similar ball bearing parts for grinding. This device consists of a faceplate *A* having a central stud *B* over which the ball bearing member is a close fit. For holding the work shown at *C* against the faceplate, four clamps *D*, held by screws *E*, are used. This work is ground at a spindle speed of 150 revolutions per minute, the wheel traveling at the rate of 17,500 revolutions per minute. Richardson elastic wheels, grain 80, grade 2R, are used.

Grinding Balls

One of the most difficult of grinding jobs is the grinding of a ball. This operation is shown in Fig. 7; the method of

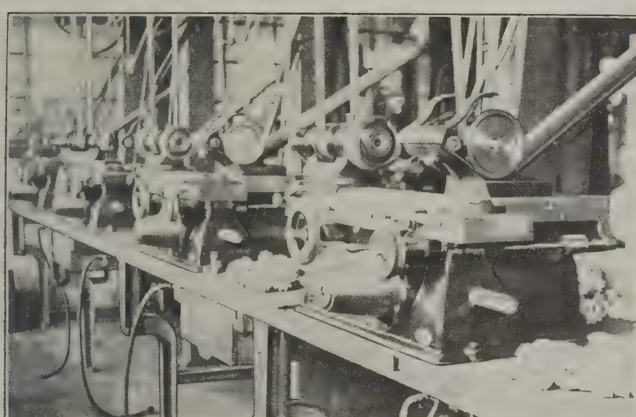


Fig. 11. A Row of Rivett Grinders in the Brown-Lipe-Chapin Gear Co.'s Factory, Syracuse, N. Y.

holding the balls for grinding is shown in Fig. 9. The holding fixture consists of a solid shank which is held in the grinding machine by the same method as an ordinary draw-in chuck. The end of this shank is tapped to receive set-screw *B* whose body is tapered to fit the tapered hole in ball *C*. After locating the work slide at the proper distance from the swivel post, it is easy to grind the balls spherical.

Grinding Steering-post Cones

The No. 3 Rivett grinding machine is also used for grinding steering post cones, an operation shown in the half-tone illus-

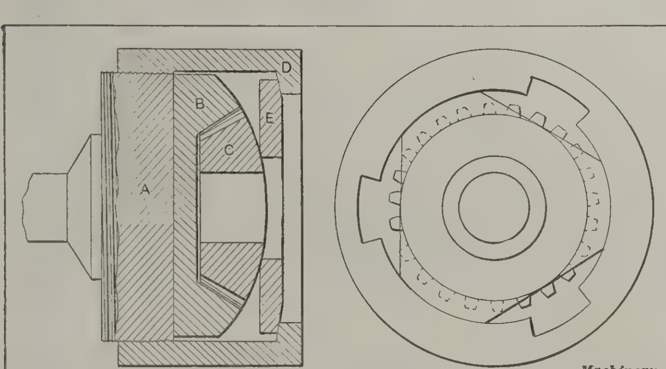


Fig. 12. Special Chuck for holding Bevel Gear Pinions for Grinding the Holes

tration Fig. 8. These cones are made from low-carbon steel and casehardened. The method of grinding these pieces is shown in Fig. 10. The work is held upon a threaded stud *A* which engages the internal thread in the piece to be ground, *B*. It is then a simple matter to grind the inside to size and also to grind the outside flange, finishing the three surfaces indicated by *F*. The work spindle revolves at the rate of 200 revolutions per minute and the wheel spindle at 17,500 revolutions per minute. The wheels used are of Norton make, being of J grade and 38-80 combination grit. The internal size must be accurate to within 0.001 inch. It is on work of this kind that the improved method of traversing the table is used to advantage, because it is essential that these pieces be ground straight—without bell-mouthing.

The Rivett Grinding Machine on Automobile Gear Work

The machines shown in Fig. 11 were photographed at the shops of the Brown-Lipe-Chapin Co., Syracuse, N. Y., where they are used for grinding the bores of small bevel gear pinions. These pinions are made from low-carbon steel and pack-hardened. As will be seen by referring to the grinding

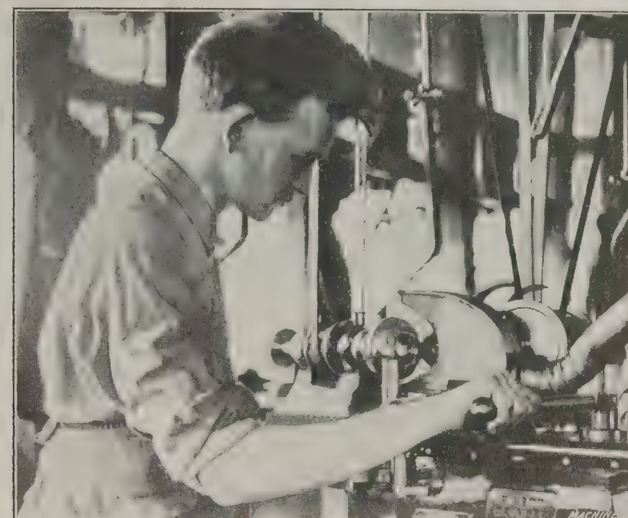


Fig. 13. Grinding the Spherical Faces of Bevel Gear Pinions

machine in the foreground, the gears are held by a special chucking device. This chucking arrangement is shown in the line illustration Fig. 12 and consists of a threaded base *A* held in the work spindle. Against the outside face of this base rests the lead matrix *B* which receives the bevel pinion *C*. A sleeve *D* is threaded onto the base and serves to draw the plate *E* down against the gear and matrix, pressing both against base *A*. In this position the bore of the pinion may be con-

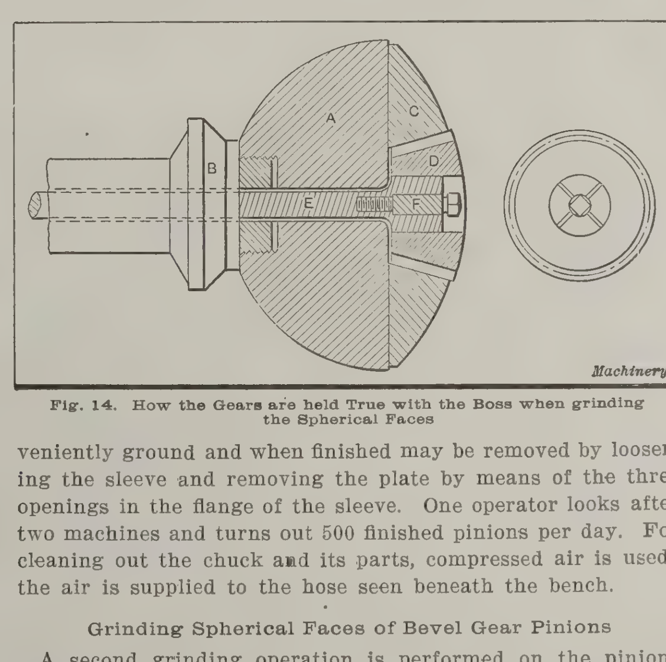


Fig. 14. How the Gears are held True with the Boss when grinding the Spherical Faces

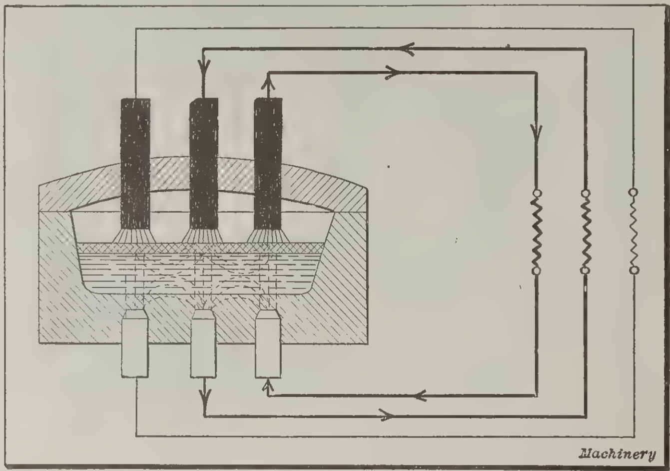
veniently ground and when finished may be removed by loosening the sleeve and removing the plate by means of the three openings in the flange of the sleeve. One operator looks after two machines and turns out 500 finished pinions per day. For cleaning out the chuck and its parts, compressed air is used; the air is supplied to the hose seen beneath the bench.

Grinding Spherical Faces of Bevel Gear Pinions

A second grinding operation is performed on the pinions mentioned above. This operation consists in grinding the spherical face, as shown in Fig. 13, the method of holding the work being shown in Fig. 14. A base *A* is threaded to the work spindle *B*. Against this base rests the lead matrix *C* in which the pinion is seated. This matrix is free to slide upon the face of the base *A*. By means of a split arbor *E*, expanded by set-screw *F*, the pinion is held by its bore, and after being gripped, is pulled back into contact with the matrix by the draw-in spindle integral with the expanding arbor. The faces of these pinions must be ground very accurately, a variation of 0.0005 inch from standard being the limit allowed. An average day's production is 650 gears.

IMPROVEMENTS IN ELECTRIC FURNACES

A paper was recently read before the Iron and Steel Institute of Great Britain by Mr. H. Nathusius on "Improvements in Electric Furnaces and their Application in the Manufacture of Steel." In this paper the author first took up the induction furnace and then the arc furnace, calling attention to the advantages and disadvantages of each. One of the disadvantages of the induction furnace is that the electrically induced heat can only be generated in the metal bath and not in the slag, which must, therefore, be heated indirectly by the underlying metal. It is, however, uneconomical to heat the slag by means of molten steel as the melting point of the latter is lower than that of the slag. Consequently, a higher



Diagrammatical View of the Nathusius Electric Furnace

temperature has to be imparted to the metal bath than would otherwise be necessary.

The objection to the arc furnace, while it otherwise has exceptional advantages, is that while it heats the slag and the surface of the charge exceedingly well, it does not offer as good a means for heating the charge itself as does the induction furnace. Mr. Nathusius has, therefore, for many years made a special study of arc furnaces and their working conditions, and while he was soon obliged to acknowledge the great advantages of electric arc heating, the idea occurred to him at the same time that it might be possible to combine the advantages of the arc furnace (good heating of the slag) with the advantages of the induction furnace (heating in the charge itself), and thus avoid the disadvantages of both systems. It became evident to him at once that the electric current offered the possibility of applying heat not only at the surface of the charge, but also at any part where an intense heat is required, such as in the charge itself and especially at the bottom of the furnace. He also recognized that the natural method of heating consisted in applying heat not from above but below. If this could be effected by some simple means a substantial advantage over other arc furnaces would be gained.

In order to meet these requirements, he has constructed a furnace which consists of a combination of an arc and resistance furnace, as indicated diagrammatically by the accompanying engraving. The characteristics of this furnace are that it has three carbon electrodes above the surface of the charge which project through the roof into the furnace, and three or a multiple of three bottom electrodes of mild steel rammed in the hearth. The upper as well as the bottom electrodes are arranged in an equilateral triangle. In this way as much as possible of the energy required for a particular furnace may be transferred to the bottom of the bath and the method of heating thus approximates that of an induction furnace. By the aid of special means for the distribution of the current, it is possible to transfer a greater or smaller amount of energy to the arcs at the surface or to the bottom electrodes, as desired. The current employed is a three-phase alternating current.

The three surface carbon electrodes are connected to the outer terminals of the secondary windings of the furnace transformer and the three bottom electrodes are connected to the three inner terminals of the secondary coil. The three inner terminals of the transformer are obtained by separating the windings at the neutral point where the three secondary windings of an ordinary three-phase transformer are connected. By this means the neutral zone—it is permissible for the sake of clearness to thus represent the electric conditions—is transferred to the bath itself and the current must gravitate from all points of supply toward this neutral point. In other words, the current, though supplied from a single source only, is forced to flow not only between the upper and bottom electrodes, but also between any upper electrode and any bottom electrode. It is thus possible, with a single source of current, to heat the charge in all parts, provided that its resistance is sufficiently high or that the current is strong enough to produce sufficient heat in the charge when the resistance is low.

INTERESTING PRINCIPLE APPLIED TO A BORING JIG AND PLANING FIXTURE

An interesting principle applied to boring and planing jigs is shown in the accompanying illustrations. Fig. 1 shows a jig which was made for boring the holes in the head of the boring machine built by the Cleveland Machine Tool Works, Cleveland, Ohio. The jig consists essentially of a planed and grooved base to which brackets carrying bushings for guiding the boring-bar are attached. The principle followed in boring these brackets for the guide bushings is illustrated in Fig. 2.

The bracket *A*, at the extreme right in Fig. 1, is slid along to the other end of the fixture, as shown in Fig. 2, and then the other bracket *B* is clamped to the right of it. This is done so that the lugs at the base of the brackets do not interfere with clamping them close together. This arrangement facilitates the accurate boring of the holes in the brackets, both laterally and vertically. Slight errors in alignment existing when the holes are bored are greatly reduced when the brackets

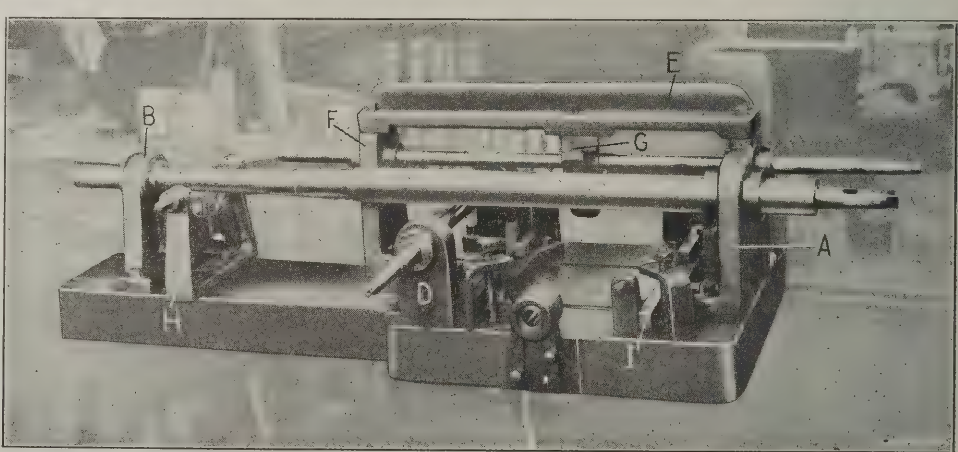


Fig. 1. Boring Jig used by Cleveland Machine Tool Works for boring Machine Heads

are set at opposite ends of the base. In fact, the principle insures that the centers are practically the same distance from the base and in line with the axis of the base slot or groove when they are placed in their respective positions on the fixture. The brackets, of course, are provided with lugs formed on their bases, which accurately fit in corresponding grooves in the jig base.

The bushing guide holes in the bracket *A* and the corresponding holes in the other bracket were at the vertices of a triangle, as is shown at *C* in Fig. 2. The lines joining their centers were neither parallel to the platen nor to the vertical travel of the boring machine head. So the lengths of the bases a, a_1 and altitudes b, b_1 of the triangles were computed to obtain the correct settings of the boring machine head for the various holes, and the settings of the head and platen were accom-

plished by means of the scales and verniers regularly supplied on these boring machines.

When the three holes in the two brackets were bored, the fixture was swung around to bore the two side brackets, one of which is shown at *D*, Figs. 1 and 3, with a boring-bar in place. The center lines of the four brackets *A*, *B*, *D*, and the one on the far side (not shown) must be at right angles. The bridge *E* was bolted and doweled to the brackets *A* and *F*, and then the center bracket *G* supported by the bridge was bored and bushed.

To clamp the work in the fixture, it is adjusted centrally in the saddle *H* by means of the screws. Then the wedges *I* under the front and rear of the right-hand end of the work are adjusted, clamped and the screws in the saddle tightened, as illustrated in Fig. 3. This gives a three-point bearing or support. To hold the work rigidly in position the wedges to the right of the center of the casting at the front and rear are adjusted and clamped. This method of clamping the casting prevents straining it, and holds it rigidly. When the wedges were first considered as a means of adjusting the work, it was thought that they would move under the cut, and thus require adjusting screws to hold them. This, however, was not the case, for after three years' service, the wedges have not been found to slip. The taper on the wedges is three-quarters inch per foot. Thirty-three boring and facing operations and six milling operations are performed on the head casting before it is unclamped from this combined jig and fixture.

This same principle of aligning the brackets applied to a planing jig is illustrated in Fig. 4, the brackets *J* and *K* at each end being bored in a manner similar to those of the jig illustrated in Figs. 1, 2 and 3. The bar *L* is employed to set the casting so that the face to be planed shall be parallel with the axis of the hole in which the bar is placed.

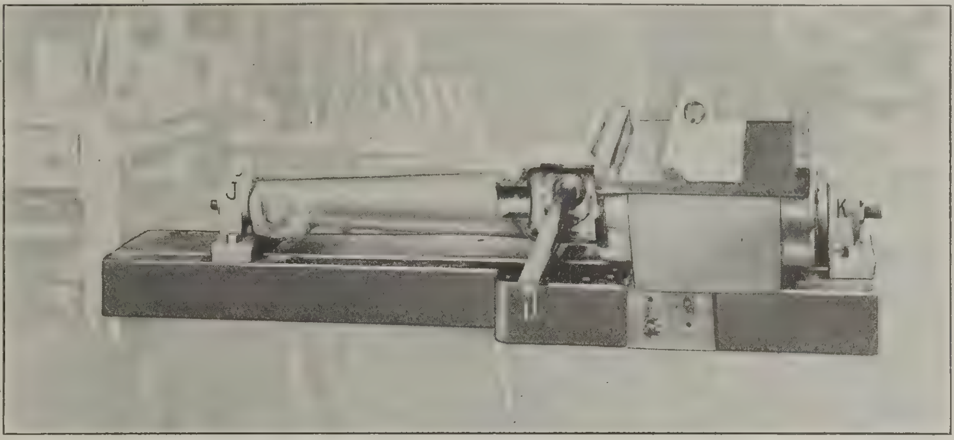


Fig. 4. Planing Fixture for Heads, made on Same Principle as Jig in Fig. 1

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The Hamburg-American liner *Imperator*, for the time being the largest ship afloat, was launched in May at the Vulcan Works in Hamburg. The length of the new vessel is 880 feet and the width, 98 feet. The gross tonnage is about 51,000 tons and the speed at sea will be 22 knots. It is equipped with four classes for passengers and can carry 700 first class, 600 second class, 940 third class, and 1750 fourth class passengers. The crew will number about 1100 so that the total number of persons on board with the accommodations fully used will be about 5100. As an indication of the enormous size of the fittings of the vessel, it may be mentioned that the weight of the anchor and chain is about 225 tons (of 2000 pounds). The diameter of metal in the individual links in the anchor chain is about four inches. One hundred life-boats will be provided on the vessel and the latest design of davits has been adopted. The electric lighting installation includes about 10,000 lamps. The vessel will be driven by four four-blade propellers of 16½-foot diameter, which are driven by steam turbines at a normal rate of 185 revolutions per minute.

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It is a whole lot easier to find fault with a foreman than it is to fill his place.

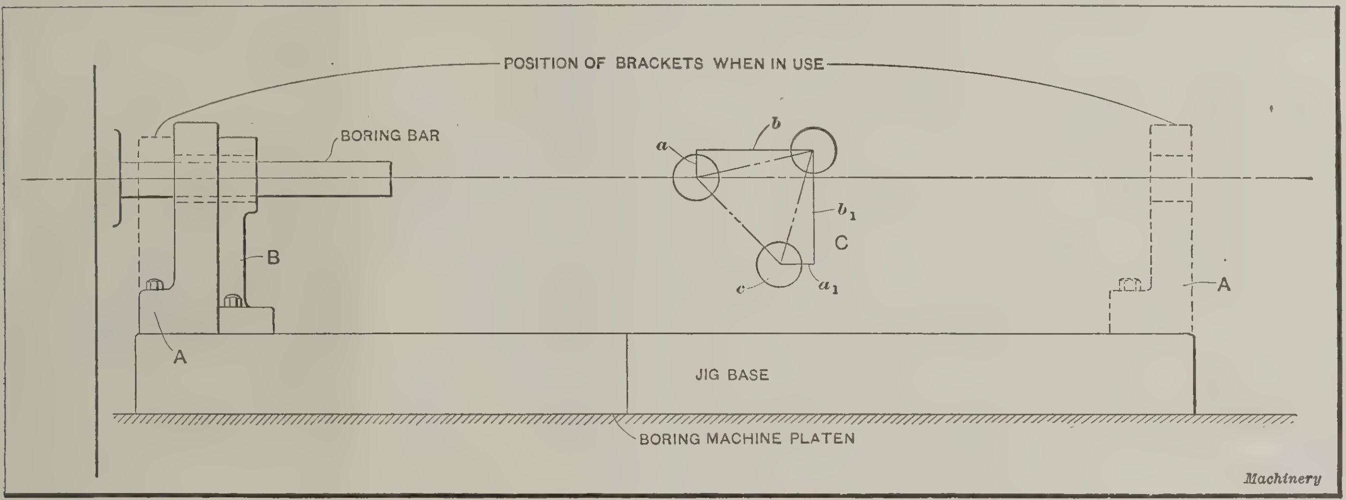


Fig. 2. Diagram illustrating Principle of Construction embodied in Boring Jig

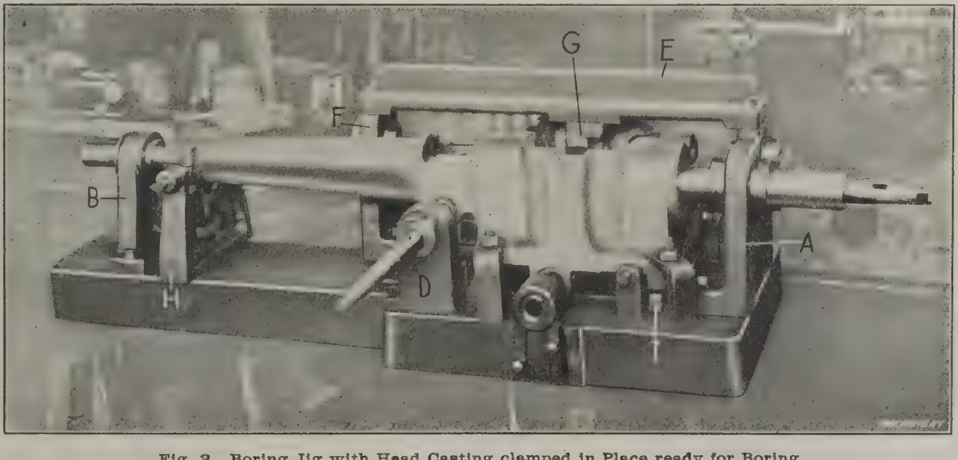


Fig. 3. Boring Jig with Head Casting clamped in Place ready for Boring

PROPOSED CHANGES IN PATENT LAWS

Several bills have been introduced in Congress during the present session relating to changes in the patent laws. In one of these, introduced by Mr. Oldfield (House Bill No. 23,417), a number of clauses are included which are of considerable interest, some of which are quoted in the following. Section 17 relates to the term of patents and their compulsory working, and reads as follows:

"Sec. 17 (R. S., sec. 4884). Every patent shall contain a short title or description of the invention or discovery correctly indicating its nature and design, and shall have annexed thereto and made a part thereof a copy of the specification, claims, and drawings of the application therefor, to which it shall refer for the particulars of the invention or discovery, and contain a grant to the patentee, his heirs or assigns, of the exclusive right to make, use, and vend the invention or discovery throughout the United States and all Territories and possessions under the jurisdiction thereof, for the term of seventeen years. But every patent granted for an invention shall be so limited as to expire nineteen years from the date of the filing, in this country, of the application upon which the patent was granted, exclusive of the time actually consumed by the Patent Office or the courts in considering the application, and where the application has been involved in interference, of the actual time in which it has been so involved, and in no case shall the patent be in force more than seventeen years.

"If at any time during the term of the patent, except the first four years, the patented invention shall not be manufactured, or the patented process carried on within the United States, its Territories, or possessions aforesaid to an adequate extent by the owner thereof, or by those authorized by him, then any person demanding it shall be entitled to a license from the owner of the patent to manufacture the invention or to carry on the patented process, unless the owner shall show sufficient cause for such inaction. Upon the refusal of such a license by the owner of the patent, the person seeking such license may apply to the district court, in the district wherein the owner has a residence or an established place of business, to compel the granting of such license. The court shall thereupon hear the person applying for said license and the owner of the patent, and, if the court is satisfied that the reasonable requirements of the public in reference to the invention have not been satisfied by reason of the neglect or the refusal of the patentee, his legal representatives, or those authorized by him to make, use, or vend the invention, or to grant licenses to others on reasonable terms to make, use, or vend the same, said court shall issue an order requiring the owner of the patent to grant a license to the person applying therefor in such form and upon such terms as to the duration of the license, the amount of royalties, security for payment, the period within which the patented invention shall be manufactured or the patented process carried on, and otherwise, as the court, having regard to the nature of the invention and the circumstances of the case, deems just.

"From the order of the district court granting or refusing to grant such a license, appeal may be taken (by the party aggrieved) to the circuit court of appeals in the same manner and form as in other cases arising under the patent laws: *Provided*, That the citizens of any country which by treaty, convention, or law provides that the manufacture of the patented invention or the carrying on of the patented process in the United States shall be equivalent to the manufacture or the carrying on of the process in such country, will be considered to have sufficiently complied with the requirements of this section if the invention is manufactured in said country within the period heretofore mentioned.

"If at any time during the life of a patent a material and substantial improvement shall be patented, the manufacture of which would be an infringement of the original patent, the owner of the improvement patent may apply to the district court in the district wherein the owner of the original patent has a residence or an established place of business to compel the granting of such a license as will enable the improvement to be manufactured. The court shall thereupon hear the respective parties, and if the court is satisfied that the improvement is of such a material and substantial nature that the reasonable requirements of the public demand that it should be manufactured and sold, the court shall issue an order requiring the owner of the original patent to grant a license to the owner of the improvement patent in such form and upon such terms as to the duration of the license, the amount of royalties, security for payment, the period within which the patented invention shall be manufactured or the patented process carried on, and otherwise, as the court, having regard to the nature of the original invention and improvement and the circumstances of the case, deems just.

"From the order of the district court granting or refusing such a license appeal may be taken by the party aggrieved to the circuit court of appeals in the same manner and form as in other cases arising under the patent laws."

Section 19, relating to the conditions under which applications must be made, reads, in part, as follows:

"Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor."

Section 32, relating to the use of patented articles by persons to whom the patentee has sold or otherwise transferred the right to use or sell the article, reads as follows:

"Sec. 32 (R. S., sec. 4899). Every person who purchases of the inventor or discoverer, or, with his knowledge and consent, constructs any newly invented or discovered machine, or other patentable article, prior to the application by the inventor or discoverer for a patent, or who sells or uses one so constructed, shall have the right to use, and vend to others to be used, the specific thing so made or purchased without liability therefor.

"Any person who purchases of the owner of a patent, or of any interest therein, any machine, manufacture, or composition of matter covered by such patent, shall have the unrestricted right to use, vend, or lease to others to be used the specific thing so purchased without liability to action for infringement; and it shall not be lawful to insert a condition in any contract relating to the sale, lease, or license to use any article or process protected by a patent or patents, the effect of which will be to prohibit or restrict the purchaser, lessee, or licensee from using any article or class of articles, whether patented or not, or any patented process supplied or owned by any person other than the seller, lessor, or licensor or his nominees; and it shall not be lawful to insert a condition in any contract relating to the sale, lease, or license to use any article or process protected by a patent or patents, the effect of which will be to require the purchaser, lessee, or licensee to acquire from the seller, lessor, or licensor, or his nominees, any article or class of articles not protected by the patent, and any such condition shall be null and void as being in restraint of trade and contrary to public policy."

Two bills have also been introduced in The House of Representatives, by Mr. Thayer, being, respectively, House Bill 11,380 and 11,381, differing only in some minor details and in respect to the penalties imposed for violations. These bills would legalize contracts to the effect that users of patented articles must buy all such supplies as are used in connection with the operation of the patented article from the owners of the patent. Bill 11,380 reads, in part, as follows:

"No person, firm, corporation, or association engaged in interstate commerce having any interest, whether as owner, proprietor, beneficiary, licensee, or otherwise, in any tool, implement, appliance, or machinery shall, directly or indirectly, in making any sale or lease of or any license to any article, restrain or attempt to restrain or prevent the vendee, lessee, or licensee from using any tool, implement, appliance, machinery, material, or merchandise not furnished by the vendor, lessor, or licensor, whether by making any condition or provision, express or implied, against such use by a term of any sale, lease, or license to use, or by requiring any obligation, express or implied, against such use from the vendee, lessee, or licensee of the article, or by imposing any restrictions upon the use of the article sold, leased, or licensed, or by making in the price, rental, royalty, or other terms of any such sale, lease, or license any discrimination based upon whether the vendee, lessee, or licensee uses or purchases any such tool, implement, appliance, machinery, material, or merchandise or not, or by any other means whatsoever: *Provided, however*, That nothing in this Act shall be construed to prevent any such vendor, lessor, or licensor from requiring that during the continuance of any letters patent on any such article no component or constituent parts of the tool, implement, appliance, or machine required for use thereon be purchased except from such vendor, lessor, or licensor, or from requiring that material to be used in the operation of any machine must be obtained from the vendor, lessor, or licensor."

* * *

A HANDY SURFACE PLATE

A convenient arrangement for holding a surface plate is used in the shops of the Cutler-Hammer Mfg. Co., Milwaukee, Wis. It consists of a heavily built and well braced table, fitted with good sized castors. The surface plate is supported on this table, which can be wheeled to any point where it may be wanted. Taking the surface plate to the work often eliminates considerable trucking of the work.

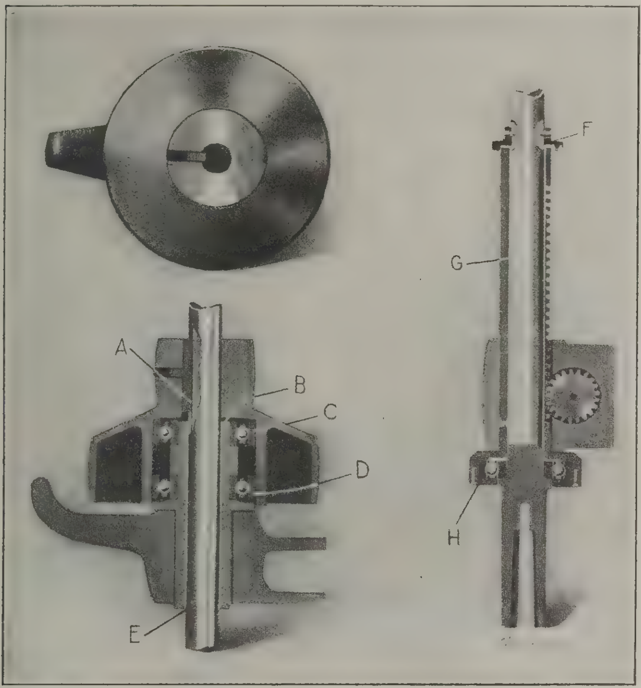
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

TOO MANY PATENTS A HINDRANCE TO PROGRESS

The article in the May number of MACHINERY on "Too Many Patents a Hindrance to Progress," raises a very interesting question: What is, in equity, a reasonable basis for the granting of patent rights? The writer of the article mentioned uses as a peg on which to hang his argument the granting of patents on the application of ball bearings to sensitive drilling machine spindles, and suggests that such patents would be valueless were it not that the maker's name and position acted as a watch dog against encroachments.

As the article in question hails from England, it appears as though allusion were made to the construction of the Alfred Herbert sensitive drilling machine. If this is so, the present



Sectional Views showing Alfred Herbert Ltd., Coventry, England, Sensitive Drill Ball Bearings—A, spindle centered by this hole; B, fixed sleeve; C and D, pulley bearings; E and G, clearance, no sleeve bearing; F, dust cap, no thrust bearing; H, the only spindle bearing

writer has no hesitation in asserting that, although the particular construction of this machine—in so far as the spindle is concerned—entails but a particular arrangement of ball bearings, there exists in this instance extraordinarily good grounds for the granting of a patent.

Novelty is a good basis, and novelty may exist in an arrangement. If mere arrangements are to be barred, then the great majority of inventions could not form suitable subjects for patents. In the drilling machine in question the spindle construction is decidedly novel—nay, more—bold. It is indeed probable that had this particular firm not put this arrangement into use, no one else would have been sufficiently bold to risk such an arrangement. As a matter of fact, ball bearing manufacturers prophesied a failure. The firm, however, in introducing it, knew from experiments that success would be assured; and, after all, if ball bearing manufacturers had but given the matter the careful attention it deserved, their own previous statements would have been sufficient evidence. Most of the catalogues of these firms recommend that journal bearings should not be subjected to more end thrust than 25 per cent of the journal pressure. This statement implies that if a journal bearing be subjected to end thrust only it would be sufficient to choose one large enough, and success would be assured. Here is now an individual who has realized this fact for the first time. Should he be debarred from obtaining a patent? If so, where must a line be drawn, in view of the fact that today the ground of mechanisms has been so covered as to make it almost impossible to invent anything entirely new?

To enable readers to judge of the merits of the case, the spindle construction is shown in the accompanying engraving. The particular advantages claimed are: First, entire absence of journal friction; note the clearance between spindle and pulley support and rack sleeve; second, cheaper construction; any other method of obtaining the same end is only possible by having one bearing to take the thrust from drilling, another to bear the weight of the spindle, and still another for the journal load; third, little necessity for oil beyond the initial supply (grease is used); the makers claim that the machine needs oiling but once a year; fourth, no adjustment necessary, the construction rendering adjustment impossible. Cone bearings—a possible construction—are by no means as efficient, and wear renders some provision for adjustment imperative.

It might be interesting to cite the fact that on machines supplied to the makers of the S. K. F. bearing, these bearings were fitted and were successful. These machines have been on the market now some four years, probably a thousand or more having been turned out in this time. This is in itself sufficient evidence of success.

The following particulars will give some idea of the power of the machine. The spindle, 1 inch in diameter, is driven by a 1½ inch belt. Without appreciable slip, ⅞ inch holes, 1 inch deep, may be drilled in cast iron (hardness: 238 Brinell) at 600 revolutions per minute in four seconds; and in machinery steel (52,000 pounds tensile strength) at 900 revolutions in 7 1/5 seconds. The accompanying table shows the complete range of the possible output:

The writer, who has had the pleasure of operating one of these machines, can assert that in drilling holes up to about ½ inch diameter, no matter what amount of weight is applied at the lever, it is impossible either to break a drill or slip the belt. In the case of the larger holes, the belt is the limiting

TABLE OF TIME FOR DRILLING ON ALFRED HERBERT SENSITIVE DRILLING MACHINES

Cast Iron			Machinery Steel		
Diameter of Drill	Speed of Drill	Time to Drill 1 Inch Deep, Seconds	Diameter of Drill	Speed of Drill	Time to Drill 1 Inch Deep, Seconds
$\frac{1}{4}$	2050	$1\frac{1}{5}$	$\frac{1}{4}$	2050	$2\frac{2}{5}$
$\frac{3}{8}$	900	2	$\frac{3}{8}$	900	$3\frac{2}{5}$
$\frac{1}{2}$	900	2	$\frac{1}{2}$	900	4
$\frac{5}{8}$	600	$2\frac{1}{2}$	$\frac{5}{8}$	900	$5\frac{3}{5}$
$\frac{3}{4}$	600	3	$\frac{3}{4}$	900	6
$\frac{7}{8}$	600	4	$\frac{7}{8}$	900	$7\frac{1}{5}$

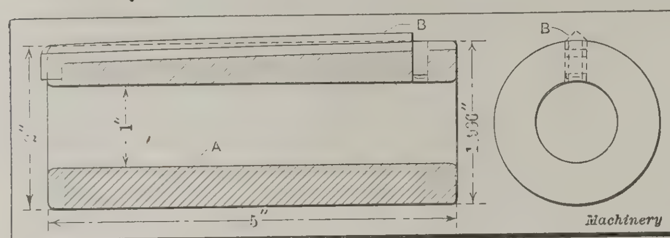
factor, but then a machine designed to drill ⅞-inch holes at the same rate as ¼-inch holes, could no longer be termed a sensitive machine. If made for ⅞-inch holes, it would be too cumbersome for ¼ inch. If it were not for the belt slipping, the journal "thrust" bearings would probably fail on the larger holes.

Didsbury, Manchester, England. FRANCIS W. SHAW

BABBITT EXPANDER AND OIL-GROOVE FORMER

Considerable trouble is met with in babbitting solid bearings when a shaft or mandrel is used as a core. When babbitt is cast around a mandrel it shrinks and grips the latter, at the same time becoming loose in the casting. In order to overcome this difficulty and at the same time provide for an oil groove in the babbitt lining, the device shown in the accompanying illustration was made. It consists of a piece of machine steel *A* which is turned and bored to the dimensions indicated, one end being 0.004 inch smaller in diameter than the other end, so as to make it easier to knock it out when fast in the babbitt. The so-called expander *B* is a piece of ¼-inch square key steel, bent over at one end, and having an angular top of about 90 degrees included angle. This piece

fits loosely in a milled slot in the sleeve *A*. The device is used as follows: A 1-inch shaft is placed through the hole in the sleeve, and the sleeve with its key is turned on the shaft until the key is in the position where the oil groove is required in the babbitt bearing. Now cast the babbitt around



A Babbitt Expander and Oil-groove Former

this sleeve and when it has set and tends to shrink away from the casting, pull the sleeve with its key out toward the left. The babbitt is then compressed upward and sideways by the key, as it passes toward the left, just enough to force it firmly into the cast iron surrounding it. J. S. B.

FIXTURE FOR FACING GAS ENGINE CYLINDERS

The fixture shown in Fig. 2 is fitted to a drill press and is used for finishing the inside face *A* of the boss of a gas engine cylinder as shown in Fig. 1. This face *A* is located in such a position that it is difficult to machine, and it is impossible to do so with a side milling cutter, so some other means had to be provided to accomplish the work. About 3/8 inch of material is to be removed from the boss.

Referring to Fig. 2, the frame of the fixture *A* is clamped to the spindle sleeve of the drill press by two bolts which are inserted through the holes in the upper part of the frame. The bar or spindle *B* is provided with a Morse taper shank which fits in the spindle of the drill press and is driven by it. The lower boss of the bracket *A* is bored out in line with the spindle of the drill press, and is bushed with a hardened and ground steel bushing *C*. Inserted in this bushing *C* is another hardened and ground bushing *D* which is prevented from rotating by means of the screw *E* fitting in the keyway cut in the bushing. Inside of the bushing *D* is a cam *J*, which is a good running fit on the bar *B*. This cam is provided with a

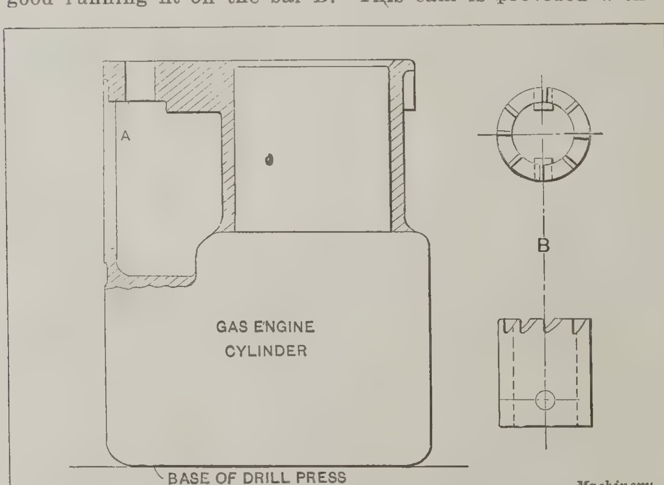


Fig. 1. The Gas Engine Cylinder and the Cutter used in Facing the Boss

spiral groove having a lead of 3/4 inch to one turn. Fitting in the spiral cam groove is a screw *F* screwed into the bushing *D*. To locate this screw in the bushing *D*, a hole *K* is drilled in the bracket through which the screw is inserted; then the bushing is rotated through an angle of 90 degrees to bring the screw into the position shown in the illustration. The lower end of the cam *J*, which is cylindrical in shape, rests on the top face of the cylinder casting and is operated by means of a handle *G* screwed into it. A thrust ball bearing *H* is interposed between the top face of the bushing *D* and the shoulder on the bar *B* to reduce the friction between these surfaces.

In operation, the spindle of the drill press with the fixture attached to it is lowered until the spindle *B* is located in the hole in the cylinder casting. Of course the cutter cannot be placed on the spindle *B* until the latter is located in the hole in the casting. When this is done, the cutter, as shown at *B* in Fig. 1, which is provided with two pins is slipped onto the end of the spindle *B*, the pins fitting in vertical grooves cut in the spindle. These grooves terminate in additional grooves, cut part way around the circumference, so that it is a simple matter to push up the cutter, turn it around, and thus lock it in position. These grooves are cut in such a manner that the cutter when in operation will be held securely.

When the cutter *I* is put in position on the spindle *B*, the operator grips the handle *G*, turning the cam in the direction indicated by the arrow. This movement of the cam imparts an upward motion to the bushing *D*, which, in turn, raises the spindle *B* and also the spindle of the drill press and the fix-

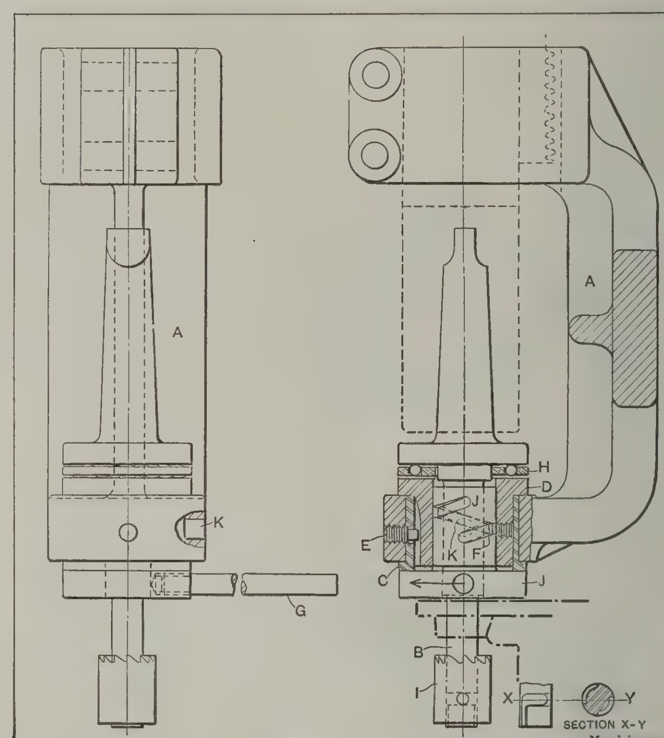


Fig. 2. The Fixture used in Facing the Boss, showing the Manner in which it is applied to the Drill Press

ture which is attached to it, the spindle being disconnected from the worm. This action brings the cutter in contact with the work, when the boss can be faced to the desired distance by simply continuing the movement of the handle *G*. The idea in designing a fixture of this type was to equalize the pressure on the casting while the facing operation was being performed. By constructing the fixture in this manner, the whole weight of the fixture is thrown down upon the bottom of the cylinder, so that the action of the cutter up against the cylinder causes an almost equal and opposing force at that point.

Detroit, Mich. WALTER F. WAGNER

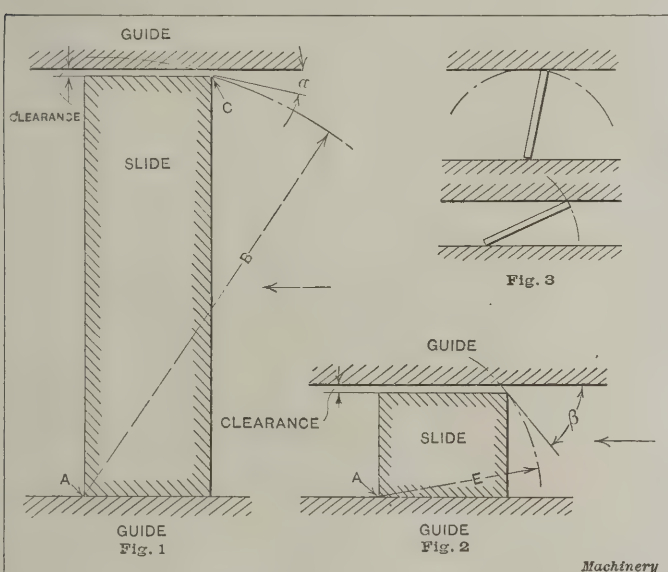
WIDE VS. NARROW GUIDES

The writer has been greatly interested in the discussion of wide versus narrow guides and believes that the ground has not yet been quite covered. Personally, he cannot agree with the conclusions of either Mr. Burley or Mr. Millar, and must endorse the view expressed in the editorial note on the subject accompanying Mr. Burley's article in the April number. Of course one must concur with some of Mr. Millar's remarks, as for example, his conclusions Nos. 3 and 4, but the conclusions Nos. 1 and 2 the writer does not think are yet proved, still holding the idea that the advantages to be gained by a narrow guide are a direct function of the relation of the slide's width to its length. His reasons for so thinking are substantially those advanced in the editorial note just referred to.

Perhaps the accompanying illustrations will make the idea plainer and introduce one element not yet touched upon, and upon which perhaps the whole matter hinges. When a slide advances between parallel guides, cross-wind may be caused

by an obstruction to one edge of the slide or by the eccentric application of the propelling force. The simplest case of an obstruction would be some grit at one edge of the slide as at A, Figs. 1 and 2. That edge is retarded and the diagonally opposite corner at once rises the clearance distance and strikes the guide. In other words, the slide in Fig. 1 when retarded at A tends to rotate with point A as a center, and the edge C describes a circular path with a radius B, the action being limited by the amount of the clearance.

Assume that the wide and narrow guides in Figs. 1 and 2 have the same clearance; when the point C of the wide guide approaches the upper guide it will do so along a certain arc, as illustrated in Fig. 1. By drawing a tangent to this arc at its point of intersection with the line of the upper guide, we form the angle α (see Fig. 1) or β (see Fig. 2) which angle may be called the "angle of approach." This angle determines the binding effect. If the angle is small, as seen in the wide guide, the friction becomes great, but if the angle is large, as in the narrow guide, the binding effect is minimized. It is really a toggle action in an unusual form. In Fig. 3 is shown a bar or gage between two walls. The binding effect is greatest when the bar can be placed in a nearly vertical position between the guides, as in the upper part of Fig. 3, while the binding effect is practically nil when the bar is at an in-



Figs. 1 to 3. Diagrammatical Views illustrating the Action of Slides having Wide and Narrow Guides

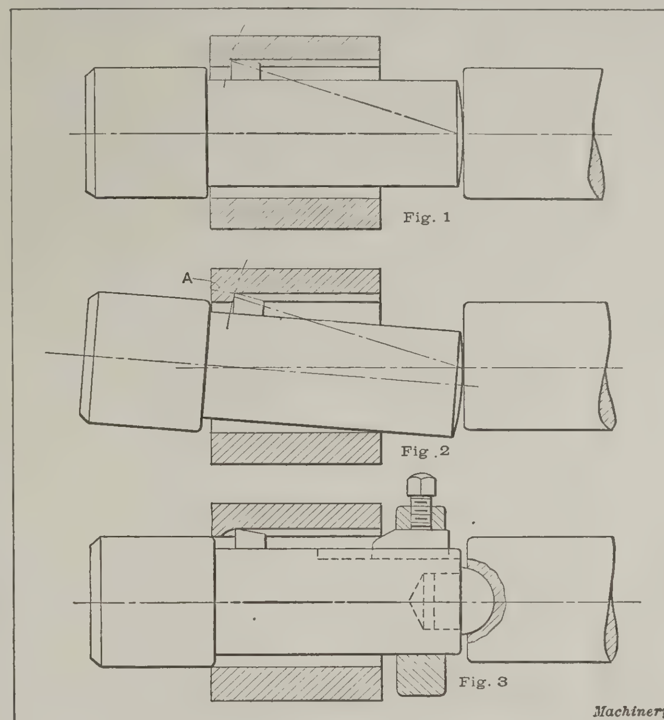
clination as shown in the lower part of Fig. 3. The writer believes that every mechanic who has noted the ease with which a plug gage, say ½ inch in diameter, 1 inch long, can be inserted in a hole and pushed along it, and who has also noted the extreme difficulty experienced when the gage happens to be of the same length, but say about 6 inches in diameter, will agree that the theory just presented is borne out by practice. S. M. RANSOME

Cleveland, Ohio.

CUTTING OIL-GROOVES IN BUSHINGS

In the article entitled "Cutting Oil-grooves in Bushings," published in the May, 1912, number of MACHINERY, an appliance similar to one which the writer saw a few years ago, but which proved to be a failure, is illustrated and described. The construction of the appliance seen by the writer is indicated in Fig. 1. This device was arranged to be used on a turret lathe, the cutter and holder being pressed in by a plain bar fixed in one of the turret holes. Instead of operating as intended, however, the shank assumed the position shown in Fig. 2 immediately after the guiding part of the cutter holder had passed out of the bushing. The cutter, instead of slipping out of the work, would proceed to cut a groove, the bottom of which would be at an angle as indicated by the dotted line A.

Now, even if the end of the shank had been flat instead of rounded, the cutter would not have left the work, but would have proceeded to cut the groove clear through. An examination of Fig. 1 will show that the cutting face of the cutter cannot possibly come out of the groove, as it is in effect undercut in relation to the path of its travel when retreating from the groove, as indicated by the circular arc shown. In order to try to improve matters, a ball and socket joint and an adjustable wedge, as shown in Fig. 3, were fitted, with the idea of compelling the cutter to leave the groove. This arrangement was fairly successful, but owing to the fact that the tool was so



Action of Device for Cutting Oil-grooves in Bushings

short, considerable force was needed, tending to damage the mouth of the hole.

Another point that might be mentioned is that the tool as shown in Fig. 1 began to tilt long before the guiding portion left the hole, and the back end of the hole was, therefore, somewhat mutilated.

The writer would like to know if your former contributor had to use any special appliances in order to insure success in his arrangement. The device shown in the accompanying illustration was abandoned and substituted by a simple slotting operation in an ordinary slotting machine. SLOTTER

SPHERICAL TURNING DEVICE

The lathe attachment shown in the accompanying illustrations, Figs. 1 and 2, and described in the following, has given good results for a long time. It was designed for the require-

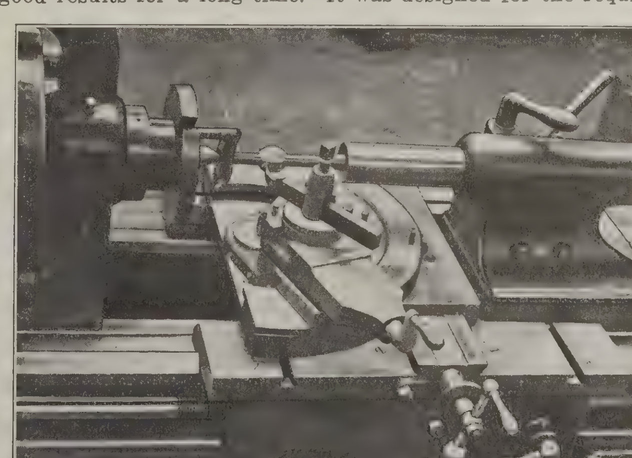


Fig. 1. Spherical Turning Device for Accurate Turning

ments met with in turning balls or other spherical parts which must have accurate dimensions, an operation which is rather difficult to carry out by hand. The appliances on the market for the purpose failed to give accurate results. The device shown is strong and capable of producing a practically

exact sphere. It is applied to an 18-inch Hendey-Norton lathe.

In Fig. 2, *B* is a cast-iron plate which is fixed directly on the dovetail slide of the lathe carriage by means of taper gibs *C*. The dovetailed groove of the plate *B* has parallel sides, and the two taper gibs, which have the same amount of taper, are introduced one from the front and the other from the back, so as to compensate for the taper. By being attached in this way, plate *B* rests rigidly on the carriage and can be fitted and taken out very easily, or adjusted to any position of the dovetailed guide. On plate *B* is fitted and rotates the turntable *D* provided with a dovetailed groove for the toolpost *P*. The turntable rotates on pivot *E*, which is fixed to plate *B* by four screws. The turntable is also guided by a circular gib *F*.

A circular rack *G* is fixed with screws in a groove provided for it; this groove is protected from chips as indicated. Rack *G* meshes with gear *H* which is fastened by a key to a worm-wheel which, in turn, is carried by shaft *I*. Plate *B* is also provided with two brackets carrying the screw *L* of the carriage. This screw meshes with the worm-wheel to which the bevel pinion *H* is fastened. The circular movement of turntable *D* is thus obtained from the carriage screw *L*, and, as this screw, through the design of the lathe, is provided with several speeds, a suitable feed can also be chosen for the spherical attachment. Stops *M* and *N* are provided in order to prevent the turntable *D* from swiveling too far. Felt packing is used to keep the working surfaces clean and free from dirt and chips. The pivot *E* has a hole in the center which is carefully ground to fit pin *O*. This pin is used for rapidly locating the carriage with relation to the center of the ball to be turned. It can be withdrawn during the operation. If particularly accurate results are required, the rotating axis of the fixture must intersect the axis of the lathe spindle. The fixture is then first located by means of pin *O* and may be adjusted by subsequent trials until a perfect sphere is formed. The form and position of the tool have no bearing on the accuracy of the work.

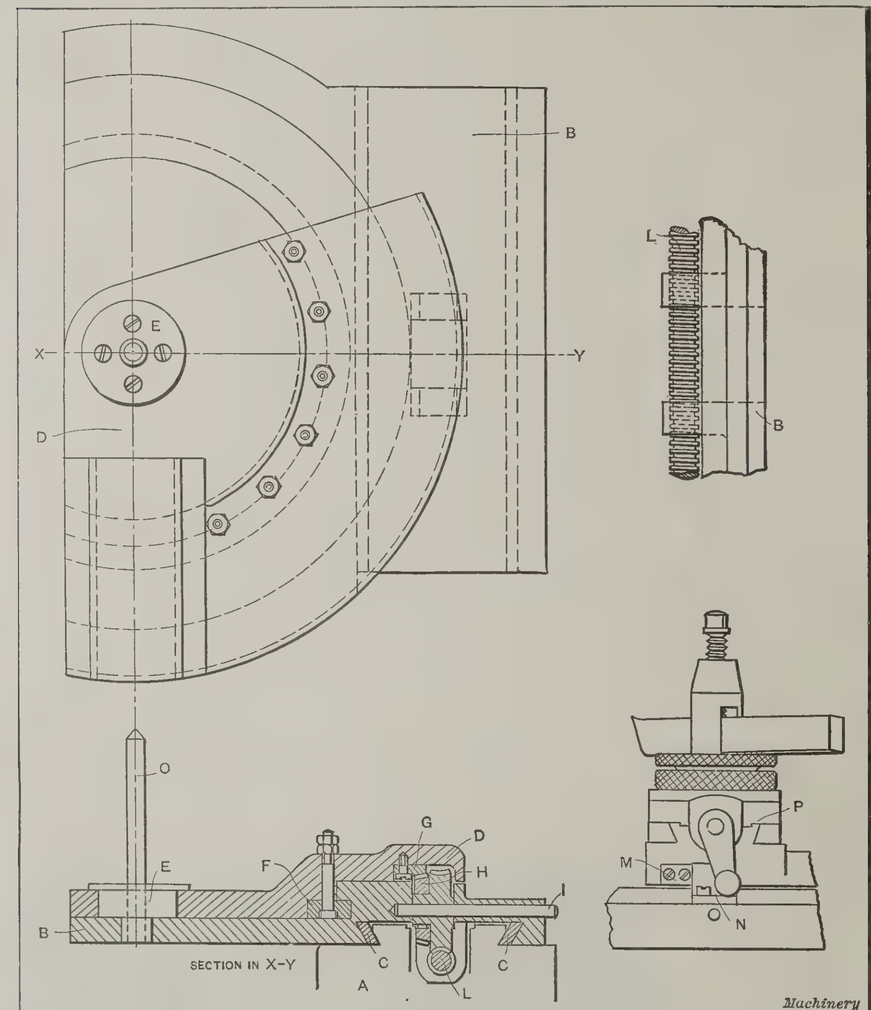


Fig. 2. Design of Spherical Turning Device

By moving the axis of the fixture in or out from the axis of the lathe spindle, circular surfaces such as rims of hand-wheels, faces of worm-wheel blanks, and similar work, can be turned. Work turned by this fixture can be finished in the same time as would be required for plain turning, and the design of several pieces has been modified so as to be turned by this fixture in order to obtain a more finished appearance.

Turin, Italy. C. Boella

OBSERVATIONS ON GEARING

In the April number of Machinery Mr. F. D. Buffum alludes to the necessity of proportioning gear teeth not merely to resist the load stresses which tend to cause breakage, but also to provide against excessive wear under continuous loads. He also asks for information relative to steel gears which are continuously transmitting the loads allowed by the Lewis formula.

During the writer's experience in designing gear mechanisms as embodied in geared heads and feed motions, there has not been a single case where steel gears running together have proved successful at tooth velocities exceeding about 400 feet per minute. A few have given trouble at even a lower speed, although in these cases the holes were hardened, ground and lapped to prevent the wear of the shafts upon which they rotated, and the gears were running in oil. In many cases the material had been changed on account of unsuccessful results.

It may be of interest to relate how one failure was dealt with. The mechanism consisted of a cone of gears driven from a long pinion through an intermediate gear—the usual tumbler gear arrangement. The long pinion was of 0.50 carbon steel; the intermediate and cone gears of 0.30 carbon steel, and soft. The whole gear mechanism was splash lubricated and the workmanship was good. Trouble first arose from the rapid wear of the tumbler gear, the only gear in continuous service. This was replaced by a casehardened gear which quickly "chewed up" the long pinion which was integral with the shaft and, therefore, could not be easily hardened. The material of the tumbler gear was then changed to phosphor-bronze, but the steel gears now wore out the phosphor-bronze gear. The final solution lay in making the tumbler gear of malleable cast iron, the idea being to provide a material somewhat more durable than phosphor-bronze but not as hard as the casehardened gear. The greasy nature of malleable cast iron probably also influenced the result.

In ordinary cases—cast iron to cast iron, or dissimilar metals, splash lubricated—the theoretical width of the face of gears as required by the Lewis formula has sometimes been cut down as much as 30 per cent. In these cases the tooth stresses have been calculated from the power delivery capacity of the belt under high tension (80 pounds per inch of width) and not from the amount of power actually delivered, which would probably not exceed more than one-half of the belt capacity. In cases of a "jam," the stresses are not always as great as might be imagined, for the reason that the shafts yield torsionally to a considerable extent, and thus relieve the stresses which would otherwise be borne by the teeth.

As regards shaft center distances, the writer does not agree with the statement that a small increase over the theoretical distance is of any great importance. In certain experiments made by the writer in which two gears of different diameters were mounted in such a way that the center distance could be varied to test the comparative noise developed at different center distances, it was found that in the case of eight-pitch gears, a closing up of the center distance of about 0.005 inch

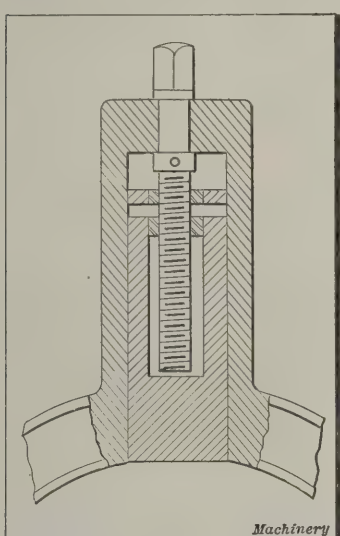
made no appreciable difference; beyond this point, owing to the jamming of the teeth, the noise increased considerably. Increases in the center distances above nominal up to about 0.125 inch also made no appreciable difference, but after this point the noise gradually increased up to the point of separation of the teeth. It is presumed that noise is a good index of the amount of wear. Backlash is of little importance if the load is continuous and not reversible.

As regards the comparative values of spur, bevel and worm-gearing, the writer would put spur gearing in the first place, unless the worm-gearing be so designed that the pressure angle is of maximum efficiency and the material the most suitable for the purpose. Either spur or worm-gear drives, however, are preferable to bevel gears. Difficulties in cutting accurate bevel gears, the unbalanced area of the tooth surface, the difficulties in setting to the correct pitch cones, all tend to prevent their successful application.

Didsbury, Manchester, England. FRANCIS W. SHAW

A LATHE STEADYREST OF UNCOMMON DESIGN

In the April number of MACHINERY, Mr. H. Terhune describes a steadyrest which the writer thinks impracticable. The writer does not understand the method of obtaining the chamber or body size hole in the jaw, or the method of assembling the screw with the top of the rest. The design is also rather expensive. The accompanying engraving shows a design which would entail the least expense, although even this construction should be used sparingly, as it will be found quite expensive.



Improved Design of Lathe Steadyrest

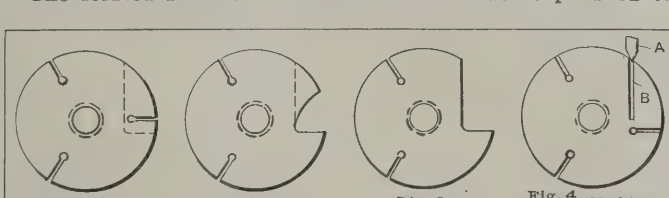
Dexter, Me. E. W. TATE

[Without entering into any discussion of the relative merits of the designs presented, it is safe to say that lathe manufacturers could undoubtedly afford to give more consideration to the design of steadyrests, even if the cost should be increased thereby. The steadyrest constitutes an important part of the lathe equipment, and if its efficiency can be increased, the comparatively slight increase in cost should not be begrudged.—EDITOR.]

TO FACILITATE THE GRINDING OF FORMING TOOLS

Figs. 1, 2 and 3 illustrate the methods which are most commonly used for making circular form tools. The saw cuts in the form tool, Fig. 1, are intended to relieve the strains due to hardening. Before this cutter can be used, however, the portion indicated by the dotted lines must be ground off. The method described by the writer in the following is intended to facilitate this operation.

The formed surface of a circular tool must be polished to remove the scale if good results are desired. For this reason most form tools are made as shown in Fig. 1, and after the cutter is hardened and polished, a cut, as shown in Fig. 2, is ground into the cutter, after which the cutter is ground as indicated by the dotted line to the appearance shown in



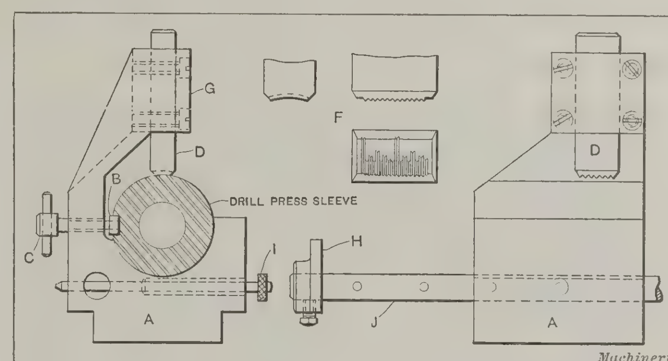
Figs. 1 to 4. Various Methods of Making Forming Tools

Fig. 3. A wide tool made in this manner will require several hours for grinding in order to remove the metal without drawing the temper of the tool. On the other hand, if the tool was originally milled before hardening, as shown in Fig. 3, it would be almost impossible to polish the tool after hardening.

The simplest and most effective means for overcoming this difficulty is indicated in Fig. 4; this will save considerable expense in the making of circular form tools. The cutter is made with an extra slot, as shown, and after the tool is hardened and polished, the piece *B* is easily broken out, without injury to the cutter, by driving in a wedge as at *A*. The cutter may be held in a bench vise and only a slight tap of the hammer is necessary, after which the cut can be quickly finished off with an emery wheel. S. NEVIN BACON

GRADUATING DRILL PRESS SLEEVES WITH A STAMP

The accompanying illustration shows a device which was used satisfactorily for graduating a drill press sleeve with a stamp. The device consists mainly of a casting *A* which is machined out to fit the drill press sleeve. The sleeve has a spline in which the block *B* is held by the screw *C* for retain-



A Device for Graduating Drill Press Sleeves with a Stamp

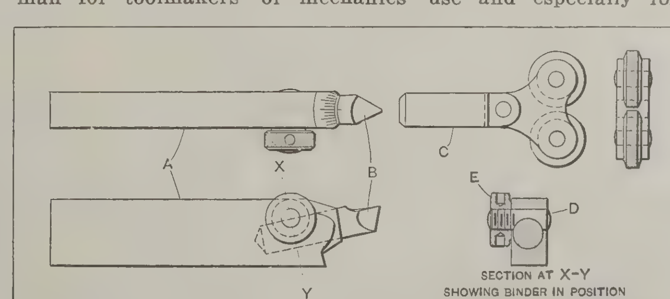
ing the sleeve in the correct position. The stamp *D*, also shown enlarged at *F*, is made to graduate 1 inch, the graduations being 1/16 of an inch apart. The stamp *D* is held in a slot in the fixture by means of a cap *G* and screws as shown.

In operation, the drill press sleeve is placed in the fixture and the end of it brought up against the stop *H*. The stamp is then given a blow with a hammer, after which the spring plunger *I* is pulled out allowing the rod *J* carrying the stop *H* to be shifted to the next hole. The spring plunger is now inserted, the stamp struck and the preceding operations continued until the sleeve is graduated to the desired distance.

J. S. B.

UNIVERSAL KNURLING AND TURNING TOOL HOLDER

The accompanying illustration shows a handy and useful knurling and turning tool holder, designed by a fellow workman for toolmakers' or mechanics' use and especially for



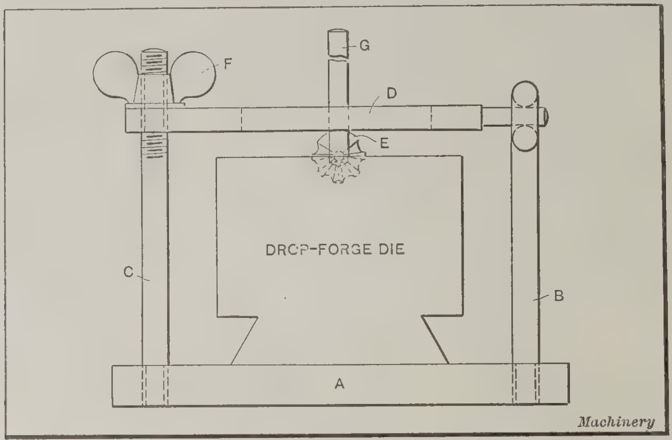
A Universal Knurling and Turning Tool Holder

those employed in experimental work. This device consists essentially of a holder *A* in which the turning tool *B* or knurling tool *C* can be held with the clamping screw *D* and clamping nut *E*. The turning tool is made from drill rod or from high-speed steel if preferred, and is cut off and ground to the required shape. It will be noticed that the hole in the front end of the holder is inclined at an angle

with the base of the holder, the purpose of which is to obtain a positive rake on the turning tool for steel, etc. A holder containing a single roll knurl can be made and inclined in either direction at any angle with the axis of the work; for this purpose the front end of the holder is graduated in degrees, as shown in the illustration. The knurl-holder shown is supplied with two knurling rolls. C. F. S.

A CHERRYING FIXTURE FOR A DROP-FORGE DIE

The accompanying illustration shows a fixture which was designed for cherrying a hole in a drop-forge die. The hole to be produced is full at both ends, as indicated in the illustration, so that an ordinary milling cutter could not



A Cherrying Fixture for a Drop forge Die

be used for producing it. The hole to be cherried is first chipped out as near as possible to the required shape, care being taken to leave an equal amount of metal on both sides of the hole to prevent the cherry from "crawling."

The drop-forge die is placed on the bed *A* of the fixture, which is provided with two studs *B* and *C*, and a strap *D* is used for applying pressure to the cherry *E*. The stud *B* has an eye-bolt on its upper end, and the strap *D* is turned down to fit it. The bolt *C* is threaded to fit a wing-nut *F* which is used in connection with the strap for applying pressure to the cutter, the cherry being worked back and forth by means of the handle *G*. The cherry or cutter *E* is provided with teeth cut both right- and left-hand, starting from the central tooth. The handle *G* is driven into a hole drilled in the cherry. C. H. WILCOX

Springfield Mass.

BEATING THE SWEDISH GAGES

In relating the following incident, I ask the readers' indulgence for not giving names, as I fear that my reception at the works where the thing happened might not be as pleasing the next time I call, should I disclose too many of the true facts in the case.

Not long ago, a well-known company producing a very fine quality of machine work, got the improvement "bug" in its head and threw out some fair machinery in order to put in the very latest types. The result of this improvement proved quite satisfactory, and the quality of the product improved correspondingly. In showing the customers through the remodeled plant, much stress was placed upon the high-class workmanship obtained by the use of the new machines. All visitors were duly impressed with the fact that the shafts were right up to their correct diameters, that the holes were just right for running fits, that plane surfaces were spotted all over with contact spots, and that every piece interchanged with every other. The general manager was usually doing the showing around, and he did not look sorry to see the president loom up in the distance and join the group. Indeed the latter person was also duly impressed with what he was shown.

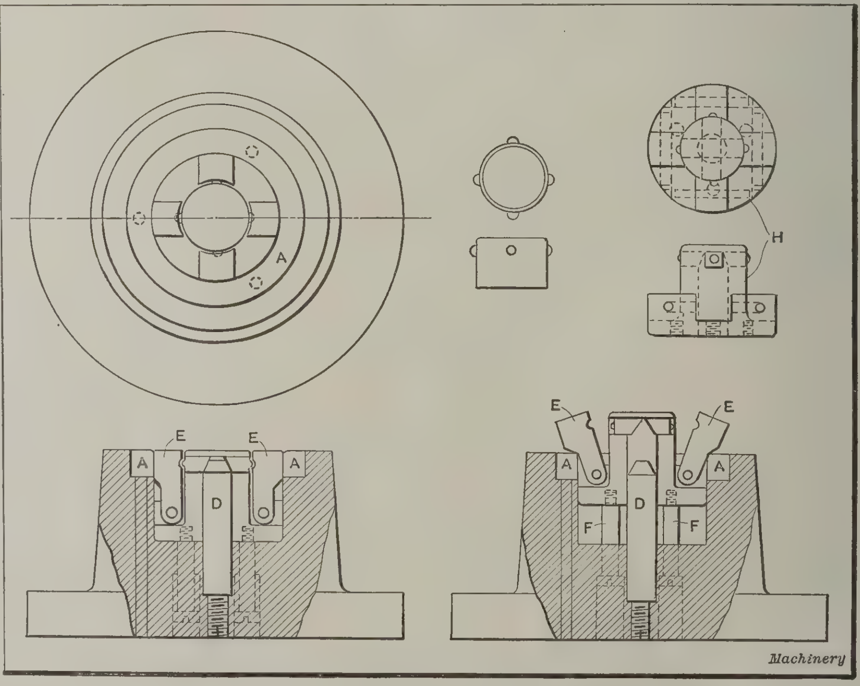
One day as the manager took a little group of visitors—prospective customers—through the plant, the climax was reached when he picked up some hardened and ground steel rings. He piled five or six on each other, in an absent-minded way, and was probably as much surprised as his visitors when he found that the surfaces were so perfect that he could lift the whole pile by the top ring. He instantly realized that this "beat the Swedish gages all hollow," and so he took full advantage of the situation, and puffed to a great extent.

A few days later he started to show another visitor this fine work, talking loudly and impressively about it, but, lo! there was "nothing doing," for just the top ring remained in the manager's hand as he lifted it up, while the others were left "peacefully at rest" upon the bench. Evidently these rings were not as well ground as the previous lot, and he asked the grinder hand why they were not as carefully ground as the lot that were lying on the bench a couple of days ago. The grinder hand claimed that he had ground but one lot of rings, and that, undoubtedly, the rings now lying on the bench were the same as the ones that had been there a few days ago. There was an old hand around the shop, however, who had seen the manager grow up in it, and had never been able to get over calling him "Jimmy," and he offered the explanation: "Well, I nearly died laughing to see you showing up the fine work of the grinder to that crowd. It did look good, sure, but it was not the grinder but the magnetic chuck that should have had the praise for the job." W. D. F.

TOOLS FOR RAISING LUGS ON SHELLS

The accompanying engraving shows a method for shaping half-spherical lugs on brass shells. The lugs were to be in an exact position in order to engage with grooves in a mating part. The method proved very successful and may be of interest to others.

A ring *A* is turned, hardened, and ground, and driven into



Method of Producing Half-spherical Lugs on Small Brass Shells

a cast-iron bolster. The upper inside corner of the ring is well rounded. In the center of the device is provided a holder for the brass shells, this holder being shown in detail at *H*. Four square holes are provided in the upper part of the holder for the punches with half-spherical ends which form the lugs. The punches are a good sliding fit in these holes, and are tapered at the back end and expanded by means of plunger *D*, which is the shape of a truncated pyramid on the end. This piece is hardened and driven lightly

into the bolster, and adjusted by means of a screw from the bottom. The four jaws E are attached to the central holder and secured by a plain pin. They are hardened and polished on the outside. The central holder is a sliding fit in the bolster and is raised by means of three springs beneath it (not shown), the limit of the movement being governed by the screws F. The two positions of the jaws and punches shown indicate clearly the operation of the device. When the jaws are in the outward position, after the lugs have been formed, the shell may be removed. The removal of the shell pushes the small punches in flush with the holder, which is then ready for the next shell. Any plain, flat punch may be used in the press. J. GALLIMORE

Meriden, Conn.

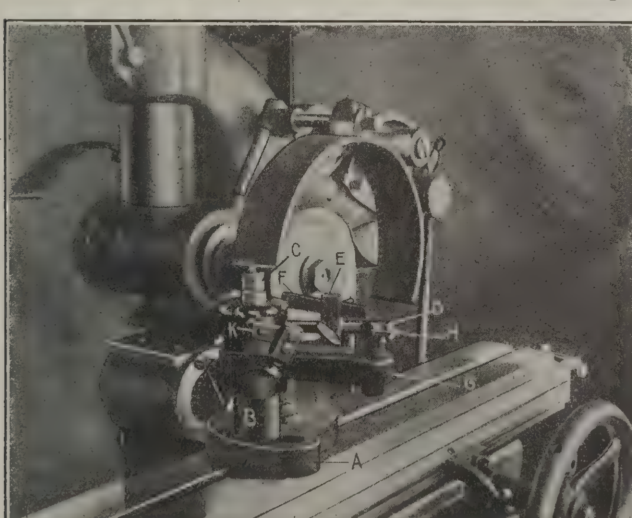
STANDARDIZATION OF GRINDER SPINDLES

The other day the writer overheard a manufacturer saying: "If the grinder spindles only were alike, how much it would save." Quite a number of different makes of machines for rough and finish grinding were used in this shop. If both roughing and finishing grinding is to be done on the same machine, it is necessary to carry a full set of wheels for each machine. On account of the different sizes of the spindles, this requires quite a large investment in emery wheels and considerable storage room for the wheels as well. Standardization with respect to the grinder spindles, especially in the larger types of machines, would be of considerable value. The change may involve some trouble to the machine manufacturers, but, when the necessity is realized—in other words, when the buyers "holler" loud enough—this change will, undoubtedly, come about. J. M. HENRY

New Britain, Conn.

A GRINDING ATTACHMENT

The grinding attachment shown in the accompanying illustration is intended for correcting errors in forming cutters caused by the hardening process. It is often said that when forming cutters are ground, they must not be indexed from the back of the tooth, because this does not give equal spacing. Now, we do not really care for equal spacing; what we want is to have all the teeth of the same length. In hardening, the cutter loses its shape, and the teeth become of different lengths,



Attachment for Grinding Form Milling Cutters

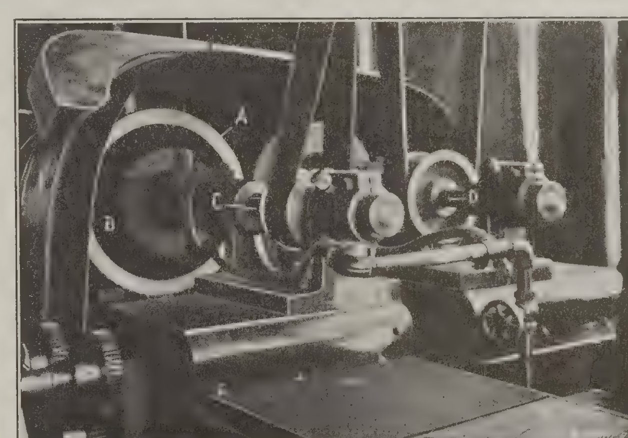
but the error can usually be easily corrected. On gear-cutting machines one tooth of the cutter often does all the work. The arbor is frequently blamed for this, but in most cases it would be found that one or more teeth are too long. These long teeth should be ground on the face until the teeth are all of equal length, as tested by an indicator, with the cutter on a mandrel between centers. This grinding will produce an uneven spacing, but it will produce a cutter where all the teeth will cut, and the cutter will remain in this condition, practically, until worn out.

The device shown in the illustration can be used on almost any cutter grinder. It takes but a short time to set up and gives satisfaction. The construction of the device, which might be varied to suit individual conditions, is apparent from the illustration. It consists principally of a base A to which is fitted an upright stud B, turned down at its upper end C to take the cutter. On the stud is also mounted a collar having an arm D. To this arm is clamped a bracket E into which is inserted the spring F which acts as a stop against the back of the tooth. The arm G is fastened by a set-screw to upright stud B, and, by means of adjusting screw H, the arm D with spring F can be slightly adjusted, relative to the fixed parts of the device, so that the cutter tooth can be gradually fed in towards the grinding wheel. A gage K is clamped to the device in such a manner that it will just touch the top of the tooth when this is of correct length, and by means of this the length of the teeth can be accurately measured. The whole device is simple, but it is possible, by means of it, to grind each tooth independently of the rest, gaging each in turn to make sure that they are all of correct length.

Nashua, N. H. CHARLES E. JACOBS

SIMULTANEOUSLY GRINDING INTERIORS AND EXTERIORS OF RINGS

In building the Dayton swaging machine, the Excelsior Needle Co., Torrington, Conn., grinds all hardened parts that are to serve as bearing surfaces in connection with the operation of the machine. The machine shown in the accompanying



Method of Grinding Interior and Exterior of Swaging Machine Rings Simultaneously

engraving was improvised to grind the interior and exterior of the steel ring that is forced into the head of the swaging machine. It is essential that the interior and exterior of the ring be true with each other; therefore, both of these surfaces are ground at one setting of the work. The ring, shown at A, is soldered to the special faceplate B. The wheel for grinding the interior of the ring is mounted on spindle C, while the wheel for the external grinding is mounted on spindle D. These spindles are mounted upon carriages on the same cross-slide and are driven in the usual manner. Provision is made for cooling the work at each of the cutting points. The method has proved very satisfactory. C. L. L.

TAPS AND THEIR WORK

Though many of the questions in connection with taps and their work have been decided, and admit of no discussion, some points still remain on which a diversity of opinion exists. These should be rapidly reduced in number when investigators are not only willing to build testing machinery and carry on expensive tests, but freely give the world the benefit of the results of these investigations. The article on "Taps and Tapping" which appeared in the April, 1912, number of MACHINERY reflects credit on the investigators, but the writer would like some further information.

If but fourteen taps were used in obtaining the data presented in Table I, it is not at all surprising that the amount of power consumed increased rapidly after tapping the two crucible tool-steel nuts. It will be seen that the second nut of this metal required more power than the first in more than half of the fourteen cases. In other words, the taps dulled

rapidly. The same holds true in the case of the phosphor-bronze nuts. Hence, it seems that the comparison between the power consumed in tapping hexagon drawn brass and that consumed in tapping phosphor-bronze is scarcely a fair one, as the tap gradually becomes dull. While it may be said that tapping ten nuts need not make much difference with a tap, the figures given show an average increase of power consumed by the second nut tapped in each kind of metal.

It is interesting to note the reduced amount of power consumed by tap No. 10 in tapping its second nut in both the third and fourth metals tapped, and the increase of 65 per cent in the case of the second phosphor-bronze nut. The hexagon screw stock seems to require less power for tapping in the case of the second nut, but for steel the average is slightly greater for the second nut. From these irregular results it would seem that such experiments should include scores of taps and hundreds of nuts, in order to reduce the effect of such amounts of power as are consumed by taps Nos. 8 and 10.

The fact that decreasing the diameter of the hole to be tapped by a ½-inch tap from 0.425 to 0.400 inch increases the amount of power consumed about 100 per cent, is not surprising, as the amount of metal removed is, thereby, also increased nearly 100 per cent, and the chance of clogging the flutes is very much greater, as we have less room in which to take care of nearly double the amount of chips.

Could not someone who has the facilities for carrying on tests of this kind also let us know the amount of power consumed in removing the metal from a thread groove under conditions as similar as possible to tapping, but with the wedge and chip-choking elements eliminated? Comparison between the amount of power consumed in tapping and in cutting threads externally would also be interesting. Has not the large amount of tool surface in contact with the work and the ever-present tendency to wedge a great deal to do with the amount of power consumed by the taps?

As a cutting tool a non-relieved tap is not an inviting proposition, but when a tap must be reversed a relieved land is supposed to gather small chips and thus dull and even break the teeth. Most tap makers avoid the tendency to wedge by making their taps slightly "reverse" taper. A reverse taper tap cannot do perfect work, but the very slight inaccuracy of thread angle caused by the reverse taper used is in most cases negligible. Reverse taper taps, however, consume much less power than parallel taps.

Hamilton, Ohio. W. S. Rowell

[With regard to the methods of making the tests recorded in Table I, in the article on "Taps and Tapping" in the April number, we are informed by the test department of the Wells Bros. Co., Greenfield, Mass., that the figures in the chart "represent the average variation of a number of tests of each material. In making these tests different sequences were used (with regard to the different materials tapped), so that the tests would be absolutely fair to each material."—Editor.]

OVERHANG IN MACHINE DESIGN

In the March number of Machinery, "Onlooker" quotes, "Overhanging is a vital error in design," and adds, "Mechanical designers are beginning to recognize this fact to a marked degree." Assuming that by "overhang" is meant the condition of a part similar to a cantilever and that a "vital error" means an absolute mistake, the writer takes exception to these statements, and will attempt to show that the former is not a practical proposition so far as design of machinery is concerned.

It is obvious that there are many types of machines impossible to design so that they will fulfill the object for which they are intended, without overhang. A radial drill, for example, of the general kind, must necessarily have an arm that can be quickly and easily swung from one position to another. If an outer stay is provided, the machine becomes restricted in its capacity. Such stays are often supplied as temporary attachments, but it is often impossible to apply them when the heaviest duty is required from the machine. Hence, the arm is made strong enough to safely withstand the strain imposed upon it by the work performed without the use of the stay.

Some English makers have eliminated the overhang of the drill spindle from the arm by designing what is called a "central thrust" arm. Thus the torsion is eliminated, but the deflection of the arm upward, with relation to the column, is not affected thereby. The deflection due to three inches of overhang is eliminated, but that due to, say, forty-two inches remains unaltered. In a well designed machine without the central thrust arm, the torsional deflection is not appreciable, even under maximum duty, so that this attempt to avoid overhang is of little practical value, as it is often obtained at a sacrifice in handiness of operation.

The shaper offers another example of a machine where overhang is unavoidable. For a large class of work it is much more suitable than the planer, although in the latter the tool is carried on a beam supported at each end. (The uprights, by the way, which carry this beam, are "overhung" from the bed, so that even the planer does not answer the requirements for a good comparison.) It is not practicable to use some kind of a support for the outer end of the shaper ram, as the usefulness of the machine would then be greatly reduced. Some makers, however, place a support under the table so as to minimize the effect of the overhang. The advantage gained by so doing may be more apparent than real, for with a given pressure between the tool and the work, the sliding ram is deflected to a greater extent than when the table is not supported; yet, this support may be useful when very heavy work is secured to the table. Notable cases of overhang are also met with in gear teeth, most cutting tools, lathe spindles, tailstock spindles, etc.

The objection to overhang is, of course, deflection under load, but this is not avoided if a beam supported at its ends is substituted for a cantilever. Under similar conditions of length and section it is reduced, but the difference is one of degree, not of kind. The writer does not, of course, advocate overhang when it can be advantageously avoided, but he realizes that conditions exist which call for a compromise, and he does not agree to the statement that "overhang is a vital error in design," and does not believe that it should be accepted without some qualification. Joseph Jewsbury

Birmingham, England.

[While somewhat erroneously expressed, it is, of course, clear that "Onlooker" did not intend to convey the idea that overhang was never permissible in machine design. Read in connection with the paragraph in which the expression occurred, it is reasonably clear that the idea in "Onlooker's" mind was that overhang was a serious error in all cases where there was no need for it—where ample support underneath or near the end of a cutting tool, for example, was possible. Undoubtedly, "Onlooker" did not intend to be taken quite so literally as our correspondent has understood him.—Editor.]

HEATING HIGH-SPEED STEEL IN A BLACKSMITH'S FORGE FOR HARDENING

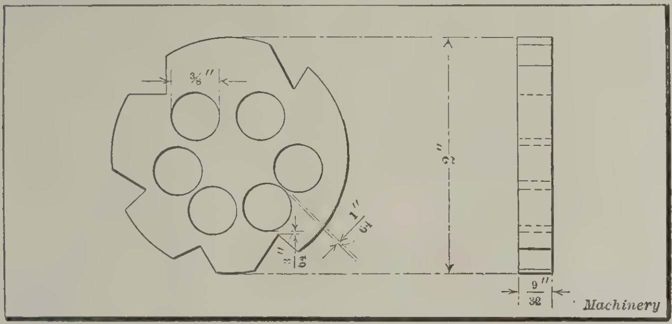
Various receipts and methods have been given for hardening high-speed steel, but the factor which renders most of these methods unsuitable for the "backwoods" mechanic is that they require conveniences not often found in a small shop. The heating appliances usually consist of a pail of water and a blacksmith's forge. With these facilities one is expected to perform any operation of heat treatment from the welding of a broken crankshaft to the hardening of a "circle tool."

Not long ago the writer was employed in a small shop as foreman, and having difficulty in getting the high-speed cutters through the hardening process satisfactorily, he investigated the methods used. The trouble seemed to be that the cutters came out either without good "red hardness," which constitutes the peculiar value of such steels, or else though hard, they would be blistered and the corners so rounded that they were spoiled. Occasionally the tools would be both soft and blistered. Inquiry revealed the fact that the soft but unspoiled cutters were heated in a gas muffle furnace which had been installed for hardening punches and dies,

while those rendered unfit for use by scaling were hardened in a blacksmith's forge with soft coal and plenty of blast.

As it was a rather hopeless task to change the gas outfit so that it would produce the required heat for high-speed steel, some experimenting was done with the forge fire, and it was finally discovered that if the work was covered with a thin coating of fire clay and salt, and further protected by a thin shield of sheet metal, it could be subjected to a coal fire. After being brought to the required heat, the tool was cooled in a tank of kerosene without removing the shield.

The accompanying illustration gives the dimensions of a piece that was hardened in this manner. The holes were drilled and then reamed with a 3/8-inch reamer, and all of the sharp corners were milled. Some idea of the lack of scaling or warping may be obtained from the statement that after the dirt was cleaned out of the holes, the shank of the same reamer could be put through. The burrs caused by milling and reaming were still as sharp and pronounced as before heating. The wall between two of the 3/8-inch holes was only 1/64 inch thick, and the wall between the milled corner and one of the holes was 3-64 inch thick. No cracks developed, nor was there any noticeable warping at these



A Piece of Work heated for Hardening in an Ordinary Blacksmith's Forge, without Scaling or Warping

points. The condition of the sharp edges would warrant the belief, that, if it had been a cutting tool it would have been in a fit condition to use without sharpening.

As to the degree of hardness obtained, the writer kept the piece in the condition in which it came from the hardening bath—without tempering—and afterward had the opportunity to test it with the scleroscope; with this instrument a reading of 105 was obtained. This reading compares very favorably with that obtained with the best grade of carbon steel hardened in a satisfactory manner. The piece illustrated is made from Bohler's rapid Styrian steel (high-speed). Judging from various other experiments which were tried, the writer has come to the conclusion that the prime necessity in hardening high-speed steel is to have plenty of heat, and to provide shields for the work to prevent the scaling which is due to exposure to the atmosphere when the tool is at the temperature for hardening. It does not especially matter when using the shield, whether the work is heated in a muffle, a barium chloride bath, or some home-made affair like that previously mentioned. With proper care excellent results may be obtained, even with that old standby, the blacksmith's forge.

F. A. Parsons

Milwaukee, Wis.

BURNISHED THREADING DIES

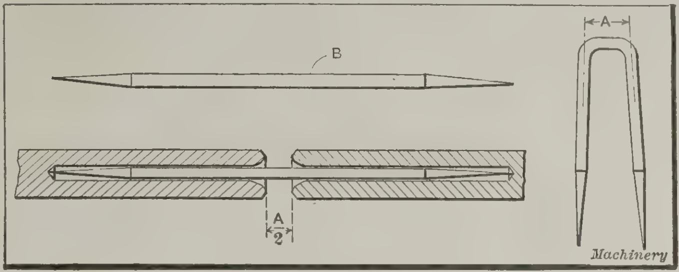
Threading dies of the button or spring types will last much longer and produce superior threads if the threads in the dies are burnished after cutting, and also after hardening, than if left unburnished as they ordinarily are. The burnishing is accomplished with a threaded master plug, which is hardened and lapped, but not fluted. This threaded plug is run through the die, which is left from 0.001 to 0.0015 inch small when the thread is cut. Lard oil is used as the lubricant. After the die has been hardened and tempered, the threaded plug is run through again.

Another advantage gained by putting the plug through the die after hardening, is that the lead of the threads, which is distorted in the hardening process, is corrected. A die made in this manner will cut clean and smooth, and will stand up much better than a die that has not been burnished because the material about the threads is compressed by the burnishing plug and all the burrs are removed.

D. T. H.

DEVICE FOR MAKING STAPLES

The accompanying engraving shows a simple device for making staples of the type shown to the right. The method is as follows: Cut off the wire to the proper length and point it as indicated at *B*. The device for bending consists of two pieces of steel rod, slightly less in diameter than the width *A* from center to center of the staple legs. Drill a hole in the end of each of these two pieces. The hole should be slightly larger than the diameter of the wire, and the depth of the



Method of Making Wire Staples

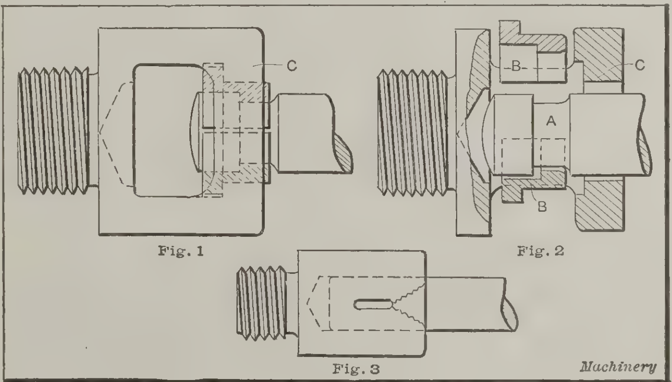
hole should be about one-half the length of the wire less one-quarter of the distance *A*. The holes should be slightly chamfered, or bell-mouthed, and the corners should be slightly beveled, as shown. When the wire is placed in these handles, they are forced together to a parallel position. The beveled corners come together and act as a fulcrum and a smooth, even bend results.

C. M. S.

IMPROVED FORM OF PULL-BUSH FOR BROACHES

The broach used with the "La Pointe" broaching machine is usually secured to the pull-bush by means of a cotter passing through the bush and broach. This connection frequently fails, the pull-bush giving way as shown in Fig. 3; or worse still, the end of the broach gives way. The trouble can be overcome by using a pull-bush of the type shown in Figs. 1 and 2.

The end of the broach is reduced in diameter as shown at *A*, leaving a shoulder; half-bushes are turned to suit the bore of the pull-bush *C*, and bored as shown at *B* to freely fit the end of the broach. The pull-bush has a slotted hole, wide enough for the insertion of these split bushes.



Improved Design of Pull-bush for Broaches

In use, the broach end is inserted through the hole in the pull-bush, the half bushes are placed on the neck, and are then drawn back into the hole as shown in Fig. 1. By making the bore large enough when designing a pull-bush of this description, it is quite a simple matter to arrange for one bush to cover a large range of broaches, and in each case retain the greatest possible strength in the broach. Split bushes are made to suit each size of broach. This cannot be done when using a cotter, and therefore the connection is cheaper to make. The half-bushes are easily made as compared with the cutting of the slots for the cotters, and it is advisable to make them so that if anything gives way, it shall be these parts. A little care in determining the width of the shoulders in these split bushes will allow for this tak-

ing place before either the main pull-bush or the broach end can give way. G. R.

SOLVING OBLIQUE-ANGLED TRIANGLES

The writer wishes to add a few words in reply to the inquiry of O. E. H. in the How and Why columns of the February number of MACHINERY. When two sides (a and b) and the included angle (C) are given, the third side (c) can be found directly from the formula:

$$c = \sqrt{a^2 + b^2 - 2\,a\,b\cos C}$$

This formula is not very convenient to use except when a and b are numbers easily squared; however, this is generally not the case. By using the formulas:

$$\sin x = \frac{2\cos\frac{1}{2}C}{a+b}\sqrt{a\,b}$$

and

$$c = (a+b)\cos x$$

the computation will be much facilitated, especially when using logarithms. By using functions of the half angle we also obtain greater accuracy and avoid the difficulties met with when using negative values. WM. W. JOHNSON

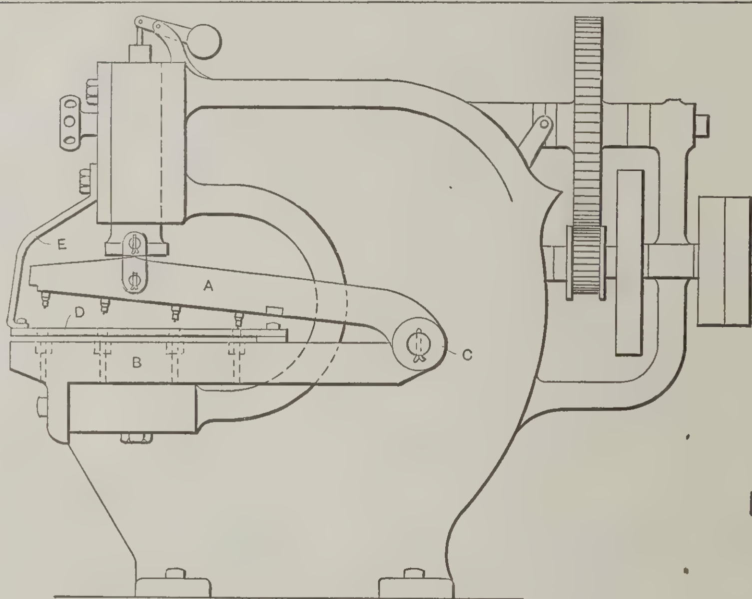
Cleveland, O.

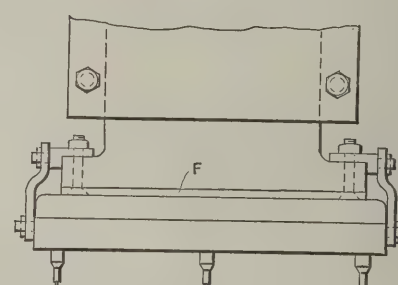
ATTACHMENT USED FOR GANG PUNCHING

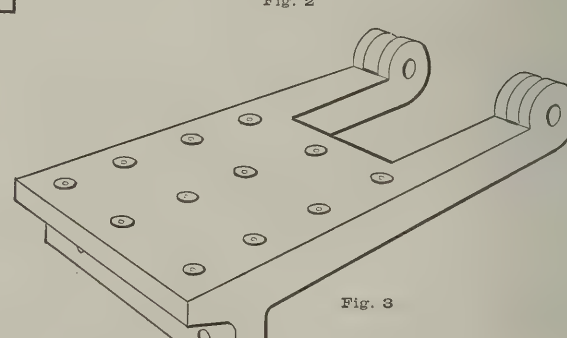
When it is desired to use a gang punch on the ordinary punching and shearing machine and the positions of the holes are such that some of them are a considerable distance outside of the lower face of the crosshead, it is not practicable to use ordinary punch and die blocks. Punching of this kind, however, can be easily done by means of an attachment such as shown in Fig. 1, which represents a side view of an ordinary punching and shearing machine equipped with punch and die blocks for gang punching. The punch block A is attached to the crosshead by means of links as indicated, while the die block B is fastened to the bed plate by any ordinary means. The punch and die blocks are connected by a hinge at C; D is the stripper and E one of the two braces supporting the front of the stripper.

In Fig. 2 is shown a front view of the punch block illustrating the manner of connecting it with the crosshead. The wearing plate F, shown in this illustration, is attached to the crosshead and bears against the punch block. In Fig. 3 is shown a perspective view of the die block giving a clear idea of its construction, the stripper being removed in this illustration. No attempt has been made to show the means of securing the punches and dies in their respective blocks, or the provisions made for getting rid of the punchings. This latter may be accomplished, for the central dies, by drilling holes at an angle from the bottom of the die to enter the opening usually provided in the center of the bed plate, and for the others by holes so drilled that the punchings are discharged at the front, back or on the sides of the bed plate.

This device has been used for punching plates about 3/16 inch thick, of high-carbon steel, which is difficult to punch. If thicker plate is to be punched, the distance back to the hinge or fulcrum C must be proportionately increased in order to give as nearly a perpendicular motion to the punch as possible. The parts are hinged together sufficiently rigid so that the punches strike the plates squarely over the holes in the dies. It would seem, at first sight, as if there would be enough of a bending action on the punches to easily break them off, but this is not the case, providing, of course, that the fulcrum C is placed at a suitable distance away from the center of the crosshead. W. L. B.







Figs. 1 to 3. Attachment for Gang Punching

SAVING A SHAFT BY KNURLING

Referring to the article, "Saving a Shaft by Knurling," in the April number of MACHINERY, the writer would like to say a few words. It would seem that a straight knurl would be best for this purpose—one that makes parallel, longitudinal grooves and ridges. It would seem that the spiral or cross-cut knurl would hardly be practicable to use. The best results are obtained when the size is increased only enough to make it possible to obtain a press fit, but it should be remembered that the bearing surface is reduced and, therefore, when an allowance of only 0.0005 to 0.0015 inch is required for a tight fit with a smooth surface, the knurling must increase the diameter from 0.002 to 0.003 inch, in order to produce just as good a fit. The ridges tend to cut into the sleeve, and if the assembled details are taken apart, the fit is none too good the second or third time.

Nevertheless, the method has its advantages. It is cheap, and the fitted part runs true, which it does not always do when some other methods for saving the work are resorted to. Although the writer has never seen the method tried for the purpose, he does not think that it would be suitable where an air- or liquid-tight joint is required, as the sleeve is generally considerably scored when the knurling is heavy.

Erie, Pa. A. N. HAMMOND

CASEHARDENING GEAR TEETH WITHOUT DISTORTION

In the May number of MACHINERY a brief item is published on the casehardening of gear teeth without distortion. The writer wishes to make some friendly criticisms on the methods there set forth. It is stated that the gears are copper-plated all over before taking a finishing cut on the teeth. The finishing cut removes the copper plate from the tooth faces and flanks, and when casehardened, these parts only become hard, the carbonizing effect of the pack being prevented on the other parts of the gear by the copper-plate. The practical result is casehardened teeth with so little distortion of the gear as a whole that it can be corrected to practically perfect accuracy by means well-known to gear makers. The well-known means alluded to are, presumably, "setting" under the press, or similar means. This, in the writer's opinion, is very bad practice, as the means used to correct the gear sets up internal strains, which are retained in the gear. Should the gear at any time receive a sudden shock, it may upset the molecular structure of the steel, and so relieve the strains. One often wonders why gears when first placed in a car appear fairly quiet, and then, while on test, suddenly become noisy, and finally have to be replaced—a procedure which has often come to the writer's notice. A great deal of noise and hammering can be traced to "setting" under the press. To overcome the trouble already stated, it should be strongly advised to leave metal for supporting the gear while undergoing heat-treatment and to take a cut all over after carbonizing except on the tooth faces and flanks. Then only these latter parts will harden.

Finally, after hardening, the gear should be located true with the teeth, ignoring all other parts, and then the surplus metal left for supporting the gear should be removed, at the same time truing it up with the teeth. This, obviously, does away with the necessity of "setting" the gear under the press.

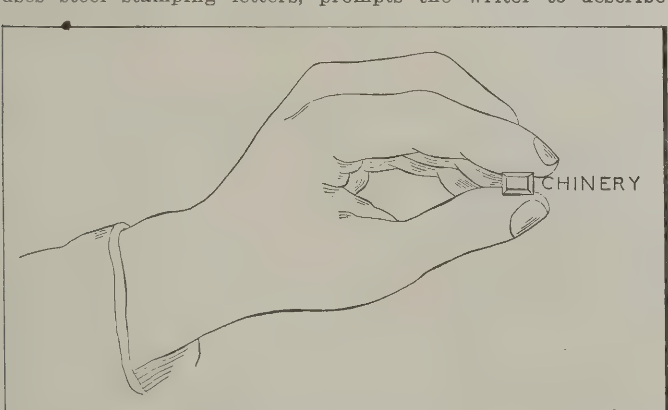
The writer does not want anyone to think that he is in any way condemning copper-plating for preventing parts from casehardening. He has seen this method in use for bicycle bottom bracket axles some ten years ago. The axles were copper-plated all over and then the plating was removed from the ball races only. It is also good practice to copper-plate the threads on the ends of hardened shafts and the like.

Anyone who wishes for further information upon the matter should refer to the article, by the writer, in another part of this issue entitled "Processes in Production of Automobile Transmission Gears."

Birmingham, England W. BETTERTON

USING STEEL STAMPING LETTERS

The "Remarks by the Onlooker," in the February number of MACHINERY, relating to the way the average machinist uses steel stamping letters, prompts the writer to describe



Method of using Steel Stamps

a method which he has used successfully. Others who have been told about it have found this method equally good, and it is, therefore, submitted with the hope that it will prove useful to someone.

The accompanying engraving shows fully as well as a description the principle of the method. The words are stamped backwards, beginning with the last letter. By doing so, it is possible to see exactly what one is about. The hand does not cover up the letters already stamped. A guide line should be scribed for the figures, so that they will line up properly.

In addition, attention should be called to the fact that cast iron should not be stamped without first chipping off the hard skin. To do so will improve the appearance of the stamping and will considerably lengthen the life of the steel stamps. A nick should be filed across the upper side of the type so that one can see or feel instantly when the right side is up. In this way, stamping of the letters upside down is avoided.

Christchurch, New Zealand. PERCY FRAMPTON

SEASONING CAST IRON FOR MACHINES

Having noticed the request for suggestions from readers as to ways and means of cheaply accelerating the seasoning process, the writer offers the following:

First, under the title "The Mobility of Molecules of Cast Iron," (a contribution to a discussion of the physics of cast iron), a resumé of some protracted investigations of this subject may be found in the transactions of the American Institute of Mining Engineers, 1896 (Vol. xxvi, beginning page 176).

Second, it was shown therein that release of cooling strains in iron castings may be very greatly accelerated—without heat annealing—by subjecting such castings to repeated shocks or vibrations while cold. In the case of ordinary test bars of one inch square section, broken transversely, with supports twelve inches apart, there was a gain in strength of bars subjected to shocks in a tumbling barrel for one hour of about twenty per cent, as compared with companion bars of the same size cast from the same ladle, not so treated.

Third, in a report of the committee of Science and Arts of the Franklin Institute on this discovery, entitled "The Molecular Changes in Cast Iron Caused by Vibration," dated May 5, 1897, and printed in the *Journal of the Franklin Institute* July, 1898, a maximum increase in load of 42 per cent and increase in deflection of 55 per cent is shown in a table giving tests of 166 bars, 26 by 2 by 1 inch tested flat, twenty-four inches between supports 83 of which were subjected to shocks as compared with untreated companion bars.

Fourth, the release of cooling strains in castings by shocks without aid of heat having been fully established by these and numerous similar and independent tests, the American Society for Testing Materials inserted a clause in its revised specifications for iron castings to the effect that test bars must not be subjected to shocks or vibrations prior to testing.

Fifth, the most effective and thorough method of removing internal stresses in iron castings "to prevent warping after finishing" is the old one of annealing by heat to cherry-red before machining, but this is impracticable in many cases, and careful tests have shown that an analogous effect may be produced by subjecting the castings while cold to rapid vibrations or shocks, thus accelerating the removal of internal stresses by molecular movement.

Sixth, finally it may be accepted as a fact that all iron castings improve with age, owing to the slow or gradual escape of cooling stresses due to rearrangement of molecules.

Philadelphia, Pa. ALEX E. OUTERBRIDGE, JR.
Metallurgist with William Sellers & Co., Inc.

A CUTTING LUBRICANT FOR COPPER

Copper, as most mechanics know, is very difficult to work with the ordinary steel tools, but if the following method is used good results will be obtained. Grind the tool as for cutting steel, giving it as much top and side rake as possible. The most important point is to have the tool well oil-stoned, not along the cutting edge but on the top, as the cutting edge must be kept clear of chips at all times. For a lubricant, use sweet cow's milk. This may seem strange, but it has proved to be about the only lubricant that will produce a surface on copper as smooth as glass.

Milwaukee, Wis. FRED FRUHNER

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

STANDARD PITCH FOR PIPE

W. K.—Why was 11½ pitch selected as the standard for pipe 1 to 2 inches in diameter? It is inconvenient to gear up for in the lathe, requiring a special change gear. Why would not 12-pitch have answered exactly as well?

A.—Twelve pitch would have been exactly as good as 11½ pitch and is sometimes used when gearing is not available for the standard. For the reason why 11½ pitch was adopted, we refer you to the readers of MACHINERY. If anyone can offer a reasonable explanation, we shall be glad to hear from them.

CAST-IRON PACKING RINGS

L. H.—Why is cast iron so generally employed for piston rings? Has it proved superior to other metals for the purpose? I have searched through several books on machine design without finding the desired information.

A.—Cast-iron packing rings are almost universally used in the pistons of small reciprocating engines and generally in the largest ones. The reasons are that cast iron is low priced; it can be cast in hollow cylinders suitable for making rings and requiring a minimum of machine work; it is close grained, tough and elastic, in suitable mixtures; it wears quickly to a mirror-like surface when working in contact with the wall of a cast-iron cylinder, being an exception to the rule that like metals do not wear well together; it is available wherever ordinary castings are made; and it is easily turned, bored and faced on the lathe. Steel, on the other hand, is higher priced; it must be forged and welded into rings, unless special machinery is available for rolling the rings up to shape; it must contain sufficient carbon to give it temper, if the rings are to be as elastic as cast iron; it wears quickly, working in contact with cast iron, and wears the cast iron rapidly also; and it is harder to machine than cast iron. Some of the bronzes make excellent packings for steam engine pistons, but they are costly and not readily obtainable. The principal objection to cast iron is that the rings are likely to break under shock; in some situations steel must be used because of this defect, especially in steam hammers.

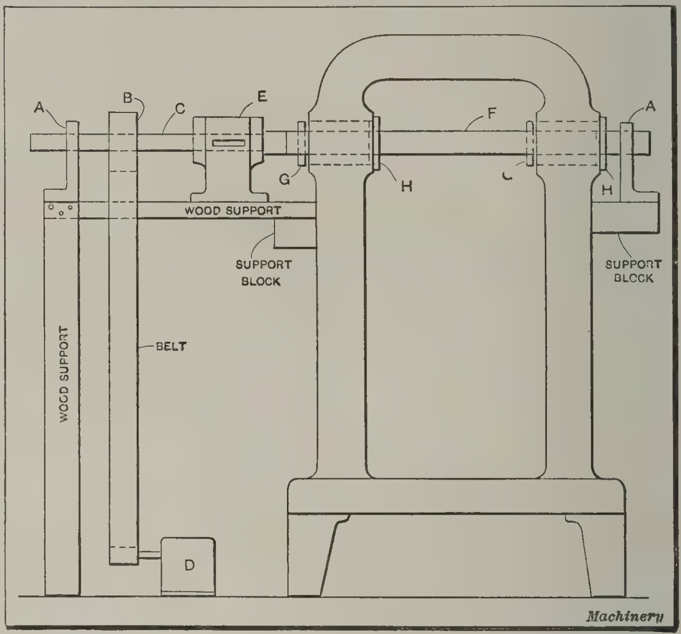
STRAIGHTENING DRILL ROD

D. A. H.—The writer would like to have proposed a method for straightening drill rod 0.105 inch in diameter, furnished in 24-inch lengths. The accuracy must be such that when the rod is rolled on a flat surface no part will be more than 0.005 inch out of true. Also, a method is required for giving a spring temper to these rods and yet have them remain straight. The writer has had to straighten many thousand pieces of untempered commercial rods, as well as a large number of spring tempered rods, and has come to the conclusion that there is no royal road to success in this respect. It seems that this is too close work for wire straightening machines, and, of all the methods tried, none approaches hand straightening. An intelligent helper after careful instruction and some practice has been found to be able to straighten fifteen to thirty rods per hour of unhardened, and ten to twenty of hardened rods, depending on the hardness of the stock, the number of short kinks, etc. The method used has been to mount a hard cast-iron surface on a bench, placing it about on the level with a man's eyes when seated. When the rod is laid on this surface the high spots show the light under them and are straightened by a blow from a 4 ounce hammer. When spring tempered rods are wanted, however, the difficulties are greater, and every rod has to be straightened after hardening. The writer learned from a steel salesman that "our steel can be hardened straight very easily; all you have to do is to heat it uniformly and dip it in water, end first." Marvelously simple until you try to do it! It is possible that someone has had similar work to do and has been more successful than the writer. If anyone has accomplished this work in a more satisfactory manner than outlined above, his experience would prove valuable and interesting.

PORTABLE BORING-BAR

Answered by William N. John, Milwaukee, Wis.

In the How and Why columns of the May number of MACHINERY, J. H. asks for a suggestion for methods to be used for reboring punch and stamping press journals. A couple of months ago we had occasion to rebore the 6-inch bearings in a No. 75½ Bliss power press. We made use of the rigging shown in the accompanying engraving. A scaffold was first erected of 3- by 10-inch planks. Then the saddle or sliding head and spindle were removed from a 24-inch back-geared drill press, the spindle being used to drive the boring-bar. On the scaffolding we also attached the lathe steadyrests from a 16-inch lathe to support the ends of the spindle and bar. On the spindle a 12-inch pulley was fastened with a feather key, this pulley being driven with a 3-inch belt from a 2½-inch pulley on a ¾ horsepower motor fastened to the floor. The boring-bar consisted of a piece of cold-rolled steel about one-half the diameter of the journal. The first cut with the boring-bar enlarged the hole about 1/16 inch. The



Diagrammatical View of Arrangement used for Reboring Bearings in a Stamping Press

cut was reduced each time the boring-bar was run through the journals, until a smooth bore was obtained; about 1/16 inch was planed off from the caps.

In the illustration *A* are the steadyrests; *B*, the 12-inch pulley; *C*, the drill press spindle; *D* the motor; *E*, the sliding head; *F*, the boring-bar; *G*, the boring-bar cutters; and *H*, plates having holes which are lined up with the old bore and which support the boring-bar. The illustration simply shows the arrangement in a diagrammatical way.

The work on this rigging was begun when the plant was shut down Saturday, and the punch press was ready for work Monday morning.

* * *

MACHINE TOOL EXHIBITION AT OLYMPIA, LONDON

The Machine Tool and Engineering Association, Ltd., of Great Britain has organized a machinery exhibition covering principally machine tools, to be held from October 4 to 26, at Olympia, London. Nearly two hundred firms have signified their intention to take part in this exhibition so far, and a casual perusal of the list of exhibitors indicates that the exhibition will be of unusual interest to mechanical engineers and to machine tool builders and users. Not all of the exhibitors, of course, are engaged in machine tool manufacture, but a large portion are makers of either machine tools or accessories. A feature of the exhibition which will be of considerable interest, will be the application of the electric drive to a great many of the tools exhibited. The arrangement for safeguarding machines will also be of interest, as it is required by the committee that passes on machines and appliances to be exhibited that all machinery and tools must be properly guarded to meet with the requirements of the ordinances of the London County Council. Altogether, the exhibition will form an unusual opportunity for studying the present status and trend of the machine tool industry in Great Britain.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE DAVIS-BOURNONVILLE "OXYGRAPH"

The "oxygraph" is a recent development effected by the Davis-Bournonville Co., 97 West St., New York, for cutting steel by the oxy-acetylene process. It is constructed on the pantograph principle and is so arranged that steel of several inches thickness can be cut to any desired shape by simply guiding the pantograph arm, which is equipped with a cutting torch and a mechanically propelled tracer. When the steel is to be cut accurately to a given shape, a drawing is placed on the table of the machine, and, as the operator guides the tracer along the outline of the drawing, the cutting torch is given a corresponding movement on a reduced scale. In this way, intricate shapes can be cut with considerable rapidity.

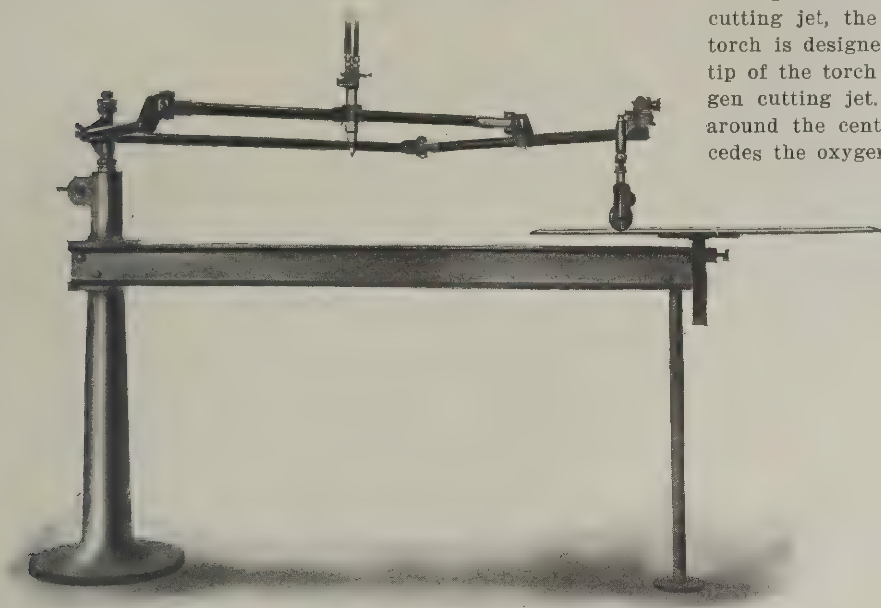


Fig. 1. The Oxygraph—A Machine for Cutting Steel by the Oxy-acetylene Flame

The oxygraph, which is shown in Fig. 1, is very simple, both as regards its construction and operation. It consists of a heavy cast-iron column and an outboard standard, upon which are mounted horizontal supports for holding the work. At the left end of the work-table, the pantograph arm is pivoted, and at the opposite end there is a steel table for holding the drawing corresponding to the outline of the form to be cut. The tracing wheel, which is a thin steel disk, is attached to the outer end of the pantograph arm and rests on the drawing-table. This wheel is positively rotated by a small motor attached to the end of the horizontal arm, and it can be swiveled about a vertical axis for moving in any required direction. This mechanical propulsion of the tracing wheel is a novel and valuable feature and has two decided advantages: In the first place, it provides a uniform predetermined speed for the cutting torch, so that the latter moves at the proper rate to obtain the greatest efficiency; and, in the second place, it is much easier for the operator to follow the lines on a drawing, because his entire attention can be given to the control of the tracing wheel, the latter simply being turned one way or the other, as may be required. The motor is connected with the tracing wheel through small gearing and shafts, and it is started or stopped by a switch conveniently located above the wheel. The motor is small and compact and requires very little power. It can be operated either by a small storage battery or a wire attached to an electric light fixture.

This machine will cut steel three inches thick at a speed of six inches per minute, and the company expects to increase this capacity considerably. It should be mentioned that the cutting is done with the oxy-acetylene flame and the oxygen cutting jet, the same as in ordinary practice, although the torch is designed especially for use with the oxygraph. The tip of the torch has five jets for heating and one larger oxygen cutting jet. The heating jets are arranged in a circle around the central cutting jet, so that a heating flame precedes the oxygen jet regardless of the direction in which the torch is moved, and another heating flame also follows the oxygen jet. It has been found that this arrangement of a heating jet in front and another to the rear of the oxygen jet is much superior to the usual one.

This machine will doubtless prove invaluable in die-making and for a great many other purposes. Fig. 2 illustrates the possibility of cutting out small crankshafts, these shafts having been cut from one-inch steel plates in 8½ minutes. With a high quality of oxygen, the kerf left by the cutting flame is narrow and a clean, sharp cut is obtained. Straight, curved or irregular outlines can be followed easily, and square corners are also cut without difficulty. The piece shown to the right in Fig. 3, was cut out by the writer without any previous experience whatever in operating the machine. This block is illustrated merely to show that straight lines, curves or right-angle turns can be followed by an inexperienced operator. This is made possible by the mechanically propelled tracing wheel, which simply needs to be guided, but takes care of itself as far as the forward movement is concerned. When a corner is reached, the wheel is given a quick turn, and, being motor-driven, immediately starts off in the other direction, so that the corner is cut clean and sharp, which would not be the case if there were any delay. The sides of the narrow path or kerf left by the flame, are remarkably smooth as shown by the sample piece at the left in Fig. 3.

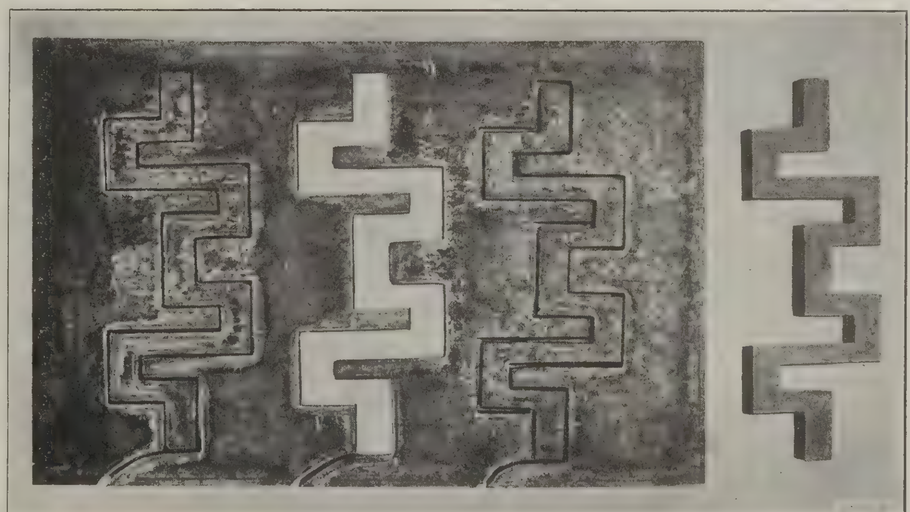


Fig. 2. An Example of Work done by the Oxygraph

The pantograph arm is made of light steel tubing, and the joints are provided with ball bearings to give a free movement. The arm can be adjusted vertically to suit the height of the work, and the drawing-table also has a vertical ad-

justment. The torch tip is about 1/8 inch above the metal when in operation, and the latest designs will have a fine, vertical adjustment of the torch so that its height can be varied in case the material being cut has an uneven surface. This machine has a capacity for widths up to 18 inches, without moving the piece being cut.

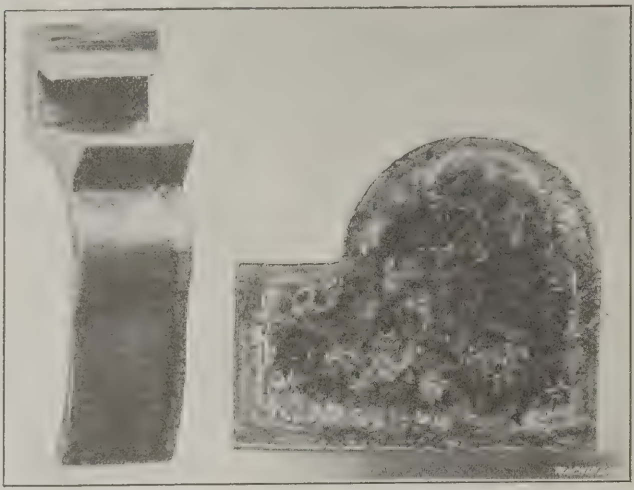


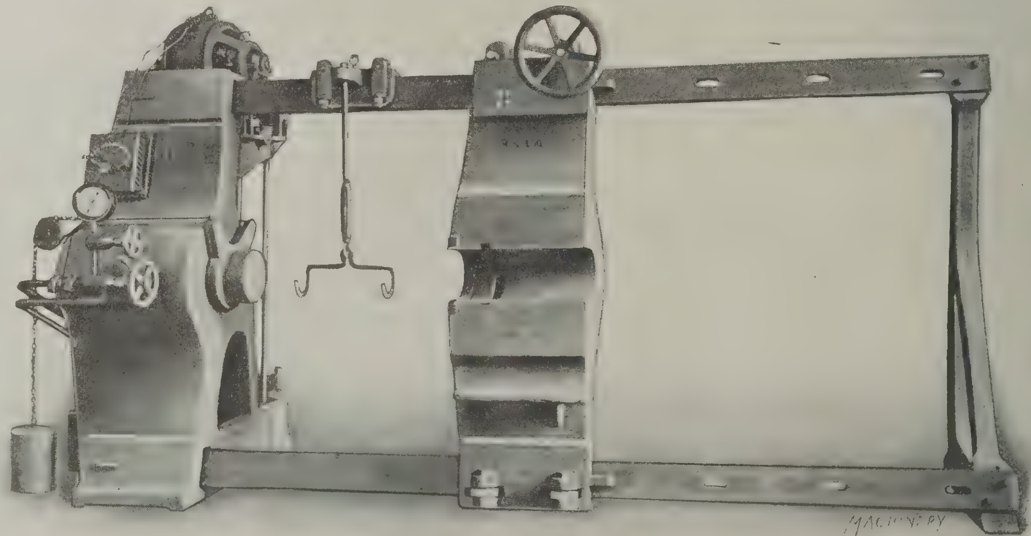
Fig. 3. Sample Pieces cut from Steel Plate by the Oxygraph

The first public demonstration of the oxygraph was given at the Master Mechanics and Master Car Builders convention recently held in Atlantic City, where it attracted considerable attention.

CALDWELL MOTOR-DRIVEN HYDRAULIC WHEEL PRESS

The motor-operated wheel press shown in the accompanying illustration, is manufactured by E. R. Caldwell & Co., Bradford, Pa. This press is a modern design having a rapid adjustment of the ram and a combination of high and low pressures, which facilitate its operation.

For convenience in handling heavy work such as locomotive drivers and irregular-shaped parts that cannot be rolled to and from the press, the upper horizontal parallel bar is not directly above the lower one, but at a slight angle which permits handling the work with an overhead crane. The plungers (not shown in the illustration) are operated by eccentrics on a back shaft which is driven through cut gears having a ratio of 3½ to 1. The plungers operate without vibration and are practically noiseless. The ram is drawn back automatically as soon as the pressure is shut off from the pumps. An extra valve to connect with the city water line is furnished, when it is possible to have such connection. By opening this valve before using the pressure from the pump, the steel-faced ram is moved out against the work more rapidly than would be possible with the pumps; the city water line valve is then closed, the pump valve opened and the plungers started.



Motor-driven Hydraulic Wheel Press built by E. R. Caldwell & Co.

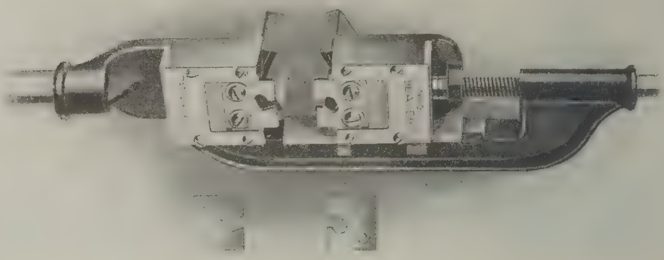
The press is equipped with low- and high-pressure pumps. The low-pressure pump operates the ram up to a certain pressure with a greater speed than the high-pressure pumps, and, consequently, increases the amount of work that can be handled by the use of the high-pressure pumps alone. The low-pressure cylinder is arranged with a relief valve, so that the pump works until there is about 50 tons pressure, when it is automatically "cut out" and the pressing operation is continued at a slower rate by the use of the high-pressure pumps.

In pressing off work, this automatic device is especially efficient. The low-pressure pump works until there is about 50 tons pressure and then the high-pressure pumps begin to operate, and continue until the work is pressed off far enough to enable it to be finished with the low-pressure. As will be apparent, this feature enables the work to be done in a minimum of time.

The pump cylinders are cast from a special semi-steel mixture which gives them great strength, and makes them proof against leakage. All presses are provided with a safety valve to prevent overloading. The plungers are driven by a direct-current, 7½-horsepower, Westinghouse motor.

BEAVER SQUARE-END PIPE CUTTER

The Borden Co. of Warren, Ohio, has brought out a new pipe cutter which severs the pipe by turning or cutting, rather than by squeezing it apart with disks or wheels. This cutter is equipped with square-end turning or parting tools that sever the pipe the same as a lathe tool. The arrangement and form of the tools or blades, and the construction of the central part of the cutter, are shown by the accompanying illustration. There is a tool on each side of the pipe, and, as these tools revolve, a narrow annular groove is cut through the pipe wall. The tools feed inward automatically, and the cutter is turned by two handles the same as a die-stock. The No. 5 size illustrated herewith, has a capacity for pipes varying from ½ to 2 inches. This cutter is said to sever a pipe square and clean and without leaving any burr to remove by filing or reaming. The inside diameter is not reduced and the square end makes it much easier to start the threading die. The cutter is strong and durable, and its blades will sever a great many pieces of pipe without requiring to be reground.



Pipe Cutter equipped with Turning or Parting Tools

BEAMAN & SMITH CYLINDER BORING AND MILLING MACHINE

The machine shown in Figs. 1 and 2 of the accompanying illustrations is a combination type designed to bore two twin-cylinder automobile engine castings simultaneously, and, at the same time, mill the flanges on two other castings. After one set of castings has been milled, it is moved into position for boring by simply revolving the table.

The machine has a substantial bed which supports at one end a carriage with two boring heads, each of which carries two spindles. This is the head seen to the left in the illustration. At the other end of the main bed there is a small cross bed located at right-angles, upon which is mounted a saddle carrying the two milling spindles. The revolving table is located near the center of the main bed. It is 54 inches square and is provided with a ball bearing, which when raised into position by a handwheel, takes the weight of the table and allows it to be revolved easily. The table, however, does not rest upon this ball bearing when the machine is in operation, but on a scraped surface of large diameter. The table has four stop-pin holes and it can be securely fastened after being located by the locking pin.

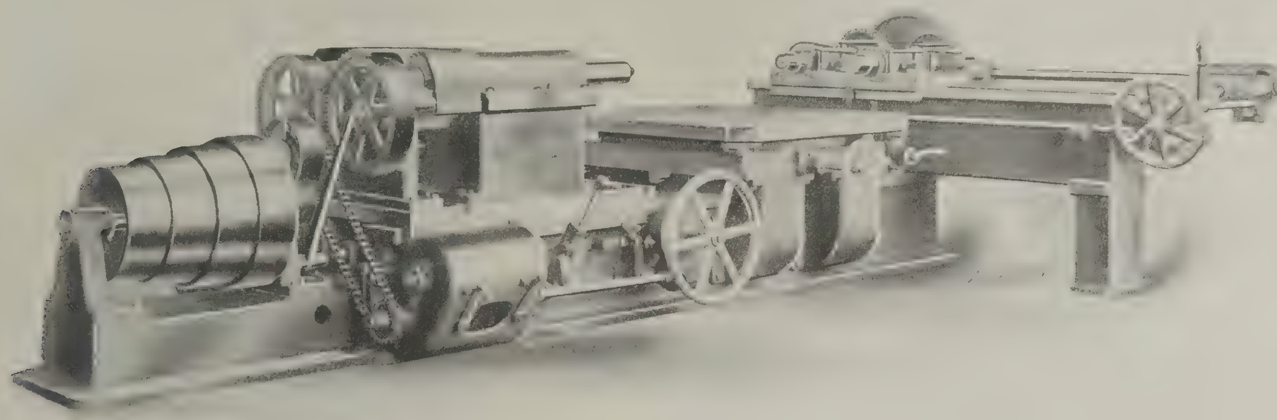


Fig. 1. Beaman & Smith Universal Cylinder Boring and Milling Machine

The carriage upon which the boring heads are mounted, is 34 inches wide, 54 inches long, and has a 30-inch movement on the bed operated by a screw of large diameter which engages a bronze nut. The thrust is taken by ball bearings and the carriage has a quick movement of six feet per minute in either direction. The front end of the carriage extends beyond the ends of the spindles (as shown in Fig. 2) and passes under the table which is bridged across the bed. This extended bearing is for distributing the wear as equally as possible.

The carriage has positive geared feeds which vary from 1/32 to 1/4 inch per revolution of the spindle. The feeds for the milling heads vary from 1 inch to 4¼ inches per minute, for any spindle speed. The four boring spindles are of crucible steel and run in boxes of hard bronze. The ends are made to fit cutters according to specifications. Each of the front bearings is 4 inches in diameter and 6 inches long, and the rear bearings are 2¾ inches in diameter and 5 inches long. Means are provided to compensate for wear. The spindles are fitted in twin heads, and the center distances are made to suit individual requirements. Gearing in the ratio of 8.4 to 1. gives speeds varying from 22½ to 44 revolutions per minute.

The boring spindles are driven by a 6-inch belt operating on a four-step cone, and the milling spindles are driven by a 5-inch belt operating on a three-step cone. The saddle for the milling spindles is 20 inches wide and 41 inches long and has a movement of 52½ inches on the cross bed. It is also provided with a quick power movement, varying from 6 to approximately 12 feet per minute in either direction. This rapid traverse is driven by a 4-inch belt operating on a 10-inch pulley. The milling spindles are also made of crucible steel and run in hard bronze boxes. They have tapered ends 3 inches in diameter for receiving face milling cutters. The front bearings are 4 inches in diameter and 6 inches long, and the rear bearings, 3 inches in diameter and 5 inches long. Gearing in the ratio of 21½ to 1, gives speeds of 7½, 10, and 14 revolutions per minute.

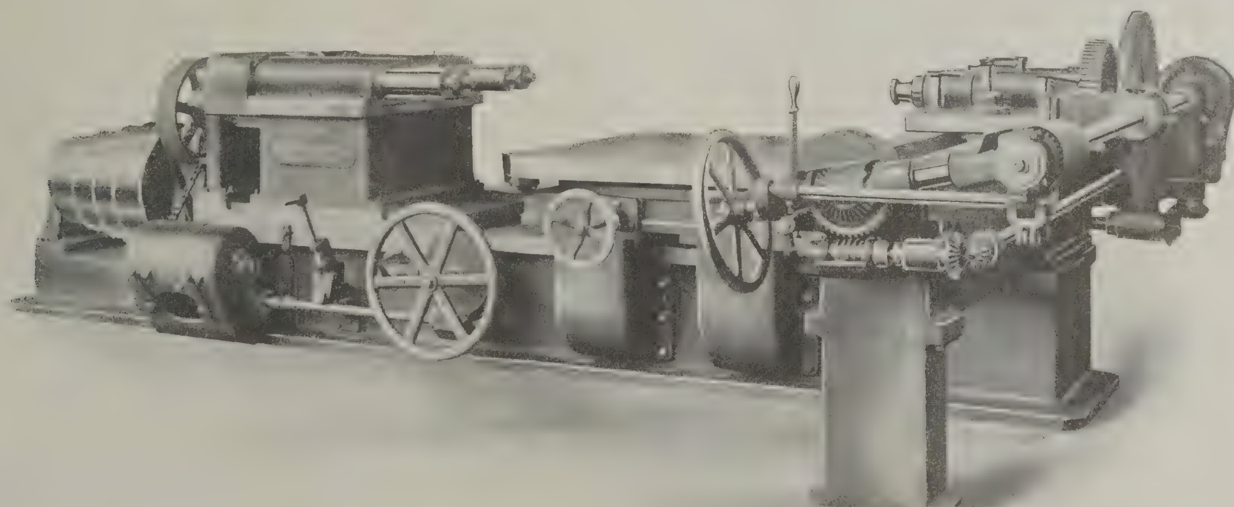


Fig. 2. Another View of the Beaman & Smith Machine

The minimum distance from the center of the table to the face of the boring heads is 27 inches, and the maximum, 57 inches. The minimum and maximum distances from the center of the table to the end of the milling spindles are, respectively, 28¾ and 31¾ inches. The vertical height from the center of the spindles to the top of the table is about 9¾ inches. The weight of this machine is approximately 28,000 pounds. It is known as the No. 2 universal, cylinder-boring and milling machine, and is built by the Beaman & Smith Co., Providence, R. I.

OESTERLEIN MOTOR-DRIVEN MILLING MACHINES

The application of variable- and constant-speed motor drives to the milling machines built by the Oesterlein Machine Co., Cincinnati, Ohio, is illustrated herewith. Fig. 1 shows a direct-connected, variable-speed, motor-driven machine. This same drive is applied to all sizes of plain and universal milling machines built by this company. A large driving gear, which runs loose on the spindle, drives the latter either by connection to the face-gear or through the back-gearing. The intermediate gear is made of hard fiber so that the drive is practically noiseless. With the push-button starter, which is located on the right side of the column above the spindle, the machine is automatically adjusted to the speed for which the motor is set.

The No. 20 plain or universal machines are equipped with a two-horsepower motor, and with a 6 to 1 speed variation all spindle speeds from 19 to 400 revolutions per minute can be obtained. A 4 to 1 variable-speed motor will give all speeds from 21 to 85 and from 100 to 400 revolutions per minute. For the single back-geared No. 24 or 28 plain and No. 25 universal machines, a three-horsepower motor is used, and with 6 to 1 and 4 to 1 variations, the same spindle speeds are obtained as previously given for the No. 20 machines. A double back-geared No. 24 plain, No. 28 plain, and No. 25 universal machine should have a three-horsepower motor, and a 3 to 1 variable-speed type will give all spindle speeds from 14 to 400 revolutions per minute. The No. 34 plain and No. 30

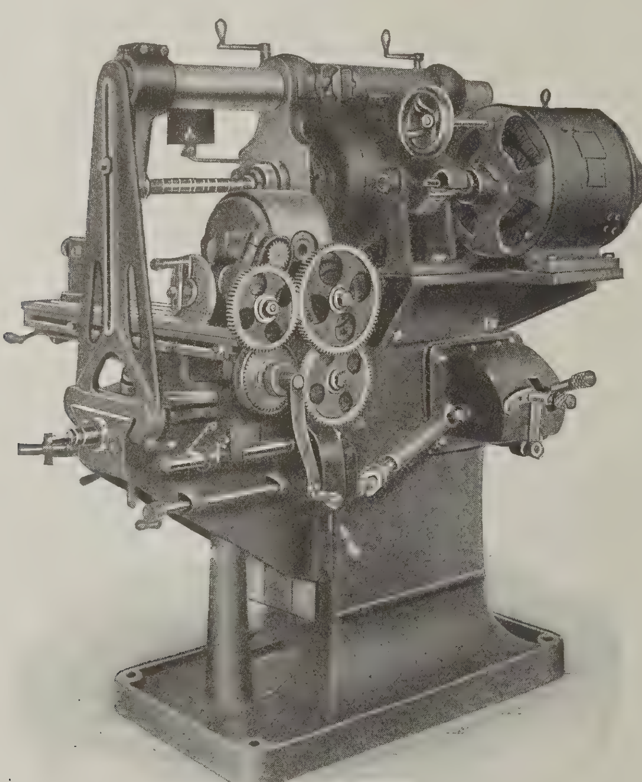


Fig. 1. Oesterlein Direct-connected Variable-speed, Motor-driven Machine

universal machines use a five-horsepower motor. The spindle speeds in any case can be changed by altering the pinion on the motor shaft.

A constant-speed motor-driven machine is illustrated in Fig. 2. The arrangement of the drive is clearly shown by the illustration. The motor may be an alternating or direct-current type. The motor shaft carries a two-step pulley which drives the two-step pulley on top of the machine. On this upper pulley shaft there is a pinion which drives a large gear inside the cone. This gear is secured to the cone, and the latter is bronze-bushed and runs loose on the shaft. The upper pulley shaft is eccentrically mounted and its position can be varied by the belt-tightening lever seen on the right-hand side of the cone. With this lever, a proper belt tension can be secured or the belt can be loosened to permit shifting it easily. The lever between the two cones is provided to facilitate the shifting of the belt.

The single back-geared machines have four-step driving cones operating at two different speeds, so that, in connection with the back-gear, 16 single speeds are secured. The double back-geared machines have three-step driving cones, which, with two speeds and double back-gears, give 18 spindle speeds

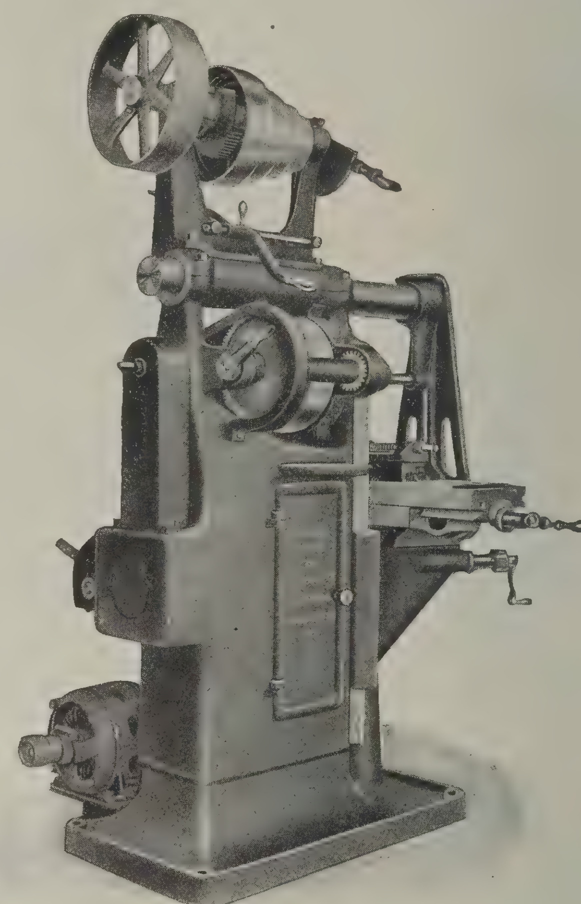


Fig. 2. Oesterlein Constant-speed Motor-driven Machine

varying in geometrical progression. A two-horsepower motor is recommended for the No. 20 plain and universal machines; a three-horsepower size for the No. 24 and 28 plain, and No. 25 universal machines, and a five-horsepower motor for the No. 34 plain and No. 30 universal machines.

CINCINNATI PRECISION ADJUSTABLE REAMER

The adjustable reamer shown in Fig. 1 has been designed by the Cincinnati Precision Lathe Co., Cincinnati, Ohio, for accurate work. The blades of this reamer are inserted in slots cut in a steel shell which is fitted to a taper shank, and held in position by a taper pin which passes radially through

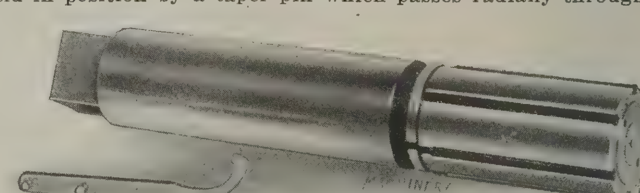


Fig. 1. Cincinnati Precision Adjustable Reamer

both shell and shank. The slots extend clear through the shell, excepting at each end, so that the blades rest directly upon the taper shank. The latter is threaded at each end of the taper, and upon the threaded parts are screwed angular collars which retain the blades, as clearly illustrated in Fig. 2, which shows the reamer with the slotted shell and the angular collars removed.

The blades are also adjusted radially by these collars, the adjustment being made by screwing the collars one way or the other and thus shifting the blades up or down the taper

shank. By employing a ground taper shank as a seat for the reamer blades, a fine degree of accuracy is obtained. The blades, which are jig ground, are exact duplicates, and the slots in the shell are accurately milled to fit the blades.

This construction gives a uniform movement and adjustment of all the blades, so that each one cuts when the reamer is in use. By adjusting the collar next to the body and then turning the collar at the small end of the taper shank, a corresponding amount, the blades are moved along the taper

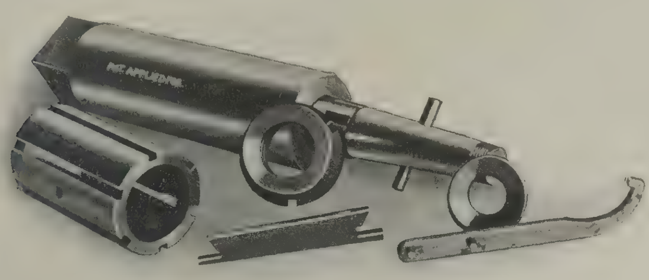


Fig. 2. Component Parts of Adjustable Reamer

uniformly and cannot become eccentric to the body of the reamer. The inner sides of the collars, which engage the ends of the blades, have a 30-degree angle so that the blades are firmly clamped against the taper shank. All threads and inner working parts of this reamer are protected from chips or other foreign material. The single combination wrench seen in Fig. 1, is used for making all adjustments.

MODERN MACHINE TOOL CO.'S FLAT TURRET LATHE

The Modern Machine Tool Co., 4657 Spring Grove Ave., Cincinnati, Ohio, is now manufacturing the flat turret lathe shown in Figs. 1 and 2. Careful attention has been given to the arrangement of the various parts so as to secure a compact, simple construction and a convenient control. The various parts of the lathe have been made extra heavy.

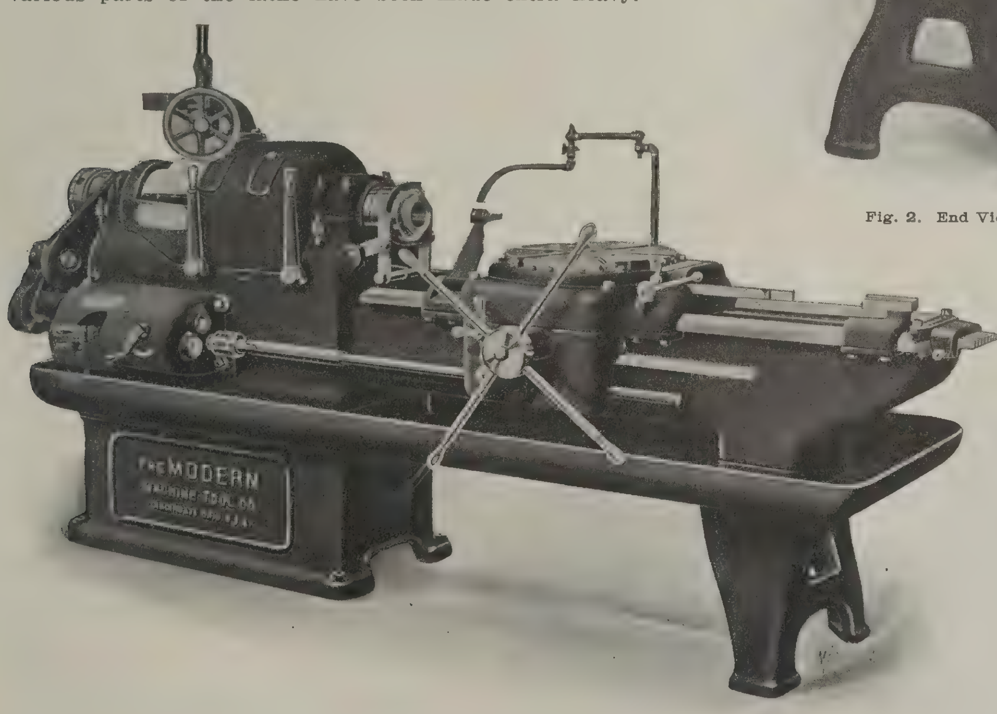


Fig. 1. Flat Turret Lathe built by Modern Machine Tool Co.

The head is very massive and is cast integral with the bed. The head contains the cone pulley for driving the machine, the friction back-gears and the automatic roller feed and chuck. The back-gears are located directly under the spindle. These gears, in conjunction with the three-step cone, give 12 spindle speeds varying in geometrical progression. The bed, which rests on a tripod bearing, is deep and heavy, and is reinforced under the front spindle bearing.

The chuck is operated by a single movement of the lever seen in front of the head. It has a strong unyielding grip and no overhang or end motion. One set of jaws can be adjusted for the full capacity of the machine, and the jaws and seat are hardened and ground. The chuck is constructed for handling rough bars, and the jaws can be made for any size or shape within the spindle's capacity. The automatic roller feed has only three moving parts. It is mounted on the spindle just back of the front bearing and is operated by the same lever that opens the chuck.

The carriage is gibbed to the outer edge of the bed by flat gibs extending its entire length. The bearing on the bed is not recessed, but there is a full contact from end to end. A binder is provided for securely clamping the carriage to the bed during forming or cutting-off operations. The backward movement of the carriage automatically indexes the turret the instant the tool leaves the work. The arrangement is such that the turret can be turned to any one of the six positions without making any other stops.

Fig. 2. End View of Flat Turret Lathe

The adjustable dog for operating the index bar is clamped to the V and governs the position of the saddle at the time the turret begins to revolve.

The carriage has twelve independent adjustable stops which operate automatically for each position of the turret and can be used in any desired combination when two or more are needed for any position of the turret. The turret is a flat circular table 18 inches in diameter, and has T-slots for clamping the tools in position. The tools can be attached to the turret for turning several diameters simultaneously when desired. The index is very large in diameter and the lock-bolt is located directly under the working tool, and so close to it that lost motion is eliminated.

The feed gear box is driven from the spindle. Eight feed changes are available for each of the twelve spindle speeds, and a graduated plate shows the amount of feed for different positions of the change gear levers. All gearing is covered.

The machine has a mechanical belt shifter which is operated by a handwheel located at the front of the head. This wheel operates two shifting arms, one of which is located

above the cone pulley on the machine and the other near the cone pulley on the countershaft. Connection is made between the upper and lower arms by a vertical shaft. By means of this mechanical shifter, the position of the belt can be changed quickly and without danger to the operator.

Bar stock up to 2¼ inches in diameter can be fed through the automatic chuck and lengths up to 26 inches can be turned. The swing over the bed is 20 inches, and over the carriage, 16 inches. The net weight of the machine is 4500 pounds. This lathe is manufactured on the unit system and the parts are interchangeable. The plain bearings are scraped to master surface-plates and straightedges, whereas shaft bearings are ground and fitted with removable bushings which can be replaced when worn, without disturbing the shaft alignment. Efficient means for lubrication are provided.

WILMARTH & MORMAN CUTTER, REAMER AND DRILL GRINDER

The cutter, reamer and drill grinder manufactured by the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich.,

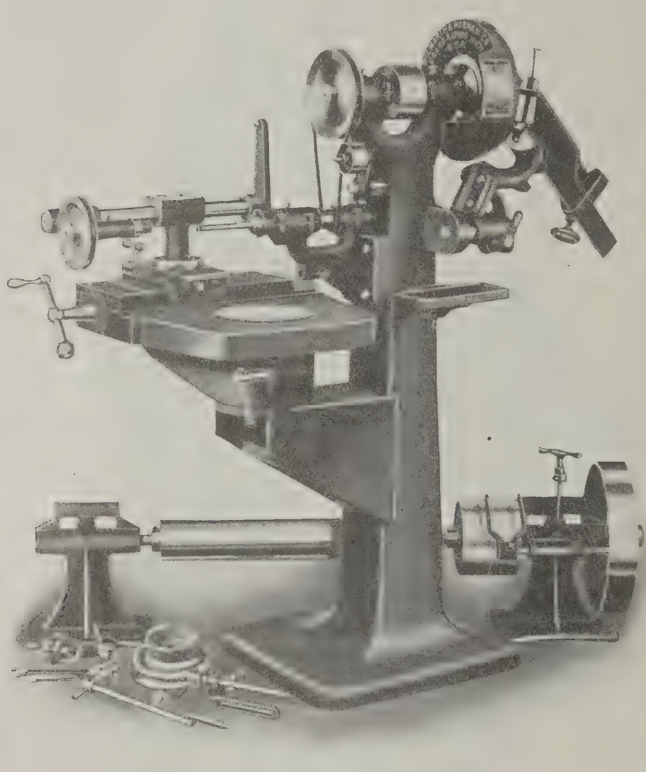


Fig. 1. "Yankee" Cutter, Reamer and Drill Grinder with Cylindrical and Internal Grinding Attachment

has been re-designed to make it more universal than the former machine. With the old-style grinder, the table of

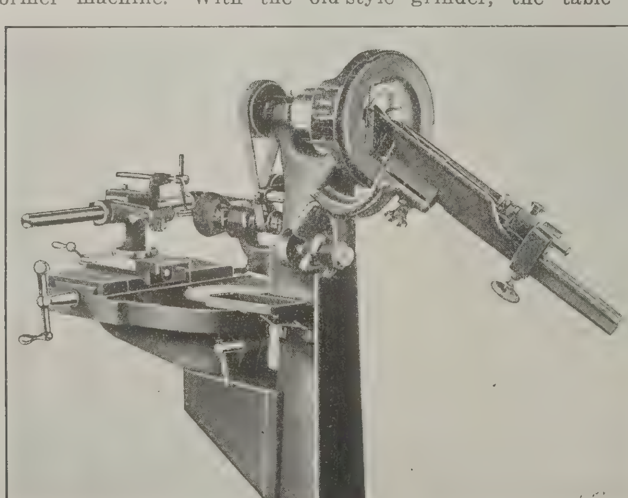


Fig. 2. Grinding Reamer with Face of Cup Wheel

the cutter grinding attachment was permanently bolted to the column and the small wheel-head was bolted to the table. With the new machine, the table and its slide is mounted on a knee so that it can be swiveled with relation to the grinding wheel, approximately 180 degrees, which permits using a cup wheel and makes it possible to apply the work to either side of a plain wheel.

Fig. 1 shows the machine complete, with a cylindrical and internal grinding attachment, in addition to the regular drill grinder. The way the machine is arranged for grinding

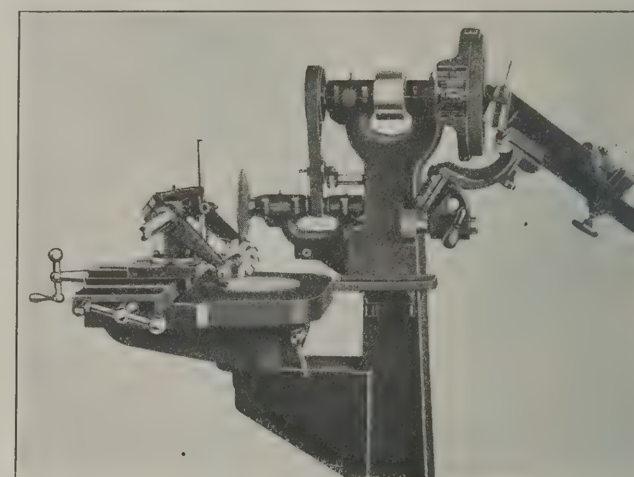


Fig. 3. Grinding Formed Cutter

reamers when using the face of a cup wheel, is illustrated in Fig. 2. This particular reamer is straight, but taper reamers are ground in the same way, except that the standard carrying the reamer, is swiveled to the required angle. In case it is desired to grind a reamer by using the periphery of a plain wheel instead of a cup wheel, this can be done by swinging the table around to bring the slide parallel with the wheel spindle. The table can be swiveled to either side, so that the wheel will grind either up or down, with relation to the teeth.

Fig. 3 illustrates the grinding of a formed cutter. The work is mounted on a suitable arbor which is placed between

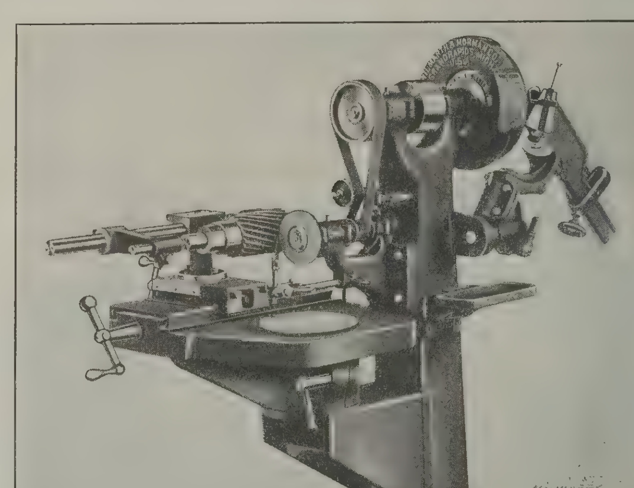


Fig. 4. Grinding Cylindrical Cutter

the centers as shown, and the teeth are ground by passing the cutter under a saucer-shaped wheel. The feed is regulated by the cross-screw movement of the upper or cross-slide which carries the swivel or standard. Hobs, gear-cutters or taps can also be ground in the same way. When grinding the flutes of a tap, the latter is, of course, held by its own centers and no arbor is needed. Fig. 4 shows the method of grinding a plain, spiral-tooth milling cutter by using the periphery of a straight wheel. A cup wheel can also be employed by setting the machine as illustrated in Fig. 2.

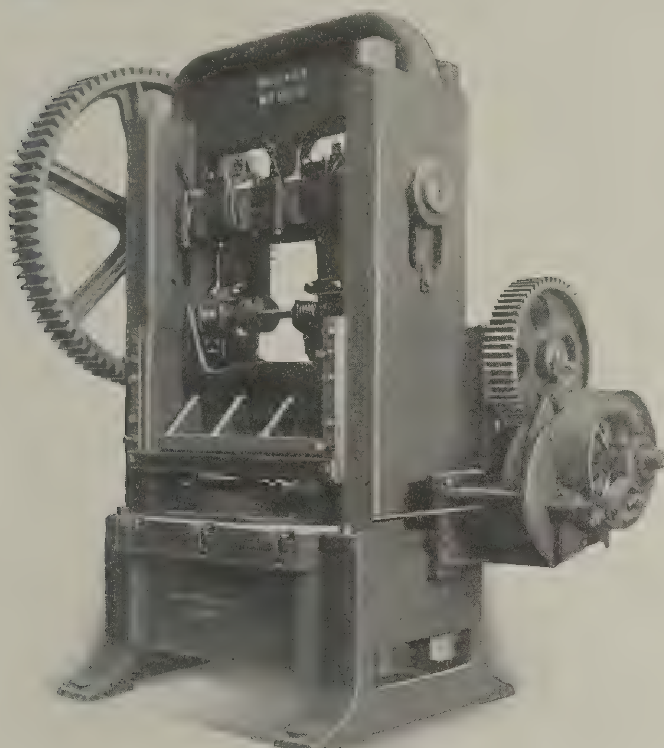
This machine is also adapted to the grinding of angular cutters, as well as face or side mills. When grinding angular cutters, the table is swiveled to the required angle as indicated by the graduated base. A vise can be furnished with this machine in case it is to be used for surface grinding. This vise is interchangeable with the regular swivel standard and has a graduated base which can be swiveled for angular grinding. The vise can also be tilted in a vertical plane, from

a 45-degree position to a point slightly beyond the perpendicular, and provision is made for securely locking it in position. This vise is intended for small hardened parts, such as vise jaws, small tools, cutters, keys, etc.

This machine has a capacity for side and face milling cutters up to 12 inches in diameter, and angular or plain cutters up to 8 inches in diameter. It will grind cylindrical work (straight or taper) up to 7¼ inches in diameter and 11½ inches long. The maximum distance between the centers is 17 inches.

NIAGARA DOUBLE-CRANK PRESS

The straight-sided, double-crank, power press shown in the accompanying illustration, was recently designed by the Niagara Machine & Tool Works of Buffalo, N. Y. The press



A Large Double-crank Press built by Niagara Machine & Tool Works

was built for the manufacture of gear guards for electric traction engines, but is suitable for a general line of heavy stamping and blanking operations. The frame is of the built-up type with tie-rods, and the slide and gibs have convenient adjustments.

Particular attention has been given to the arrangement of the press, so as to obtain a compact design occupying a minimum amount of floor space. Outboard bearings are entirely eliminated, and all parts of the drive which require occasional adjusting, are easily accessible.

The friction clutch is of the multiple-disk type. The friction surfaces are lined with end grain hardwood blocks. The clutch is entirely encased and all projecting rotating parts which might endanger the operator when oiling the clutch, are eliminated. The clutch is operated by four sets of toggles and links, which are made of steel. The brake which works in unison with the clutch, consists of two brake levers, which are actuated by a pair of toggles. An interesting feature of this construction is that the pressure on the brake blocks is always equalized, thus avoiding transmitting the pressure of the brake arms to the shaft bearings.

These presses are built in different sizes varying from 48 inches to 12 feet between the housings, and weighing from 30,000 to 150,000 pounds.

ROCHESTER BORING, MILLING, DRILLING AND TAPPING MACHINE

A horizontal boring machine of the "table type," which embodies many interesting features, has been brought out by the Rochester Boring Machine Co., Rochester, N. Y. This machine, besides performing the usual operations of boring,

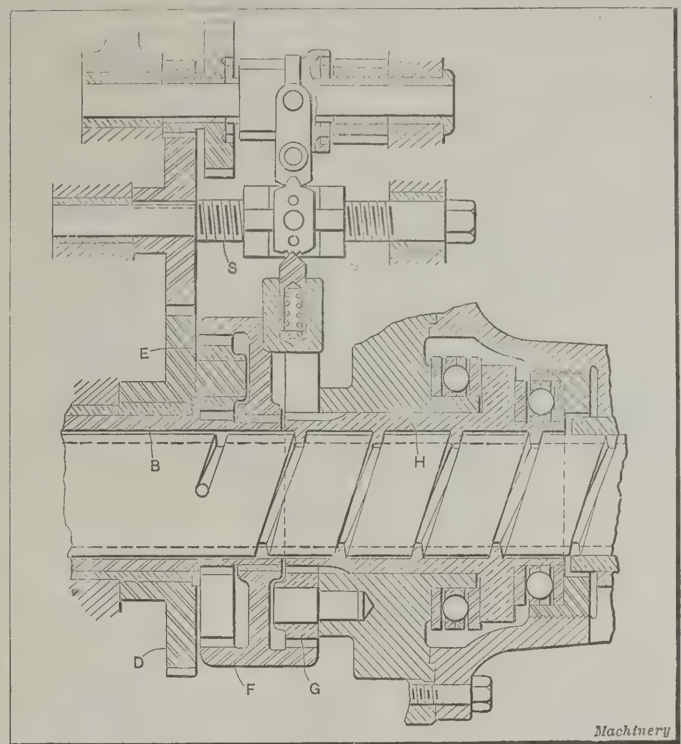


Fig. 1. Differential Feed Mechanism and Automatic Limit Stops for Spindle of Machine shown in Fig. 2

milling, and drilling, can also be arranged for tapping, splining oil grooves or thread cutting. The control of the machine is centralized, it being possible to make feed or speed changes, operate the rapid traverse movements, or start, stop and reverse the machine from one position convenient to the operator. No two feeds can be engaged at the same time, and it

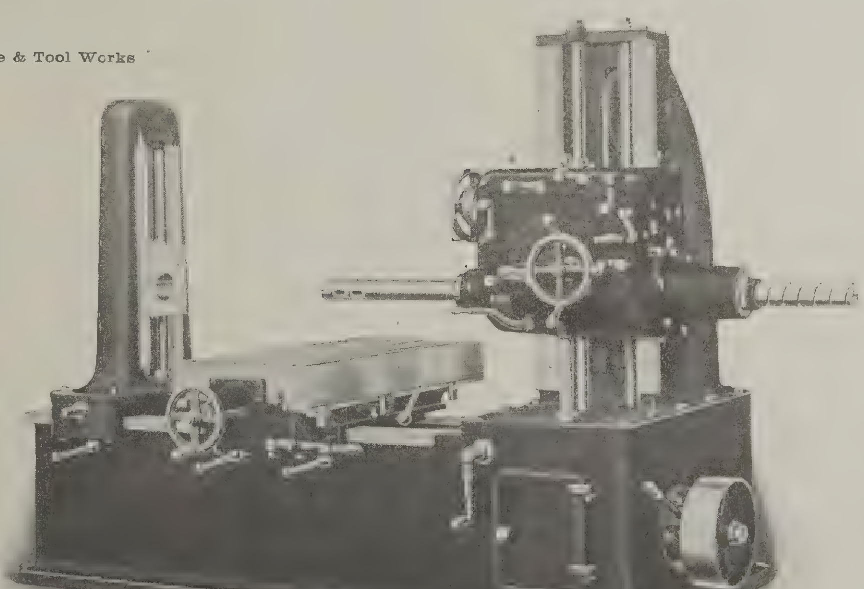


Fig. 2. Rochester Boring, Milling, Drilling and Tapping Machine

is also impossible to engage simultaneously the rapid traverse for different directions.

The main drive through the bed to the operating mechanism is simple and direct. The pulley shaft can be arranged either parallel to the machine, as shown, or at right-angles to the bed. The single, constant-speed driving pulley has a friction clutch for starting or stopping, which is controlled by the

small lever seen to the left of the pulley in Fig. 2. The horizontal lever on the lower left-hand corner of the saddle, can also be used for starting, stopping or reversing. This machine can be equipped with a motor drive, if desired. For a standard electric drive, the motor is mounted at the top of the column and connects direct with the vertical driving shaft. The motor can, however, be applied to the driving pulley shaft, if desired. Constant-speed motors for either alternating or direct currents are used, as all speed changes are obtained mechanically.

The bed has a continuous web construction and is closely ribbed in both directions. Chutes are provided in the bed for removing chips at the rear, and there is also a reservoir in one end for cutting oils or lubricants. The upright column upon which the saddle travels, is bolted and doweled to the bed and has a deep section with large surface bearings.

The mechanism for feeding the main spindle operates on the same principle as the feed mechanism illustrated in MACHINERY for July, 1910, in connection with a description of the floor-type machine built by this company. The feeding movement is transmitted from the change-gear mechanism to a differential geared drive which rotates a long bronze nut mounted directly on the spindle and engaging a square thread. The driving gears for the spindle are mounted on a sleeve *B* (see detail sectional view, Fig. 1) which has its own independent bearings. Clearance is provided between the sleeve and spindle and the latter is rotated by long splined keys fitted in the driving sleeve and engaging double splines, thus giving a balanced drive. Sleeve *B* has gear teeth cut on the end shown in Fig. 1, which mesh with three pinions *E* mounted on studs that form part of the differential feed-driving gear *D*. By means of a double internal gear *F* and three other pinions *G*, which mesh with the spindle feed nut *H*, the latter is positively rotated at the same speed and in the same direction as the spindle, so long as gear *D* remains stationary, which is the case when the feeds are disengaged. When the feed is applied, the spindle nut either rotates faster or slower than the spindle and this differential movement between the nut and spindle, gives a feed in one direction or the other.

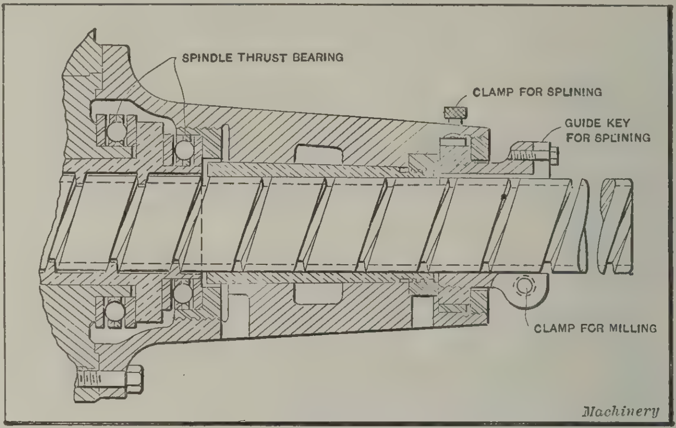


Fig. 5. Rear Spindle Bearing

The nut makes contact with the sides of the thread only, and the end-thrust is taken direct by the large ball bearings shown. The end-thrust for milling is taken by a bronze thrust bearing independent of the end-thrust for boring. All feeds, before being applied to the different parts, are transmitted through a friction clutch which enables instantaneous engagement or disengagement and provides a yielding point when desired. The reverse mechanism is located at the source of power and the feed can be reversed without stopping the machine.

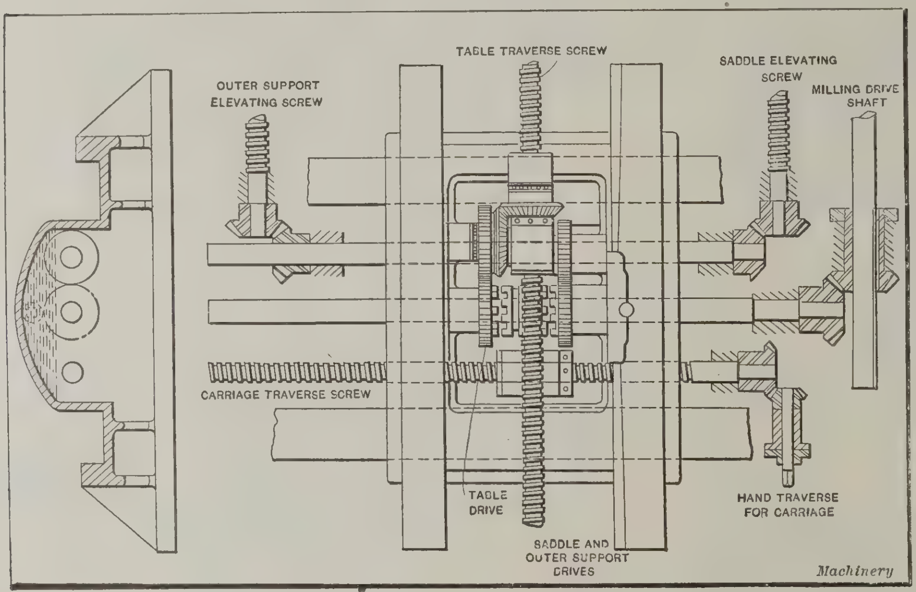


Fig. 3. Diagrammatical View showing Table, Carriage and Power Distribution

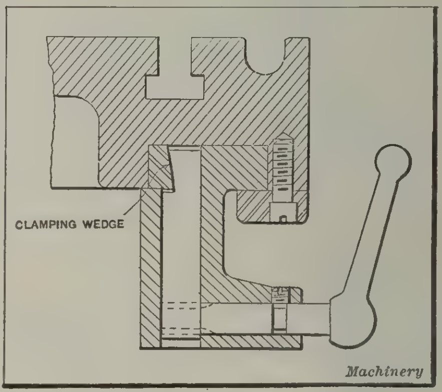


Fig. 6. Locking Clamp for Table

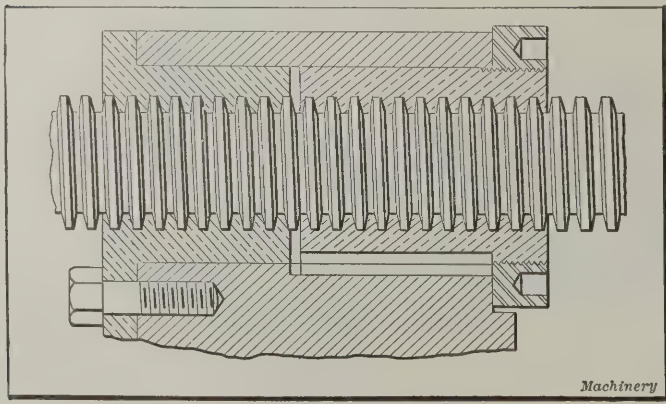


Fig. 4. Two-part Nut for Taking up Wear

Sixteen boring and drilling feeds are provided and a similar number of different milling feeds for the saddle and table. These feeds and the rapid power traverse, are applicable to the spindle, saddle, table and carriage. Automatic limit stops are arranged for movements in either direction, in addition to adjustable knockouts for the table feeds. It is impossible to engage two feeds, speeds or traverses at the same time. The driving and feed gearing is enclosed and runs in oil. The lubricant is forced to a reservoir at the top of the saddle by a pump and from there it is distributed by leaders to the different bearings, and the overflow runs over the gears.

The feeding and traversing movements are transmitted to the table through a vertical shaft in front of the saddle and a shaft in the bed. At the table the feed is distributed either for the cross-wise movement or for elevating the saddle and outer support. Fig. 3 shows a diagrammatical plan view of the carriage for the table and illustrates the arrangement of the mechanism. A power cross feed is provided for the table and also a power lateral traverse for the carriage, when specified. The nuts for the screws are made in two parts, as shown in Fig. 4, for taking up wear or backlash. One section of the nut has a flange, as shown, and the other part can be adjusted longitudinally by a threaded collar, but is held against rotation.

The bearings for the spindle are located at the extreme ends of the saddle, thus giving a rigid support. A sectional

view of the rear bearing is shown in Fig. 5. These bearings are of phosphor-bronze and can be easily adjusted from the outside, in case of wear. The knockout or limit stop for the extreme travel of the spindle is shown in Fig. 1. An intermediate gear located between the feed change gears and the feed driving gear, rotates screw *S*. A nut on this screw is moved a certain predetermined distance, representing the maximum travel of the spindle. At the extreme travel of the nut, a lever segment is automatically actuated, which disengages the feed back-gear clutch and throws it to the neutral position, thereby stopping the feed.

When the machine is used for splining, the spindle is moved in and out without rotating, by the rapid power traverse. The spindle gear clutch is set in the neutral position, thus disengaging the spindle driving gears, and a guide key (see Fig. 5) is inserted in the milling clamp collar at the end of the saddle. This key engages one of the splined ways in the spindle, and the collar is held against rotation by a friction band which is tightened by a thumb-screw on the outside of the bonnet. Both the collar and spindle are held in this way against rotation, and the spindle is guided, as it moves lengthwise, by the key previously referred to. Spiral oil grooves of different pitches can also be cut by using the rapid power traverse in conjunction with the rotary movement of the spindle. When cutting spiral grooves, the clamp collar used for straight grooving is, of course, disengaged.

Graduated dials reading to thousandths of an inch are provided for all movements, and precision screws are used throughout. On the front end of the saddle there is an "indicator" corresponding to the center of the spindle, which is convenient for adjusting to a given height with a surface gage, when boring. The table is clamped directly under the spindle and the form of locking binder used is shown in Fig. 6.

These machines are built in two sizes at the present time, the principal dimensions of which are, respectively, as follows: Spindle diameter, 3 and 3½ inches; longitudinal traverse of spindle, 32 and 40 inches; spindle speed changes, 12 for both machines; feed changes, 16; vertical traverse of saddle, 21 and 25 inches; maximum height from table to spindle, 22 and 26 inches; maximum distance between saddle and outer support, 5 feet and 6 feet; table cross-feed, 30 and 36 inches; lateral traverse of table, 36 and 42 inches. These machines are so constructed that the standard range can be varied easily to suit special requirements, when necessary.

GARVIN AUTOMATIC-INDEX MILLING MACHINE

The milling machine shown in Fig. 1 is an automatic-indexing type, especially adapted to tap manufacturing plants. This machine is built by the Garvin Machine Co., Spring and Varick Sts., New York. In addition to the automatic fluting of taps and reamers, the machine can be used for cutting gears, ratchets or for repetition work of a similar nature. The modifications introduced in this design comprise quick-acting work-holding apparatus, automatic indexing, automatic feed with a quick return effected by a long spring and checked by an air cushion, and automatic stopping of the machine when the work is completed.

When a cut is finished, the table is tripped by the dog seen to the left, which releases a latch and allows the feeding worm to drop out of mesh with the worm-gear. As the table is then disengaged from the power feed, it is moved rapidly to the other end of its travel by a spring enclosed in a tube at the end of the table. The arrangement of the feed gearing and quick-return mechanism is shown in Fig. 2. The rapid motion of the table is checked before the fixed stop is reached, by an air cushion formed in the cylinder shown by the section to the right.

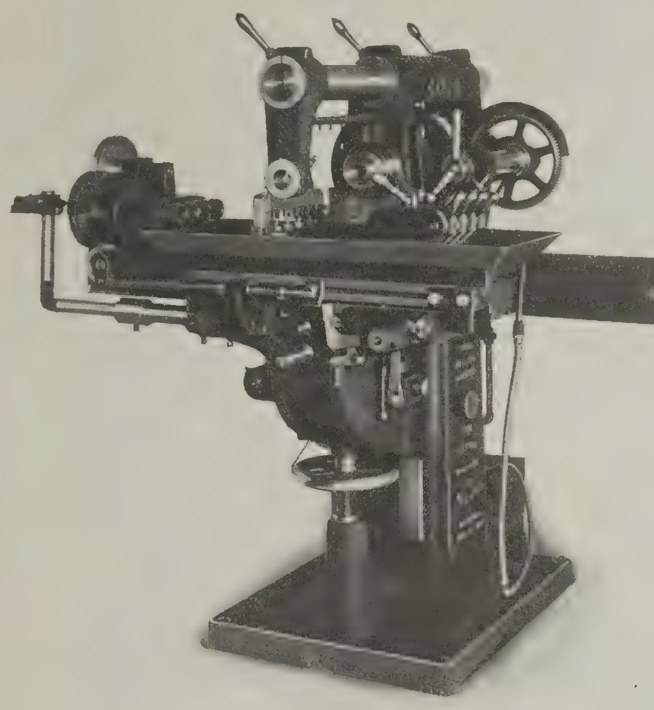


Fig. 1. Garvin No. 13 1/2 Automatic-index Milling Machine

At the same moment that the dog trips the table, the left-hand stop-collar on the screw seen in front of the machine to the left, Fig. 1, comes in contact with a stationary bracket; this trips the tilting table of the machine by means of a cam shown to the left in Fig. 2, the shaft carrying this cam being operated by the longitudinal movement of the screw on which the stop-collar is mounted. As the cam is turned, the table swings downward slightly, the swiveling movement being around a pivot at the right-hand end. This prevents the cutter from dragging when the work is being returned for another cut. As the table approaches its extreme position on the return stroke, the right-hand dog at the front strikes a stop-plunger, thus shifting the worm back into mesh with the worm-gear at the same moment that the table comes to rest. As the table reaches the end of its travel, the right-hand stop-collar on the screw previously referred to, strikes a stationary bracket and operates the cam lifter, thus tilting the table back to its working position. The index pawl is also lifted so that the dial can index, after which it falls back instantly.

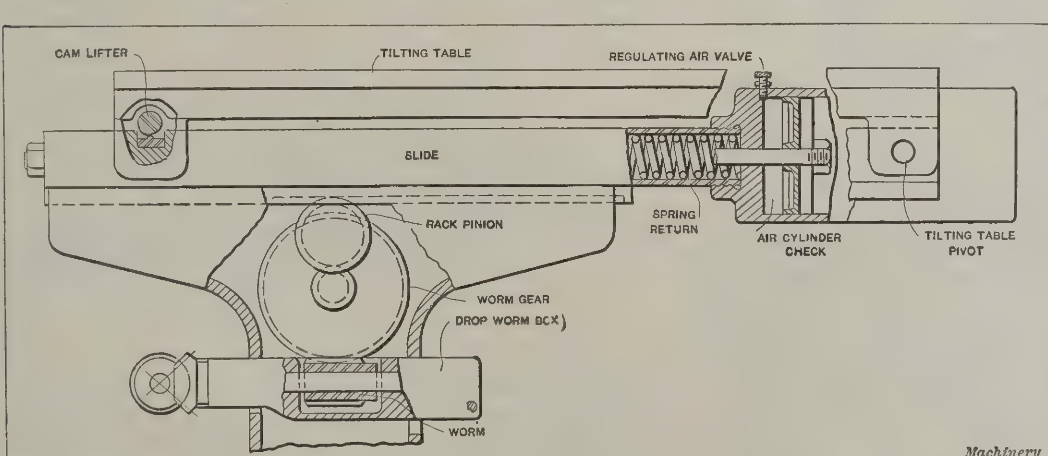


Fig. 2. Feeding and Quick-return Mechanism of Garvin Machine

The machine is now ready for another cut, and this operation of feeding forward, returning rapidly and indexing, continues until the work is finished. The machine then trips

again and, on indexing, a projecting pin on the index dial pushes a sliding pin on the telescope bar seen to the left of the machine, and releases a rope connecting with a spring on the countershaft, thus stopping the machine.

The maximum distance between the centers is 16 inches, and a cut 7½ inches long can be taken anywhere within this distance. The centers have a capacity for holding work on all four spindles up to 2 inches in diameter, and diameters up to 4 inches can be handled, when only the two outer spindles are used. The weight of the machine is 2200 pounds.

HOSKINS RECORDING PYROMETER

A new recording pyrometer which is now being built by the Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., is shown in Fig. 1. The record chart of this pyrometer is always visible, thus making the instrument "indicating" as well as recording, and the electrical movement, as well as the clock and marking device, is at all times entirely enclosed, even when changing charts. In designing this pyrometer, the principal points aimed at were accuracy, reliability and simplicity.

The electrical movement of the pyrometer is a finely built milli-voltmeter of the D'Arsonval type. It is sensitive to a fraction of a milli-volt and was especially designed for this pyrometer. It is claimed that this milli-voltmeter is much less susceptible to outside temperature conditions than the ordinary types. It is actuated by the electro-motive force

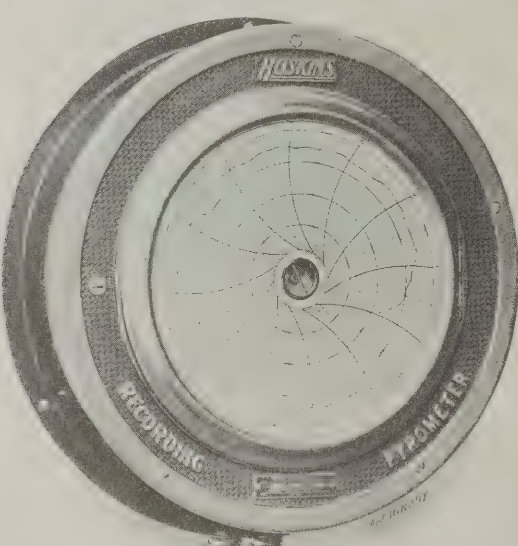


Fig. 1. Recording Pyrometer made by Hoskins Mfg. Co.

set up by a base metal thermo-couple which is connected by wire leads to the binding posts shown at the bottom of the meter case. This thermo-couple, when subjected to heat, is said to generate an electro-motive force four times as great as that of the ordinary platinum-rhodium couple, for a corresponding temperature; the additional power thus gained adds to the accuracy and reliability of the pyrometer.

The record chart is caused to revolve by a clock movement contained within the meter case. The chart is a circular disk of paper which is thin and translucent but strong and durable. It is clamped in place on the revolving clock shaft by a small thumb-screw. A circular disk of carbon paper of the same size as the chart, is also clamped on the shaft, back of the chart and with the carbon side toward it. When a chart is being put in place, as shown in Fig. 2, it is held temporarily against a stationary dial-plate which completely covers the electrical and clock movements.

The clock also actuates an arm which is curved to correspond to the arc through which the end of the recording pointer travels. At half-minute intervals the curved arm momentarily brings a small stylus or metal point, carried at the end of the recording pointer, against the carbon paper, thus making a dot on the back of the chart. As the chart revolves, these dots, which are plainly visible from the front, continue to be made, giving the appearance of a continuous line, as shown in Fig. 1. The location of the dots relative to the concentric circles printed on the chart, indicates the temperatures to which the thermo-couple has been subjected. The charts are made to indicate degrees Centigrade or Fahrenheit, or milli-volts, as desired, and to cover periods of twelve or twenty-four hours.

This method of making records permits two records to be made at the same time, just as duplicate letters are made on the typewriter. When a considerable number of copies of any particular record are wanted, blueprints may be made directly from the chart. On the margin of the chart, a place is provided upon which to mark the date and time at which the

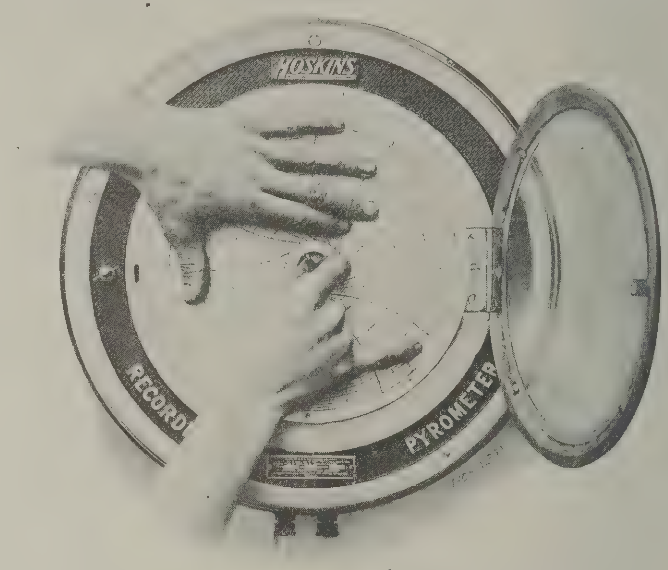
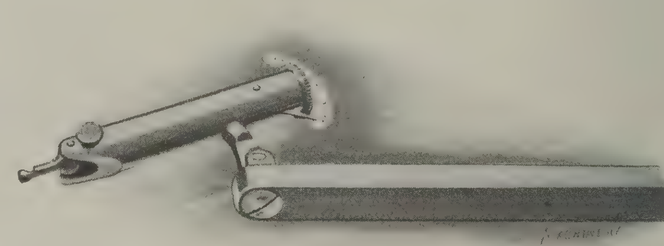


Fig. 2. Placing a New Chart in Hoskins Pyrometer

record was started and the name of the furnace or operation. This pyrometer is especially desirable when it is necessary to intrust it to the care of an unskilled workman, as there is no exposed mechanism which the operator can put out of order. There are no pens or other inking devices to look after, and when the chart is removed from the meter, it is complete and ready for use, and requires no "fixing" solution as in the case of sensitized charts. As one sheet of carbon paper is sufficient for twenty records, the cost for carbons is very small. With the exception of the clock movement, which is a Seth Thomas standard eight-day movement, every part of the pyrometer is made by the Hoskins Mfg. Co.

UNIVERSAL TEST INDICATOR

The universal test indicator illustrated below is made by the Alvan Mfg. Co., Newark, N. J. This indicator has hardened cone-pivot bearings which are kept in constant uniform adjustment by spring thrusts that prevent lost motion and consequently errors in reading. These cone bearings also



Universal Test Indicator

make the indicator very sensitive, and it is claimed that no adjustment is ever required.

The indicator proper is attached to the toolpost holder by a universal joint, which is frictionally held in any desired position. By means of this joint the indicator can be set at any angle with relation to the shank. Either side of the contact point can be used, and the spring tension is reversed by half a turn of a button on the end of the barrel. This indicator multiplies error in the ratio of 50 to 1, and has a capacity up to 0.020 inch.

NATIONAL DROP-ARM SPOT WELDER

The National Electric Welder Co., Warren, Ohio, has recently placed on the market a new electric spot-welding machine which has been designed to combine the advantages of the regular horizontal machines with those of the special swing and drop-arm types. In designing this welder, the idea was to so construct it that such work as welding the side seams of a box or tube, a well as the bottom of a box or can, could be accomplished.

The lower arm was made adjustable to adapt the welder to a wide range of work. The front face of the column is machined and carries gibs, one of which is held in place by studs and nuts. By loosening the nuts, the supporting bracket with the low tension leads and welding point can be adjusted to any convenient height with relation to the upper point. The movement is effected by the wrench shown just below the horizontal arm, which operates a pinion mounted inside the bracket. This pinion meshes with a rack on the inside of the bed-plate, and has ratchet teeth on the side which are engaged by a spring-pin on the adjusting handle.

National Drop-arm Spot Welder

The current is conducted to the lower bar and welding point by the heavy copper conductor shown. This conductor is machined to fit into the end of the movable bar, and a solid and efficient contact is made at this point. The upper overhanging arm is of cast iron and is designed to resist springing or deflection, when subjected to the pressure required for making satisfactory welds.

This welder is known as the drop-arm type, and it is built in three sizes, having distances between the center of the welding points and the face of the machine of 12, 24 and 36 inches, respectively. The movable arm on all of these sizes can be dropped 25 inches from the highest point at which it can be used.

These machines have a combination hand and foot lever control. If the work being welded is of such a nature that the operator can use both hands to advantage in holding it, the welding points and switch can be operated by the foot lever, and, if desired, the hand lever can be removed. The machine can be also hand operated, in which case the foot treadle can easily be removed.

The machines are equipped with an automatic switch which operates only after the welding points are brought firmly into contact with the work. The act of releasing the pressure, whether using the foot- or hand-lever control, causes the switch to open, which prevents injury to the work or welding points by separating them after the welding current is broken. The copper contacts are cooled by a stream of water which is conducted to within ¼ inch of the faces bearing on the heated metal. In this way the parts are kept cool and the burning or "mushrooming" of the copper points is avoided.

TOLEDO ELECTRIC WELDERS

The Toledo Electric Welder Co., Langland & Knowlton Sts., Cincinnati, Ohio, has brought out a new welding machine designed especially for welding flat tires varying from ¾ by ¼ inch up to 2 inches by ¼ inch, or 1¾ by ⅜ inch. This is

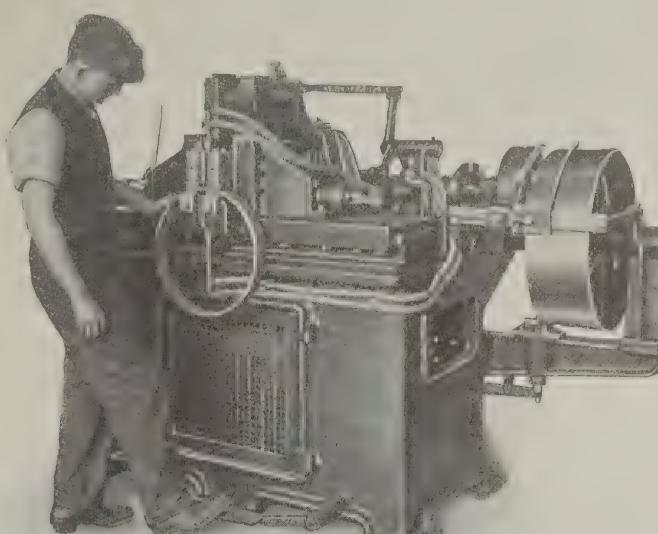


Fig. 1. Toledo Power-driven Machine for Welding Flat Tires

a power-driven machine and it will electrically weld a 1¼- by ¼-inch tire in 13 seconds.

In the operation of the machine the tire is placed in the jaws of the welder, as shown in the illustration; the workman then presses a foot lever, the clamping jaws close on the stock and the ends are brought together. The current is automatically turned on, and in a few seconds the iron is raised to the welding temperature. When the heat is just right a second pressure on the foot lever automatically turns off the current and forces the ends of the stock together. At the same time two steel dies located between the clamping

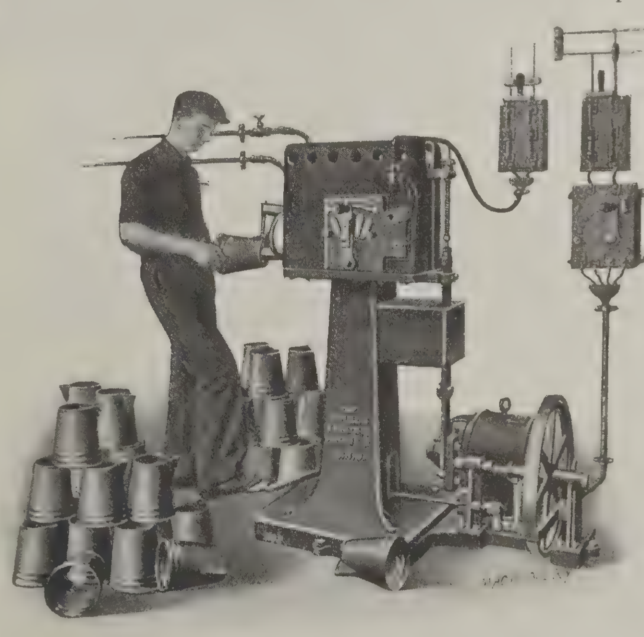


Fig. 2. Power-driven Spot Welder

jaws come together and reduce the fin or projection that is raised, thus leaving the welded portion practically the same thickness as the rest of the stock so that grinding or hammering is not necessary. At the end of this second operation the

clamping dies automatically open, after which the tire is removed and the next one is inserted. From 1800 to 2000 tires can be welded per day of 10 hours.

Alternating current is required to operate the welder, and it can be arranged for any standard voltage from 110 to 550 volts. A special transformer in the base of the welder reduces the voltage to from 3 to 5 volts, which is all that is used in the machine. This low voltage makes the machine absolutely safe, as the operator cannot get the slightest shock under any condition. A regulator is furnished to control the current, thus allowing the operator to vary the heat according to the size of stock to be welded. The dies are water cooled, and a very small amount of water is required. Adjustments are provided to vary the pressure of the welding heads, according to the size of stock to be welded.

This company has also added a new power-driven spot welder to its line. This machine is illustrated in Fig. 2, which shows an operator welding spouts on coffee pots. A small variable-speed motor furnishes the power for driving the machine, and welds are made at the rate of 80 to 150 per minute. The machine works on the same principle as the ordinary power-driven punch press. The operator presses down on a foot treadle which engages a clutch and starts the machine. When the foot pressure is released the machine stops, and when it stops the dies are open ready for the next weld. One weld or any number can be made. The welding dies move up and down like a sewing machine, as long as the treadle is held down.

When the dies are brought down on the stock the current is turned on to make the weld, and at the instant the melted metal is forced together the current is turned off. The current is controlled automatically and there is no possibility of drawing an arc and burning the stock when the die points are moved apart. The machine is easy to operate as a punch press, and there is no danger, either from the mechanical operation or the welding current. Like all welding machines, it is necessary to have a single-phase, alternating current. Where a two- or three-phase current is used, one phase of the multiphase system can be connected to the welder.

FOOTE-BURT MUD-RING AND FLUE-SHEET DRILL

The large two-head drilling machine illustrated herewith was designed primarily for drilling the mud rings and flue sheets of locomotive boilers but it is also suitable for a general line of heavy work. It is built by the Foote-Burt Co., Cleveland, Ohio. By referring to the front view, Fig. 1, it will be noted that each of the two heads is an independent and self-contained unit, thus permitting the feeds and speeds for each spindle to be regulated according to the size of the hole. The heads have an in-and-out adjustment of 8 inches on the knee, which, in combination with the 24-inch lateral adjustment of the table, makes it possible to cover a large lay-out at one setting of the work.

The saddles carrying the heads and motors are very heavy and have a four point bearing on the massive box-section cross-rail. The saddles are traversed along the rail by ratchet wrenches, and, owing to a suitable gear reduction, adjustment is easily made. The end view of the machine (Fig. 2) gives an idea of its massive construction and also shows the position of the driving motors. By mounting the motors as shown, a simple form of drive is secured. The primary drive from the motor is through a rawhide pinion and a coarse pitch spur gear to a horizontal shaft which transmits the motion through bevel and spur gearing to the spindle. The bevel gears are made of forged steel, have planed teeth and are carefully heat-treated and hardened. These gears run in extra-long bronze bushings, thus insuring alignment.

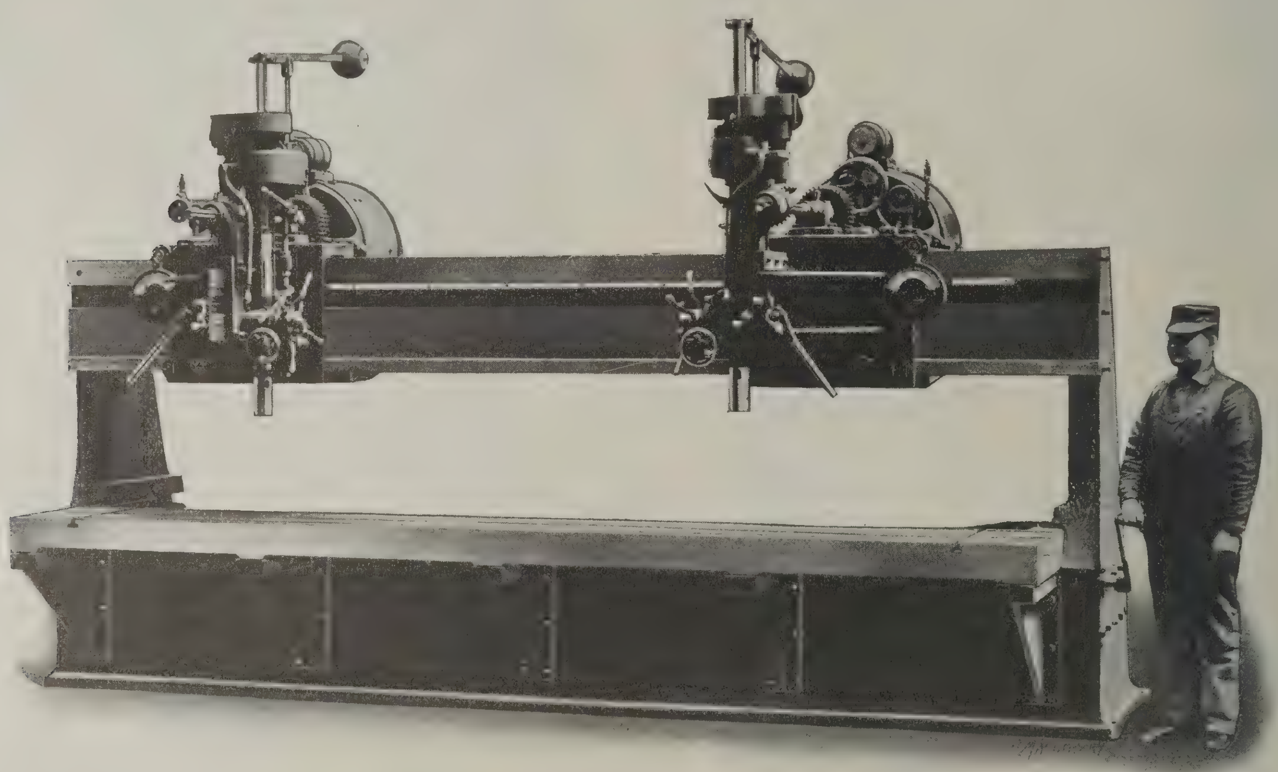


Fig. 1. Foote-Burt Mud-ring and Flue-sheet Drill with Reliance Speed Dial and Automatic Speed and Starting Control

Each spindle has an individual clutch, so that it can be started and stopped at will, without stopping the motor. With this arrangement, the motor can be adjusted for a single speed and need not be disturbed in case it is necessary to stop the spindle. The feed changes are obtained through a quick change gear device operated by a conveniently located lever. The power feed has an automatic stop, in addition to the usual hand trip and clutch, and there is a quick-return movement operated by the spider handwheel shown. The spindle and feed worms have ball thrust bearings of the company's own design. Each head is equipped with an individual oil pump and tank.

When drilling mud rings, the brackets supporting the table are removed and special mud-ring chucks are placed on the table, which is run back between the housings. The brackets are doweled in position, and can be removed and replaced readily.

The possibility of eliminating gear changes and using wide-range motors in conjunction with a direct drive is well illustrated by this equipment. Adjustable-speed, 7½-horsepower

motors of the armature-shifting type are used. These are made by the Reliance Electric & Engineering Co., and have a speed range of from 200 to 1600 R. P. M. The shifting of the armature for obtaining the speed changes is effected by a small motor which is mounted on top of the main driving motor, as shown in Fig. 2, connection being made with the shifting mechanism through a chain and sprockets. To adjust the speed, the operator simply presses the "fast" or "slow" button of a small speed control "station" conveniently located at the front of each head.

This machine is equipped with a Reliance speed dial similar in principle to the one illustrated and described in the department of New Machinery and Tools, for March, 1912. This particular dial has two scales, the upper one of which is graduated to show the cutting speeds in feet per minute, and the lower one, the various sizes of drills. The dial is first set for the cutting speed desired, by turning a small knurl in front of the case; the speed of the motor is then adjusted until the pointer is opposite the size drill to be used.

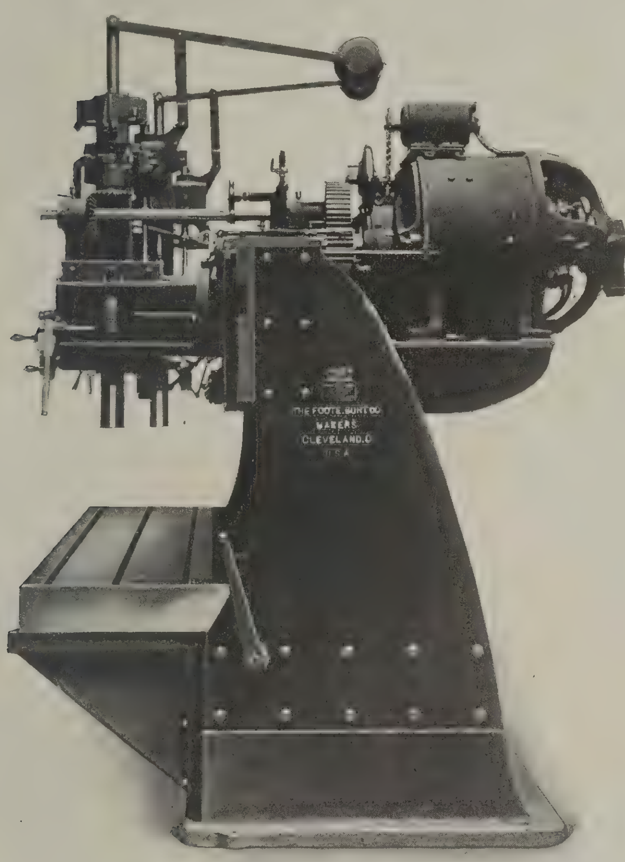


Fig. 2. End View of the Foote-Burt Machine

The starting and stopping of the motor is controlled through automatic starters operated by push buttons. These starters are located on each head close to the speed control station. This combination of automatic starting and speed control enables the operator to give his entire attention to the work in hand.

This machine has a width between the housings of 14 feet 4 inches, and the maximum distance from the end of the spindle to the table is $21\frac{1}{2}$ inches. There is a 12-inch power feed and three feed changes varying from 0.006 to 0.020 inch. The maximum and minimum center distances between the spindles are, respectively, 10 feet and 18 inches. The spindle speeds range from 37 to 347 R. P. M. The table has a working surface of 14 feet 4 inches by 24 inches, and the weight of the machine is 28,000 pounds.

WORTH WEDGE-WASHERS

There are many different ways of locking a nut on a bolt, but comparatively few of the innumerable devices designed for this purpose have come into general use. Either the expense of manufacturing the device has been prohibitive, or its application to a bolt or nut has required too much time. The Steel Specialties Co., Boston, Mass., has placed on the market a very simple device which, it is claimed, effectively prevents a nut from jarring off a bolt. This nut fastener is in the form of a washer which, as shown by the illustration, has a scalloped inner edge with projections or prongs which point outward before the washer is applied to a bolt. After the washer is placed over a bolt, it is straightened or flattened by driving it down with a punch or larger size nut, which causes the prongs to wedge tightly between the threads of the bolt and the body of the nut. A washer has been applied in this way to the bolt shown in the illustration. After a washer is in place, the nut can be screwed off with a wrench, but it will not jar off. The "wedge-washer" can be removed easily by severing one side with a chisel, and it is said to leave the thread uninjured.

Wedge-washers to prevent Nuts from Jarring Off

NEW BRITAIN PORTABLE STEEL TOOL-RACK

The portable tool-rack or work-stand shown herewith is made of steel instead of cast iron, which gives a light but strong construction. The corners of the drawn-steel trays are rounded to facilitate cleaning, and the trays are stiffened by return flanges on the edges, which also contain the corner braces. The legs are screwed into the braces attached to the upper tray and pass through the lower ones. The lower pans can be fastened to the legs at any desired height. In all trays, the holes for the brace rivets or legs are at the top edge of the pan, so that oil cannot leak through them.

These tool-racks are made in two sizes. The size illustrated is 26 by 32 inches, and there is a smaller size measuring 20 by 26 inches. The casters have ball-bearing swivels and the balls are in a retainer cage and can be handled as a unit. These racks are manufactured by the New Britain Machine Co., New Britain, Conn.

Tool-rack or Work Stand made of Steel

NEW MACHINERY AND TOOLS NOTES

Boring Tool. R. M. Clough, Tolland, Conn. Adjustable boring tool for sizing holes either to standard diameters or slightly under, when a finishing reamer is to be used. This tool has blades which are clamped in position with a square-ended wrench.

Tool Grinder. J. G. Blount Co., Everett, Mass. Wet tool grinder similar in construction to machines previously built by this company, but considerably heavier. The bearings are self-oiling, and the wheel is 30 by 3 inches. The machine is equipped with a vertical, centrifugal pump.

Toolpost Grinder. American Electric Tool Co., West Newton, Mass. Portable electric grinder carrying a 6 by ⅜-inch wheel, which operates at a speed of 3500 R. P. M. This grinder can be applied to a lathe toolpost and is applicable to the grinding of lathe centers, milling cutters, etc.

Tool Grinders. Northampton Emery Wheel Co., Leeds, Mass. Wet tool grinders having wheels 16, 20 and 24 inches in diameter, respectively. Water is thrown up against the wheel from a tank in the base, by an endless chain, and the quantity can be varied by a conveniently located lever.

Die Milling Machine. Harrington Machine Co., Erie, Pa. The spindle of this machine is at right-angles to the work-table, and clearance in the dies is obtained by using angular mills. Both the table and spindle can be tilted to an angle either to the right or left to secure better light or to suit the convenience of the operator.

Riveting Machine. C. W. Meadowcroft, Sr., 4702 Large St., (Frankford), Philadelphia, Pa. Rotary riveting machine built in the following styles: As a bench machine with foot control, as a column foot-lever type, and as a dial feed machine, the latter taking the place of the foot-lever designed for certain classes of work.

Electric Furnace. Multiple Unit Electric Co., 136 Liberty St., New York. Electric muffle-furnace with special controller built in the furnace case. Temperatures varying from 200 to 1800 degrees F. can be maintained indefinitely, and the furnace will operate on a 100 or 220 direct or alternating-current circuit, but cannot be used with both circuits, as the controller is built with reference to the voltage.

Band Finishing Machine. Gardner Machine Co., Beloit, Wis. Motor-driven band finishing machine, the wheels of which are mounted directly on the armature shaft. Adjustable, cast-iron dust-hoods nearly enclose the wheels, and there is an opening at the bottom for exhaust connection. The band wheel is so arranged that the band is kept taut under a constant spring tension. This machine is also made for a belt drive.

Tube Cleaner. Joseph T. Ryerson & Son, Chicago, Ill. Tube-cleaning attachment designed to be used in connection with this company's tube-cutting machine. The principal parts are a friction wheel, and adjustable twin-roller cleaning burrs which are built of hardened serrated steel disks. These cleaning burrs are assembled in a unit, which is readily interchanged with the roller tube support employed when the machine is used for cutting tubes.

Cylinder Boring Machine. Newton Machine Tool Works, Inc., Philadelphia, Pa. Locomotive cylinder and valve chamber boring and facing machine, so designed that the valve chamber can be bored without resetting the work. The table has a vertical adjustment and the spindle, which is 7 inches in diameter, has a rapid power traverse in either direction, in addition to the hand adjustment. The minimum distance between the center of the spindle and the top of the table is 16 inches and the maximum, 40 inches.

Gear-cutting Machine. E. J. Flather Mfg. Co., Nashua, N. H. Forty-inch automatic gear-cutting machine arranged with a bevel gear attachment and equipped with a motor drive. The power is transmitted through an endless leather belt, the tension of which is varied by adjusting the base of the motor. The indexing mechanism is enclosed and mounted in a detachable bracket. The machine is built on the unit system, and the indexing, feed, and speed mechanisms, as well as other parts, are finished and tested before being assembled.

Gang Drill. W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. 20-inch, sliding-head gang drill made with from two to six spindles. This machine can be equipped with either a plain lever feed, a combined lever and worm feed, or a self-feed and automatic stop. The automatic stop mechanism is so designed that it can be set to disengage the worm from the worm-gearing, thus permitting the drill spindle to be returned quickly, or it can be arranged to disengage the miter feed gears, which stops the feed but leaves the worm-gearing in mesh for accurate facing operations.

Drilling Machine. Langelier Mfg. Co., Providence, R. I. Special drilling machine intended for drilling and countersinking two holes on the opposite sides of jewelry beads. The machine is also applicable to many other uses. It is equipped with two vertical spindles which are opposed, one being below and the other above the part to be drilled. These spindles are actuated through rack and pinions and both move toward the work simultaneously. To cases where it is necessary to drill two holes on the same axis and part way through the work, this machine is especially adapted.

Turret Drilling Machine. Turner Machine Co., Danbury, Conn. Four-spindle turret drilling machine intended for work requiring more than one operation at one setting. The spindles are mounted in a vertical turret and are driven through spur gears. By means of an indexing device, any one of the four spindles can be quickly located and locked in the operating position. The maximum distance from the operating spindle to the table is 28 inches. The over-all height is 6 feet 2 inches, and the weight 700 pounds. This machine is also built in other styles and sizes to suit different classes of work.

Loxograph. The Loxograph Instrument Co., Wilmington, Del. The loxograph is a triangular straightedge as well as a true 45-degree angle, and the ruling edges are supported out of contact with the paper by hardened steel knife-edged wheels. As these wheels do not pick up ink, the instrument can be moved over wet ink lines without blurring or smearing them, so that the work of making ink drawings can proceed rapidly, as it is unnecessary to wait for the ink to dry. Flooding is also impossible, even though the ink wets the ruling edges. The loxograph is made in 5¾- and 10-inch sizes, respectively. The instrument has been thoroughly tested, and is said to effect a considerable saving in time.

Tool-Grinding Machine. Brown & Sharpe Mfg. Co., Providence, R. I. Universal and tool-grinding machine which will take work up to 18 inches in length and swing 12 inches. It is especially adapted to the grinding of milling cutters, straight or taper reamers, etc. This machine can also be used for straight or taper cylindrical grinding, and, by means of attachments, internal and surface grinding can also be done. The base and column are cast in one piece, thus giving a rigid support for the wheel spindle. The spindle head has a traverse adjustment of 1½ inch, a vertical adjustment of 4 inches, and a radial movement to any position. The sliding table is operated by a crank at the front of the saddle, and can be swiveled to 45 degrees either side of the central position. Sixteen changes of work speeds are obtained through a multiple, friction-disk speed mechanism. Provision is made for wet grinding.

* * *

THE TRAINING OF DRAFTSMEN

In a paper read before the American Society of Engineer Draftsmen, Mr. F. G. Higbee gave a brief summary of the particularly important subjects in which a draftsman ought to be proficient in order to fill his position in life to the best advantage to himself and his employer. Primarily, a draftsman must know how to draw; that is, he must have mastered the technique of drawing and must be able to execute a neat and clear drawing with legible letters and dimensions. This, of course, is merely a foundation upon which to build. A good draftsman must have a good grasp of shop methods and should have a fair conception, both by observation and actual practice, of patternmaking, foundry practice, forging and machining operations. Next, a good draftsman and designer must have a grasp of the theoretical principles of mechanisms. Pulleys, belting, gearing, mechanical movements, fastenings, bearings, and lubrication are the elements which he should take up in turn and study and discuss with those who could give him practical pointers.

It is also necessary in order to be a fair draftsman and designer to have some knowledge of the properties of the various materials used in engineering work and machine construction. He must also have a fair knowledge of the mathematical and mechanical principles involved in calculations of the strength of materials. Mathematics is ever an important subject and one on which many draftsmen fall short. The so-called higher mathematics are, perhaps, seldom required, but trigonometry and logarithms and a fair portion of plane and solid geometry will never fail to prove useful. The good machine designer also needs an understanding of the principles of physics and chemistry; the practical application of electricity and magnetism; the laws of vapors and gases; hydrostatics, and in general, of the fundamental physical laws which are the foundation of all engineering work. Last, but not least, the study of English should never be overlooked or neglected by one who expects to hold anything but a subordinate position. Its proper use is essential to every man who would win the respect and confidence of his associates and superiors, and no training in engineering is complete without a knowledge of how to convey ideas correctly in written form.

This outline gives the necessary foundation for any draftsman who hopes to be able to advance, and it provides a foundation upon which any man may build, no matter to what aspirations his ambition may have inspired him.

DRILLING MACHINES FOR PANAMA CANAL GATES

Sixteen electrically operated machines of special construction are being used for drilling and reaming rivet holes in

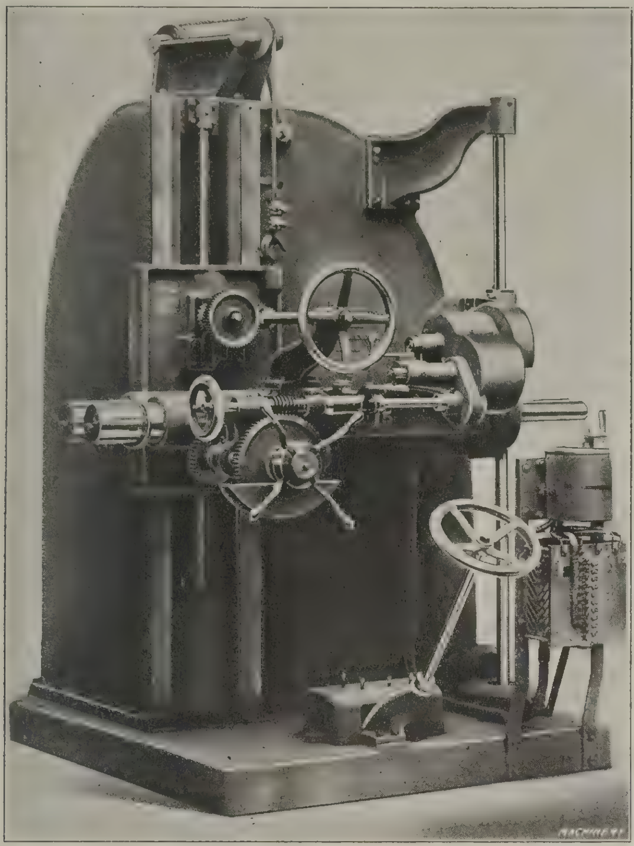


Fig. 1. Foote-Burt Special Drilling Machine for Canal Gates

the enormous lock gates of the Panama Canal. Each of these machines weighs about six tons. They are mounted on broad adjustable scaffolds which are suspended on chains attached to

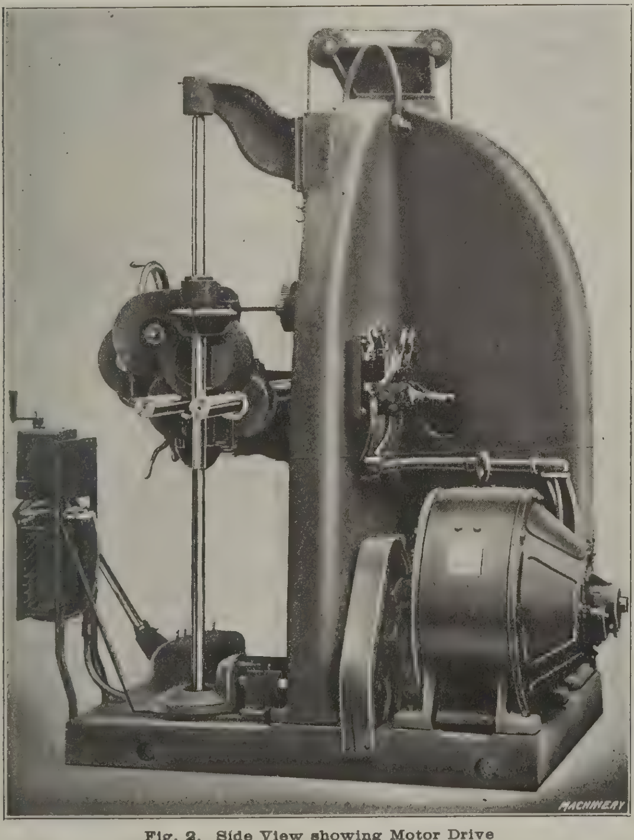


Fig. 2. Side View showing Motor Drive

brackets on top of the gate, as shown in Fig. 3. On each scaffold there is a standard gage track along which the machine is moved for drilling the horizontal rows of rivet holes. This movement is effected by the inclined handwheel seen in Fig. 1, which is a front view of one of the machines. This handwheel operates through a train of gears, and the adjustment can readily by made as roller bearings are used.

All of the controlling mechanism is centrally located as the illustration shows. The horizontal shaft and handwheel above the spindles, actuates, through suitable reduction gearing, a screw which raises and lowers the drilling head. This head is counterbalanced so that vertical adjustment is easily made. The spindles have a quick-return movement effected by any one of the four levers of the spider-wheel shown.

Each machine has four changes of power feed which are obtained through a quick change gear mechanism. The length of the power feed is 16 inches and either of the spindles can be fed independently. The clutch lever for engaging either spindle is located just above the No. 15 seen on the head of the machine, and the feed changing lever is just above this clutch lever. There are nine speeds varying from a very slow speed for heavy drilling, to very high speeds for lighter work. The

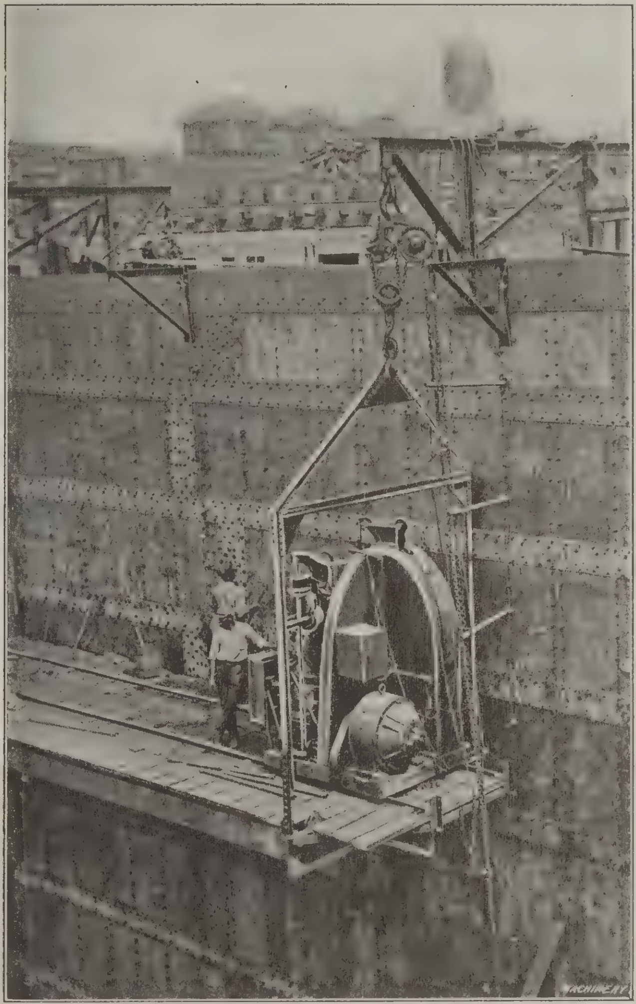


Fig. 3. Drilling Machine on Scaffold for Drilling Rivet Holes in Panama Canal Lock Gates

spindles are arranged to suit the uniform spacing of the rivet holes in the lock gates. During a test made at Gatun, one of the machines drilled 1 1-16 holes through 1-inch plates in four seconds, or at the rate of 15 inches per minute.

These machines are driven by Westinghouse direct-current, adjustable-speed, shunt-wound motors rated at 10 horsepower. The motor is mounted directly on the base, as shown in Fig. 2, and connection is made with the spindles through the gearing shafts, as shown.

These machines were placed in operation in February of this year, on the main gates at Gatun, and they are to be used on all the gates in the three locks. They were designed and built by the Foote-Burt Co., Cleveland, Ohio, especially for use on the Panama Canal.

* * *

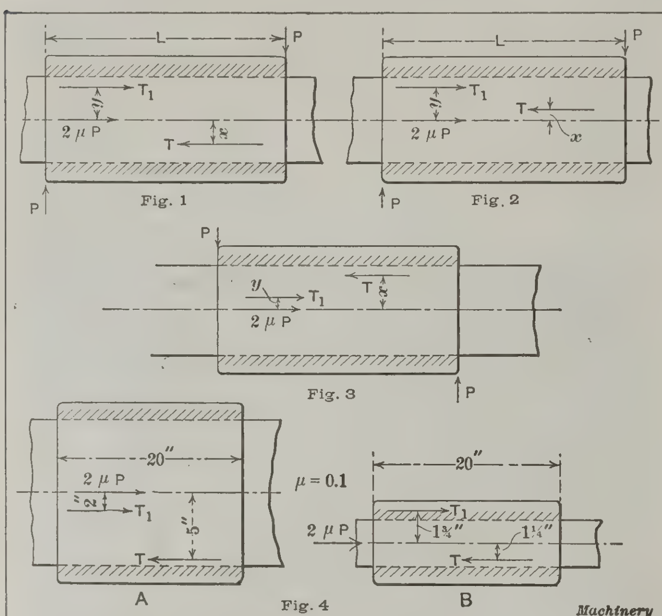
The third and last installment of "Watch Movement Manufacture" will appear in a future number.

THE ADVANTAGE OF THE NARROW GUIDE

By JOSEPH JEWSBURY*

The recent articles on the "narrow guide" which have appeared in MACHINERY have called attention to facts which have not been recognized hitherto by many designers of machinery. The writer, in common with others, had instinctively accepted as an axiom that the narrow guide did reduce "cross-wind," and had never attempted a mathematical analysis of the conditions. In the catalogues of some leading makers of machine tools, it is stated that one of the advantages of the narrow guide is that it reduces "cross-wind."

In the present article the writer intends to deal with the question of the relative locations of the guide center, feeding force, and the main resistance. This will, in a way, supplement the analysis given by Mr. H. T. Millar in the May number of MACHINERY, engineering edition. Five arrangements of positions of guide center line, feeding force, and resistance of cut are possible. Three of these are indicated in Figs. 1, 2 and 3.



Analysis of the Action of Forces involved when Moving a Slide against the Resistance of a Cut

In Fig. 1, the guide center line is located between the feeding force T and the resistance T_1. Fig. 2 shows T and T_1 on the same side of the guide center, T_1 having the greater eccentricity, and in Fig. 3, T acts at a greater distance from the guide center than T_1 and on the same side of it. The two remaining conditions are when the feeding force is in the same line as the cutting resistance, either eccentric to the guide center or on the same line.

Using the notation shown in the accompanying engraving, we have from Fig. 1:

$$P L = T x + T_1 y \qquad (1)$$

$$2 \mu P = T - T_1$$

$$\text{Hence, } P = \frac{T - T_1}{2 \mu} \qquad (2)$$

From (1) and (2):

$$\frac{L (T - T_1)}{2 \mu} = T x + T_1 y$$

$$T = \frac{T_1 (L + 2 \mu y)}{L - 2 \mu x} \qquad (3)$$

In Fig. 2, $P L = T_1 y - T x$, and by proceeding as before, we find:

$$T = \frac{T_1 (L + 2 \mu y)}{L + 2 \mu x} \qquad (4)$$

Similarly for Fig. 3, $P L = T x - T_1 y$, and

$$T = \frac{T_1 (L - 2 \mu y)}{L - 2 \mu x} \qquad (5)$$

In the other two cases T is equal to T_1, neglecting other resistances.

Comparing the results (3) and (4), and (3) and (5), it is obvious that, with the same values for L, T, x and y, the feeding force is greatest with the arrangement shown in Fig. 1. The dimensions of x and y determine whether the arrangement in Fig. 2 or Fig. 3 is more efficient. As an example, assume that $T_1 = 2000$ pounds, $L = 20$ inches, $x = 4$ inches, $y = 6$ inches, and $\mu = 0.1$.

In Fig. 1, Equation (3),

$$T = \frac{2000 (20 + 2 \times 0.1 \times 6)}{20 - 2 \times 0.1 \times 4} = 2208 \text{ pounds.}$$

In Fig. 2, Equation (4),

$$T = \frac{2000 (20 + 2 \times 0.1 \times 6)}{20 + 2 \times 0.1 \times 4} = 2038 \text{ pounds.}$$

Hence, the feeding force is 170 pounds greater in the former case.

From (3) and (4) we find that the feeding force in Fig. 1 is to that in Fig. 2 as $L + 2 \mu x$ is to $L - 2 \mu x$. From (3) and (5) we find that the feeding force of Fig. 1 is to that of Fig. 3 as $L + 2 \mu y$ is to $L - 2 \mu y$. This shows that it is best, whenever possible, to have the feeding force act on the same side of the guide center as the cutting resistance. As pointed out in the article on this subject in the May number, the advantages of the narrow guide are dependent mainly on its correct location. That this is true, and that this is in fact the deciding factor, is proved by the expressions (3), (4) and (5), and can be strikingly illustrated by an example. Comparing the relative values of the feeding forces in cases A and B, Fig. 4, it will be found that for this particular case no advantage is gained by the adoption of the narrow guide, owing to the unfavorable location of the feeding force and the resistance.

$$\text{Case A, Equation (5), } T = \frac{T_1 (20 - 2 \times 0.1 \times 2)}{20 - 2 \times 0.1 \times 5} = 1.03\, T_1$$

$$\text{Case B, Equation (3), } T = \frac{T_1 (20 + 2 \times 0.1 \times 1.75)}{20 - 2 \times 0.1 \times 1.25} = 1.03\, T_1$$

Hence, T is practically the same in both cases.

Two well-known examples from practice may be pointed out where the feeding force acts on the same side of the guide center as the main resistance, *viz.:* the cutter slide of the Brown & Sharpe gear cutter illustrated in the article referred to in the May number of MACHINERY, and the side shaper of English design when arranged with a narrow guide.

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NEW ELECTROPLATING PROCESS

Consul Horace Lee Washington, of Liverpool, England, reports that a new electroplating process has recently been developed by two Italian chemists. A description of this process recently appeared in *Chambers Journal.* The process is creating considerable interest, as it comprises a means of depositing metals of any character upon any insoluble surface by electrical energy. It is claimed that china, wood, glass, celluloid, paper and other substances which have hitherto been regarded as beyond the electroplater's art can be coated as easily as metals generally electroplated. The plating enters the fabric of the material so treated and becomes practically an integral part of it. If an attempt, for instance, is made to chip the plating from a glass vase the glass will come away with the metal coating. When plating china, the article must be in its unglazed condition, and glass which is to be treated must first be roughened by sandblasting to remove the polish, so as to enable the metal to secure a firm grip. The process, which is known as the Marino process, is also of considerable hygienic value in the household, where many articles may now be used plated with suitable metals. The possibility of being able to deposit a coating upon aluminum, for example, thus saving it from oxidation, will popularize the use of this metal in the home and in many industries where it is now excluded on account of the fact that it rapidly corrodes in the presence of acids.

M. C. B. AND A. R. M. M. ASSOCIATIONS CONVENTIONS

The forty-sixth annual convention of the Master Car Builders Association and the forty-fifth annual convention of the American Railway Master Mechanics Association were held at Atlantic City, N. J., June 12 to 19, inclusive. The Master Car Builders convention was held June 12, 13 and 14, and the Railway Master Mechanics convention June 17, 18 and 19, on Young's new pier.

The technical program of the Master Car Builders Association included the following papers and discussions:

June 12—"Train Brake and Signal Equipment"; "Brake Shoe Equipment"; "Car Wheels."

June 13—Discussion of reports on "Safety Appliances"; "Rules of Interchange"; "Prices for Labor and Materials"; "Rules for Loading Materials"; "Damage to Freight Equipment by Unloading Machines"; "Overhead Inspection"; "Coupler and Draft Equipment"; "Car Trucks"; "Springs for Car Trucks"; "Train Lighting and Equipment."

June 14—Discussion of reports on "Train Pipe and Connections for Steam Heat"; "Tank Cars"; "Specifications for Tests of Steel Truck Sides and Bolsters"; "Capacity Marking of Cars"; "Lettering Cars."

The following officers were elected for the Master Car Builders Association:

President, C. E. Fuller, Union Pacific Ry.
First vice-president, M. K. Barnum, Illinois Central R. R.
Second vice-president, D. F. Crawford, Pennsylvania Lines.
Third vice-president, D. R. MacBain, L. S. & M. S. Ry.
Treasurer, John S. Lentz, Lehigh Valley R. R.
Executive Committee—R. E. Smith, Atlantic Coast Line; C. E. Chambers, Central R. R. of New Jersey; and Henry LaRue, Chicago, Rock Island & Pacific R. R.

The program of the American Railway Master Mechanics convention was as follows:

June 17—Discussion of reports on "Mechanical Stokers"; "Revision of Standards"; "Specifications for Cast Steel"; "Locomotive Frames."

June 18—Discussion of reports on "Main and Side Rods"; "Safety Valves"; "Safety Appliances"; "Design, Construction and Maintenance of Locomotive Boilers"; "Contour of Tires"; individual paper on "Increased Power Obtained with Superheat as Compared with the Maximum Power Obtained with Saturated Steam," by Prof. C. H. Benjamin and Prof. L. E. Endsley; "Steel Tires."

"June 19—Discussion of reports on "Flange Lubrication"; "Minimum Requirements for Headlights"; "Standardization of Tinware"; "Maintenance of Superheated Locomotives"; "Engine Tender Wheels."

The following officers were elected for the American Railway Master Mechanics Association:

President, D. F. Crawford, Pennsylvania Lines.
First vice-president, T. Rumney, C. R. I. & P. R. R.
Second vice-president, D. R. MacBain, L. S. & M. S. Ry.
Third vice-president, F. F. Gaines, Central of Georgia Ry.
Executive Committee—G. W. Wildin, N. Y., N. H. & H. R. R.; C. F. Giles, L. & N. Ry.; and William Schlafge, Erie R. R.

The Railway Supply Manufacturers Association holds an annual exposition of railway car and locomotive parts, supplies, apparatus, etc., on the pier simultaneously with the conventions. The exhibit this year was larger than ever before, the space having been increased by extending the pier, thus making 7400 square feet additional space available, and increasing the total area to 83,500 square feet. Among the manufacturers exhibiting were the following:

Ajax Mfg. Co., Cleveland, Ohio. Scrap reclaiming rolls and forgings.

American Infusion Steel Process Co., New York. Compound for casehardening and converting low-grade steel into high-grade steel.

American Tool Works Co., Cincinnati, Ohio. Motor-driven machine tools comprising 24-inch geared head lathe, 16-inch relieving lathe, 2-foot geared radial drill, 6-foot plain radial drill, 16-inch shaper and 24-inch shaper.

American Vanadium Co., Pittsburg, Pa. Vanadium steel, iron, brass and bronze locomotive parts, vanadium steel forgings, etc.

Baker Bros., Toledo, Ohio. Automatic drilling machine.

Baush Machine Tool Co., Bethlehem, Pa. Hydro-pneumatic radial drill.

Bullard Machine Tool Co., Bridgeport, Conn. Forty-two-inch vertical turret lathe.

Carborundum Co., Niagara Falls, N. Y. Carborundum and Aloxite grinding wheels.

Chisholm & Moore Mfg. Co., Cleveland, Ohio. Chain hoists, and I-beam trolleys.

Davis Boring Tool Co., St. Louis, Mo. Line of Davis expansion boring tools.

Davis-Bournonville Co., New York. Oxy-acetylene welding and cutting apparatus, including the "oxygraph," a device working on the pantograph principle.

Duff Mfg. Co., Pittsburg, Pa. Track jacks and screw jacks.

Gilbert & Barker Mfg. Co., Springfield, Mass. Apparatus for storing and handling oils.

Goldschmidt Thermit Co., New York. Thermit products and exhibits showing the application of the thermit process for welding.

Gould & Eberhardt, Newark, N. J. Twenty-four-inch shaper and model showing construction of sixteen-inch shaper.

Edwin Harrington Son & Co., Inc., Philadelphia, Pa. I-beam trolleys and spur geared and screw hoists.

Higley Machine Co., New York. Cold metal saw.

International Oxygen Co., New York. I. O. C. generators for producing oxygen and hydrogen, etc.

Landis Machine Co., Waynesboro, Pa. Double head bolt cutters.

Lucas Machine Tool Co., Cleveland, Ohio. Precision horizontal, boring, drilling and milling machine.

Manning, Maxwell & Moore, Inc., New York. Hendey lathes, Gridley automatic machines, Cincinnati gear cutters, Cincinnati crank planers, Reed engine lathes, National Co.'s forging and heading machines, etc.

Newton Machine Tool Works, Philadelphia, Pa. Cold saw cutting-off machine of the internal type.

Niles-Bement-Pond Co., New York. Niles new model car wheel boring machine and Pond reversing motor drive planer.

Norton Co., Worcester, Mass. Grinding wheels and floor grinders.

Norton Grinding Co., Worcester, Mass. Ground car axles and car wheels.

Oxweld Acetylene Co., Chicago, Ill. Oxy-acetylene and oxy-hydric welding apparatus.

C. F. Pease Co., Chicago, Ill. Automatic blueprinting and washing machine.

Wm. Sellers & Co., Inc., Philadelphia, Pa. Locomotive injectors, parts of high power car wheel lathes, etc.

Standard Roller Bearing Co., Philadelphia, Pa. Roller bearings, car journal boxes and other anti-friction bearings.

Tabor Mfg. Co., Philadelphia, Pa. Inserted tooth saws.

Van Dorn & Dutton Co., Cleveland, Ohio.. Portable electric drills and reamers.

Vixen Tool Co., Philadelphia, Pa. Vixen files and machine for testing files.

Warner & Swasey Co., Cleveland, Ohio. Hollow hexagon turret lathe.

Watson-Stillman Co., New York. Hydraulic jacks.

Wilmarth & Morman Co., Grand Rapids, Mich. Surface grinders, lathe center grinders, drill grinders, etc.

Yale & Towne Mfg. Co., New York. Chain blocks, electric hoists, trolleys, locks, etc.

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SPRING MEETING OF THE A. S. M. E.

The Spring meeting of the American Society of Mechanical Engineers was held in Cleveland, Ohio, May 28-31. Past president Ambrose Swasey, chairman of the executive committee, opened the meeting with a speech of welcome. Dr. A. C. Humphreys, president of the society, spoke on the economic relations of the engineer and society. The professional sessions were held in the Chamber of Commerce, as was also the membership reunion and informal reception. The registration of members of all grades was the largest of any Spring meeting in the history of the society, being nearly 600. The technical program included the following papers and lecture:

"A New Analysis of the Cylinder Performance of Reciprocating Engines," J. Paul Clayton.

"Equipment of a Modern Flour Mill on a Gradual Reduction System," John F. Harrison and W. W. Nichols.

"Design and Mechanical Features of the California Gold Dredge," Robert E. Cranston.

"Problems in Natural Gas Engineering," Thomas R. Weymouth.

"Sound Waves—How to Photograph Them and What They Mean," Dr. Dayton C. Miller of the Case School of Applied Science.

"New Processes for Chilling Cast Iron," Thomas D. West.

"Strength of Steel Tubes, Pipes and Cylinders Under Internal Flume Pressure," Reid T. Stewart.

"On the Control of Surges in Water Conduits," W. F. Durand.

"Speed Regulation in Hydro-electric Plants," Wm. F. Uhl.

"The Present State of Development of Large Steam Turbines," A. G. Christie.

"A Discussion of Certain Thermal Properties of Steam," G. A. Goodenough.

"The Reduction in Temperature of Condensing Water Reservoirs Due to Cooling Effect of Air and Evaporation," W. B. Ruggles.

"Results of Tests on the Discharge Capacity of Safety Valves," E. F. Miller and A. B. Carhart.

An informal reception for the members was held at the home of Mr. and Mrs. Ambrose Swasey, Tuesday afternoon, May 28, and a reception and dance at the Colonial Club Thursday evening, May 30.

The plants of Warner & Swasey Co., Brown Hoisting Machinery Co., Winton Motor Co., Peerless Motor Car Co., National-Acme Mfg. Co., White Co., American Steel & Wire Co., Wellman-Seaver-Morgan Co., Akron; Goodrich Rubber Co., and the Diamond Match Co., at Barberton, were open to members.

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AEROPLANE EXPOSITION IN BERLIN

An International Aeroplane Exposition was held in Berlin, Germany, during the month of April. The most interesting fact brought out during the exposition was that so large a number of firms exist in Germany that are directly interested in the aeroplane industry. At the exposition there were 176 exhibitors in all, of which twenty-two were firms exhibiting aeroplanes. There are twenty-seven German firms building aeroplanes exclusively, and twelve more constructing aeroplanes in addition to other products. Many of these aeroplane factories are, of course, very small. Several, however, are organized wth a considerable capitalization—for example, one company is capitalized at $375,000, another at $150,000, another at $62,500, while three are capitalized at $25,000 each. There are between 400 and 500 aeroplanes in use at the present time in Germany. Of the forty aeroplanes shown at the exposition, thirty were monoplanes, nine biplanes, and one a triplane. The proportion of the various types, however, is somewhat misleading as regards the relative popularity of the various types, as the biplanes were exhibited by several of the German firms who had been most successful, while many of the monoplanes shown were experiments by unknown firms. For military purposes, and in general when the greatest speed is not essential, the biplane seems to have proved most satisfactory in Germany.

In general, the designs followed closely the various French types, and there was an absence of freak machines such as are generally seen at expositions of this kind. Consul General A. M. Thackara of Berlin, from whose report to the Department of Commerce and Labor the facts above are abstracted, states that, at the present time, America has little to learn from Germany as regards actual designs of aeroplanes, as the ideas in prominence at the Berlin exposition were largely of French and American origin. This condition, he states, will, however, probably not obtain much longer, as the aeroplane problem is now being attacked in Germany from every side both by the aviator in the field and the scientist in the laboratory.

The most powerful aeroplane exhibited was the Boris Loutzkoy monoplane which was fitted with two 100-horsepower "Argus" motors, each driving an independent propeller, revolving around the same axis. With both motors, the aeroplane, it is claimed, can attain a speed of ninety-three miles an hour. The machine can fly, however, with either motor alone. The weight, with pilot, one passenger, and supplies for a six-hours' flight is about 3000 pounds. The width of the machine is 62 feet, the length about 50 feet and the supporting surface, 560 square feet. The "Argus" motor used in this aeroplane is of the four-cylinder type, making 1250 revolutions per minute, and having a weight of 288 pounds or slightly less than 3 pounds per horsepower. Hilz of Dusseldorf exhibited a motor of 120 horsepower, the weight of which was only 2.2 pounds per horsepower.

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PERSONALS

Frank Salomon, president of the Otto Gas Engine Works, Philadelphia, Pa., will sail on the *Cincinnati* July 4 for a six weeks' trip in Germany.

Ehrich Krell, vice-president of the Otto Gas Engine Works, Philadelphia, Pa., will return July 1 from a three months' business trip to Germany and England.

C. E. Coolidge, Western representative of the Niles-Bement-Pond Co., has resigned to take charge of the manufacturing equipment in the various plants of the U. S. Motor Co.

Frederick J. Benjamin, advertising manager of the Pawling & Harnischfeger Co., Milwaukee, Wis., has resigned to become advertising manager of the *Iron Trade Review*, Cleveland, Ohio.

W. H. Shafer, for several years superintendent of the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, has resigned to take the position of general manager of the Rivett Lathe Mfg. Co., Boston, Mass.

Charles A. Moore, president of Manning, Maxwell & Moore, Inc., New York, has returned from Europe, improved in health, after an absence of nearly two years, and has resumed attention to business.

John Johannigman, for the past ten years secretary of the Oesterlein Machine Co., Cincinnati, Ohio, resigned his position April 15. Mr. Johannigman intends to enter the machine tool manufacturing business.

H. Cadwallader, Jr., recently with the Isthmian Canal Commission at Panama, is now efficiency engineer with the Continental Motor Mfg. Co., of Muskegon and Detroit, Mich., installing the Taylor planning system.

Phil A. La Brie, formerly with the Gisholt Machine Co., Madison, Wis., has taken a position as salesman for New England with the Fitchburg Machine Works, Fitchburg, Mass., manufacturers of "Lo-swing" lathes.

J. E. Fries, engineer with the Crocker-Wheeler Co., Ampere, N. J., has been transferred to the San Francisco office as Pacific Coast engineer, where he will be able to render prompter service to the rapidly growing business of the company on the Pacific Coast.

Clarence A. Hills, who was lately made superintendent of the Abbott-Detroit Motor Co., Detroit, Mich., was presented by the employes of the Hupmobile Co., with whom he had been associated for the past two years, with a gold watch and diamond stickpin upon leaving to take his new position.

Dwight N. Lane has been made superintendent of the works of the Bantam Anti-Friction Co., Bantam, Conn. Mr. Lane, who was connected for ten years with the New Departure Mfg. Co., Bristol, Conn., is well equipped with long shop experience in connection with the manufacture of ball bearings for his new position.

Marion A. Morris has been appointed superintendent of the J. H. Sessions & Sons Co.'s plant at Bristol, Conn., succeeding Mr. Frank Garrigus, resigned. Mr. Morris was formerly connected with the Scovill Mfg. Co., and was superintendent for the Blake & Johnson Mfg. Co., from which position he recently resigned.

Joseph V. Woodworth, consulting engineer at the New York office of the Taft-Peirce Mfg. Co., Woonsocket, R. I., has resigned, and taken the position of consulting engineer and New York representative of the Boston Pressed Metal Co., Worcester, Mass., with offices in the Tribune Building, 154 Nassau St., New York.

J. P. Thompson, who has been employed as general superintendent of the Van Norman Machine Tool Co., Springfield, Mass. (formerly Waltham Watch Tool Co.), assumed his duties June 5. Mr. Thompson was until lately general superintendent of the Cameron Steam Pump Co., New York, and formerly was with the Pond Machine Tool Co., Plainfield, N. J.

* * *

OBITUARIES

Gilbert Hart, inventor and patentee of safety emery wheels, in the manufacture of which he made a fortune, died May 31 in Detroit, Mich., aged eighty-four years.

Col. Francis A. Walker, the oldest employe of the E. & T. Fairbanks Co., St. Johnsbury, Vt., died April 26, aged eighty-seven years. Col. Walker entered the employ of the company at the age of twenty to learn the molders' trade, and for sixty-two years was a foreman.

Valdemar F. Lassoe died May 22 at his home, 83 Decatur St., Brooklyn, N. Y., aged seventy-six years. He was born in Copenhagen, Denmark, where he received an engineering education, and came to this country at the age of twenty-four. He was associated with Capt. John Ericsson in designing the *Monitor*, and subsequently worked with him for twenty-eight years. After Mr. Ericsson's death he became consulting engineer for the American Hawaiian Steamship Co., for which he designed twenty-eight steamships. He was also, for eighteen years, consulting engineer for the North German Lloyd Co., and was the originator of the system now employed for using oil as fuel on steamships. He was a frequent contributor of engineering articles to technical journals. Mr. Lassoe is survived by a widow and one daughter.

Wilbur Wright, who, with his brother Orville, was the first to accomplish mechanical flight, died of typhoid fever at Dayton, Ohio, May 30, aged forty-five years. Wilbur and Orville were bicycle repairers in Dayton when they became

interested in aviation. The first experiments were made with gliders, and the first flight with a motor propelled aeroplane was made at Kitty Hawk, N. C., December 7, 1903. This flight of 852 feet was made in 59 seconds. Numerous short flights followed, and on September 26, 1905, a flight of 11⅛ miles was made at Dayton in 38 minutes, 3 seconds, this one being longer than all previous flights put together. The Wright brothers were notable for modesty, reticence and perseverance. They worked under most discouraging circumstances for years before the world recognized that they had actually solved the problem of navigating the air.

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COMING EVENTS

July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Cornell University, Ithaca, N. Y., opened Rand Hall May 23 with appropriate exercises. The building, 50 by 170 feet and three stories high, is a memorial to Jasper R. Rand, Jasper R. Rand, Jr., and Addison C. Rand.

New Haven Manufacturers' Exhibit Association, New Haven, Conn., has been organized by the manufacturers of New Haven for the purpose of making a permanent industrial exposition. About eighty per cent of the manufacturers have taken space and installed exhibits in the Auditorium Bldg., 671-673 Chapel St.

National Metal Trades Association, New England Bldg., Cleveland, Ohio. Proceedings of the fourteenth annual convention of the association at the Hotel Astor, New York City, April 11, 1912. The proceedings include a number of valuable technical papers on industrial education, employers' liability and workmen's compensation laws, safeguarding machinery, etc.

University of South Carolina, Columbia, S. C. Catalogue for the year 1911-12, together with announcements for the year 1912-13. This catalogue contains the usual information relating to the courses of study, the requirements for admission, and the departments of instruction, together with a list of students. It is illustrated with unusually fine halftones showing the various buildings of the university.

American Museum of Safety, 29 W. 39th St., New York. Paper entitled "Boat Installations and other Life-saving Devices for Safety at Sea," prepared by Mr. Axel Welin, of London, England, and read at a meeting under the auspices of the museum at New York, May 9, 1912. The paper is well illustrated with halftones and line engravings showing the arrangement of life boats and davits.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the college of engineering 1912-13. This catalogue gives a list of the faculty and instructors, and general information relating to the courses, admission requirements, fees, scholarships, etc. Some interesting information relating to the history of the Polytechnic Institute, its equipment, administration, regulations, and student organizations, is also given, together with a roster of students for 1911-12.

American Museum of Safety, 29 W. 39th St., New York. No. 3 of the "Manuals of Safety," covering foundry practice, by Wm. H. Tolman, director of the museum. This little book, consisting of forty 4½- by 7-inch pages, reviews especially the dangers of the foundry and the departments connected with it, and suggests a number of remedies to avoid accidents and injurious effects on the health of the workers. The book is profusely illustrated, and sells at 25 cents.

University of Wisconsin, Madison, Wis., announces that the twelfth annual six weeks' summer school of its College of Engineering opens June 24. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shop work and surveying, in addition to which, subjects may be taken in the College of Letters and Science. Further information may be obtained from Dean F. E. Turneaure, University of Wisconsin, Madison, Wis.

NEW BOOKS AND PAMPHLETS

The Evolution of Vertical Lift Bridges. By Henry Grattan Tyrrell, bridge and structural engineer, Evanston, Ill., reprinted from *Applied Science*, 1912.

Bolts, Base Plates and Plating for Steel Stacks. By Arthur M. Green, Jr. 16 pages, 6 by 9 inches. Published by the Rensselaer Polytechnic Institute, Troy, N. Y.

An Analytical Study of the Action of the Vacuum Dashpot. By Karl Nibecker. 22 pages, 6 by 9 inches, and one folding chart. Published by the University of Pennsylvania Mechanical and Electrical Engineering Department, Philadelphia, Pa.

Twenty-third Annual Report on the Statistics of Railways in the United States, for the year ending June 30, 1910. 898 pages, 6 by 9 inches. Published by the Interstate Commerce Commission, Washington, D. C.

Proceedings of the Thirty-first Annual Convention of the American Water Works Association. Held at Rochester, N. Y., June 9-10, 1911. 490 pages, 6 by 9 inches. Published by the secretary of the society, 47 State St., Troy, N. Y.

Starting Currents of Transformers. By Trygve D. Yensen. 43 pages, 6 by 9 inches. 18 illustrations. 6 tables. Published by the University of Illinois, Urbana, Ill.

This is bulletin No. 55 issued by the Engineering Experiment Station of the University of Illinois, and deals with the starting currents of transformers with special reference to transformers with silicon steel cores, in which the current may rise to more than seven times the full load current—a phenomenon which is fully explained in the bulletin.

Constructing Concrete Porches. By A. A. Houghton. 62 pages, 5 by 7¼ inches. 18 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

This book is No. 9 in a series of reference books for concrete workers and contains a treatise illustrating and describing the construction of monolithic concrete and concrete block porches, taking up the molding of columns, balusters, lattice work and railings, as well as plain and reinforced types of porch floors. The book is concise and direct in the treatment of its subject.

Tests of Columns. By Arthur N. Talbot and Arthur R. Lord. 44 pages, 6 by 9 inches. 20 illustrations. Bulletin No. 56 of the University of Illinois, Urbana, Ill.

This bulletin contains an investigation of the value of concrete as reinforcement for structural steel columns. The tests recorded show that structural steel columns having a filling of concrete, if properly made, develop nearly all the strength of both the steel and concrete. The tests also show that up to the point of failure of the column, the fireproofing shell of the concrete adheres tightly to the remainder of the column.

Electrical Injuries. By Charles A. Lauffer. 77 pages, 4 by 6½ inches. Published by John Wiley & Sons, New York. Price 50 cents.

The author of this book is medical director of the relief department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and is well qualified to treat the subject here dealt with. The book covers the causes, prevention and treatment of injuries with which workmen and others may meet in connection with electric currents. The book is intended to be of use to practical electrical men, and treats the subject in clear and simple language.

Concrete Bridges, Culverts, and Sewers. By A. A. Houghton. 58 pages, 5 by 7¼ inches. 14 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

This book is No. 8 in a series of reference books for concrete workers and contains a treatise illustrating and describing the various types of solid and reinforced arch, slab, and girder concrete bridges, and the molding of concrete culverts, drains and sewers. The book is written in a clear and concise manner and will prove useful also to persons who are not following concrete work as an occupation, but who wish to get a general idea of the methods and principles involved.

American Exporter's Export Trade Directory. Compiled by B. Olney Hough. 267 pages, 6 by 9 inches. Published by the Johnston Export Publishing Co., New York City. Price $3.00.

This book contains lists of foreign buying agencies in the United States, manufacturers' export agents, New York bankers engaged in foreign exchange business, foreign exchange dealers and brokers, marine insurance companies and export trucking companies in New York City, and foreign freight forwarders. Detailed information of steamship services to foreign parts, a list of consuls of foreign countries in the United States, and of American consulates in foreign countries are also given.

Rubber Hand Stamps and the Manipulation of Rubber. By T. O'Conor Sloane. 167 pages, 5 by 7 inches. Published by Norman W. Henley & Son, New York. Price $1.00.

This is a new, revised and enlarged edition in which chapters on the use of rubber in surgery and dentistry and the construction and repairing of rubber tires have been added. The object of the book is, in general, to present in the simplest form the subject of the manipulation of India rubber. Among other subjects the book deals with the making of rubber stamps, rubber type, sheet rubber goods, solution of India rubber, ebonite, vulcanite and gutta-percha, etc.

Brazing and Soldering. By James F. Hobart. 51 pages, 5¼ by 8 inches. 18 illustrations. Published by Norman W. Henley & Son, New York. Price, 25 cents.

This is the fifth revised and enlarged edition of Mr. Hobart's book, treating of the subject of brazing and soldering. It covers, in general, the same field as the previous editions, giving specific information regarding brazing alloys, and solders, and methods used in brazing and soldering. One chapter is devoted to special methods of soldering and covers electrical work, and tin plate, galvanized iron and zinc, lead and aluminum soldering. Compositions of various solders and fluxes are also given.

Coalfields and Collieries of Australia. By F. Danvers Power. 412 pages, 6 by 8½ inches. 231 illustrations. Published by Critchley Parker, Melbourne, Australia. Price 25s.

While coal mining plays a large part in the mining operations of Australia, this is the first work devoted to this important branch of the commercial activities of the commonwealth. The author, who is a member of the American Institute of Mining Engineers, as well as of the corresponding British and Australian societies, is well equipped to handle this subject, and the book will prove of value to those who are interested in the development of the Australian commonwealth and its mining industries.

Knots, Splices and Rope-work. By A. Hyatt Verrill. 102 pages, 4¾ by 6¾ inches. 148 illustrations. Published by Norman W. Henley & Son, New York. Price, 60 cents.

This book is a practical treatise giving complete and simple directions for making the most useful and ornamental knots commonly employed. The book is well illustrated to show the exact methods used in making knots and splices. The contents of the book will be best understood from a review of the chapter headings: Cordage; Simple Knots and Bends; Ties and Hitches; Nooses, Loops, and Mooring Knots; Shortenings, Grommets, and Selvagees; Lashings, Seizings, Splices, etc.; Fancy Knots and Rope Work.

Superheated Steam in Locomotive Service. By W. F. M. Goss. 66 pages, 6 by 9 inches. 51 illustrations. Published by the University of Illinois, Urbana, Ill.

This is bulletin No. 57 of the Engineering Experiment Station of the University of Illinois. It gives the results of a study of recent German practice in the use of superheated steam as well as of an elaborate series of tests made upon an American locomotive. The conclusions are to the effect that the use of superheated steam introduces no serious difficulties; that it brings about a material saving in the use of coal and water; and that the power capacity of American locomotives can be readily increased by this means.

Diary of a Roundhouse Foreman. By T. S. Reilly. 158 pages, 5 by 7 inches. Published by Norman W. Henley & Son, New York. Price $1.00.

This book contains a number of articles published some years ago by the author in the *Railway and Engineering Review*, under the title "Diary of a Roundhouse Foreman." It is in compliance with many requests that these articles are now put in book form. The author has attempted to give a general idea of the nature and range of problems that a roundhouse foreman has to meet. For this purpose it has been assumed that a typical young machinist has been placed in charge of a roundhouse, and his experiences are set forth in a manner which indicates that the author is a good story teller.

House Wiring. By Thomas W. Poppe. 103 pages, 4½ by 6½ inches. 74 illustrations. Published by Norman W. Henley & Son, New York. Price, 50 cents.

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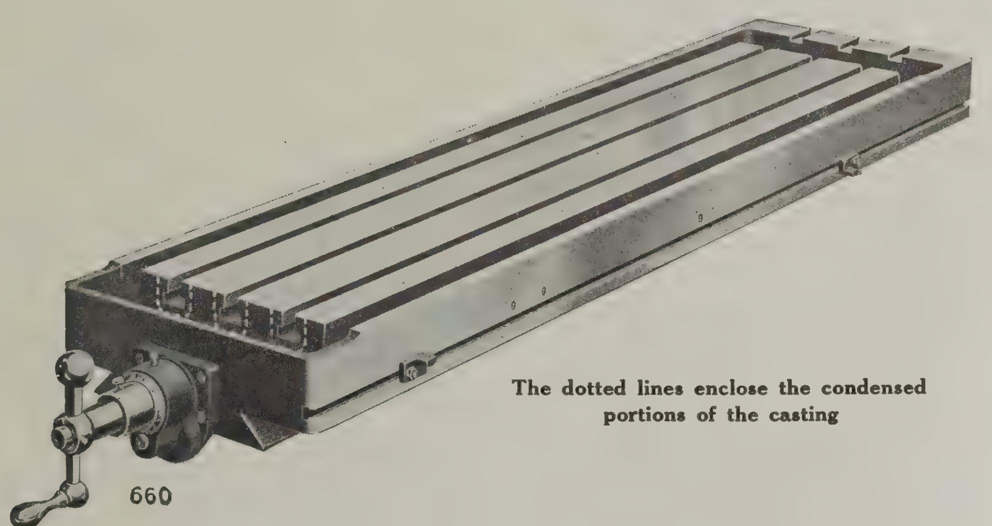

The dotted lines enclose the condensed portions of the casting

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This book is a treatise describing and illustrating up-to-date methods of installing electric light wiring and is intended primarily for persons of limited experience who wish to obtain a practical knowledge of the installation of electric lighting systems. The subject is treated in a simple and concise manner and illustrations are used throughout the book to clearly convey the ideas presented. The book consists of seven chapters headed as follows: Showing the Plans and Layout of the Electrical Work; Flexible Metallic Wiring Systems; Installing Rigid Conduit; Combining Flexible and Rigid Conduit; Wiring and Switch Diagrams and Connections; Grounding Metallic Conduit Systems; Knob and Tube System.

Farm Gas Engines. By H. R. Brate. 195 pages, 5 by 7 inches. 37 illustrations. Published by the Gas Engine Publishing Co., Cincinnati, Ohio. Price $1.00.

This book is intended to present, in a simple way, the methods used in the successful running of gas engines. Examples are given of various troubles met with in the manipulation of these engines, the book being intended especially for persons who use small units for agricultural work on small industrial plants. Special attention has been called to the troubles met with in the ignition system. The language used is clear and simple and well adapted to the class of readers for which the book is intended. The various chapters of the book discuss two- and four-cycle gas engines, fuels, carburetion, compression, ignition, magnetos, batteries, coils, lubrication, cooling, gas tractors, portables, farm pumping plants, farm lighting plants, farm machinery operated by gas engines, and marine engines.

Primer of Scientific Management. By Frank B. Gilbreth. 108 pages, 5 by 7½ inches. Published by D. Van Nostrand Co., New York. Price $1.00.

In the early part of 1911 the *American Magazine* published a series of articles by Frederick W. Taylor, entitled "The Principles of Scientific Management." As a result of the publication of these articles, hundreds of letters were sent to the magazine requesting further information on the subject. These letters were all handed to the author of the present book and are answered in it. Hence, the book is not a complete treatise on scientific management, but gives in a catechism form a comprehensive idea of the main principles of the subject. The book is divided into five chapters headed as follows: Definitions of Terms of Scientific Management; Laws, or Principles, of Scientific Management; Application of the Laws of Scientific Management; The Effect of Scientific Management on the Worker; and Relation of Scientific Management to Other Lines of Activity.

Elementary Internal Combustion Engines. By J. W. Kershaw. 171 pages, 5¼ by 7¾ inches. 117 illustrations. Published by Longmans, Green & Co., New York. Price, 90 cents.

The author of this book, who is a lecturer in engineering at the University of Sheffield, England, states in the preface that it is intended to give an elementary account of the construction and working of internal combustion engines and power gas producers, and thus to serve as an introduction to the more advanced books dealing with the subject. The explanations have, for this reason, been made as simple as possible, but within its scope the book is thorough and comprehensive and provided with a great number of sectional illustrations showing the exact workings of the various parts of the gas engine. The contents by chapters are as follows: The Gas Engine; Large Gas Engines; Gas Engine Governing; Ignition; The Indicator and Indicator Diagrams; Calorific Power; Gas Producers; Theory of Gas Producers; Oil Engines; Petrol Engines; Oil Engines for Ships; Other Combustion Motors; Engine Efficiency.

Concrete Costs. By Frederick W. Taylor and Sanford E. Thompson. 709 pages, 5 by 8 inches. 82 illustrations. Published by John Wiley & Sons, New York. Price, $5.00.

This book is designed to meet the needs of both the contractor and the engineer and architect in making rough and approximate as well as accurate and detailed estimates. It is also intended to make possible an economical layout and a scientific management of the work in combination with task and bonus systems. The book contains an immense amount of data relating to all phases of concrete work and it is impossible in a brief review to give more than a general idea of its contents. It has twenty-three chapters which are headed as follows: Approximate Costs of Miscellaneous Concrete Work; Approximate Cost Data on Concrete Structures; Approximate Costs of Reinforced Concrete Buildings; Determination of Labor Cost; Task-work in Construction; Proportioning Concrete; Tables of Quantities of Materials for Concrete and Mortar; Cost of Concrete Materials; Excavating and Crushing Stone for Concrete; Handling and Transporting Materials; Labor of Hand Mixing; Machinery Plants for Mixing and Handling Concrete; Labor Costs of Machine Mixing; Forms for Mass Concrete; Arch Centers; Forms for Reinforced Concrete; Tables of Concrete Volumes; Tables of Steel Areas and Quantities; Tables of Times and Costs Bending and Placing Steel; Tables for Designing Forms; Tables of Quantities of Lumber for Forms; Tables of Times and Costs of Labor on Forms; Estimates for Reinforced Concrete Construction.

Practical Thermodynamics. By Forrest E. Cardullo. 411 pages, 6 by 9 inches. 224 illustrations. Published by McGraw-Hill Book Co., New York. Price $3.50.

While this book is intended primarily as a textbook for the use of classes in mechanical and electrical engineering, it is written in a manner which will appeal especially to the practical man. The author has presented his subject so that any person who would like to obtain a general understanding of thermodynamics without going into the subject deeply enough to analyze the mathematical deductions, will be able to do so without difficulty. The book has been prepared with a clear view of both practical and theoretical considerations, and the laws which underlie the action of thermodynamic apparatus are so presented that the reader will not only be able to comprehend the principles involved, but also to correctly design apparatus based upon these thermodynamic principles. The book has a pleasing and refreshing touch of originality, and as the writer himself states in the preface, he has not hesitated to present new methods whenever these methods seemed simpler and better than the older ones. Many of the definitions given, therefore, differ radically from those found in other textbooks, and the whole subject has, as a result, become more simple and also more logical. Such items as can only be fully comprehended and satisfactorily studied by more advanced students have been printed in smaller type, so as to distinguish them from the remainder of the text. In this way, it is possible for students who have advanced further to deal with the subject in a most thorough manner, while beginners may read only such parts as are especially intended for them at their present stage of development. A great number of problems for exercises are presented, these problems being given at the end of each chapter. The answers accompany the problems in each case. The general scope of the work will be best understood from a review of the headings of the chapters of the book: The Nature and Measurement of Heat; The Thermal Properties of Gases; The Expansion of Gases; Thermodynamic Processes and Cycles; The Thermal Properties of Vapors; Wet and Superheated Vapors; Mixtures of Gases and Vapors; The Steam Engine; Steam Cycles; Losses in the Steam Engine; Notes on the Design and Testing of Steam Engines; The Steam Turbine; Condensing Machinery; Combustion; The Steam Boiler; Boiler Plant Auxiliaries; Water-cooling Apparatus; Hot-air Engines; The Internal Combustion Engine; Notes on the Design and Performance of Internal Combustion Engines; Gaseous Fuels; Compressed Air; Refrigeration; Heating, Ventilation, Evaporation and Drying; Entropy Diagrams; The Kinetic Theory of Heat.

NEW CATALOGUES AND CIRCULARS

Nelson Valve Co., Chestnut Hill, Philadelphia, Pa. Catalogue S on steel valves and fittings made of acid open-hearth steel.

National Tube Co., Frick Bldg., Pittsburg, Pa. Circular describing the N. T. C. regrinding globe and angle valves with union bonnet.

Davis-Bournonville Co., 97 West St., New York. Booklet No. 4 on autogenous welding and cutting of metals by the oxy-acetylene process.

Wayne Oil Tank & Pump Co., Fort Wayne, Ind. Circular of oil storage outfits for gasoline, gasoline lubrication oils, paint oils and varnishes.

Deane Steam Pump Co., 115 Broadway, New York. Bulletin D-171 on horizontal duplex piston pumps, operated by direct-connected vertical gasoline engines.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet on Joseph Dixon, comparing his work with that of others who have made great inventions and discoveries.

McEwen Bros., Wellsville, N. Y. Booklet illustrating and describing pumps for steam turbine drive. Complete description and tables of necessary data are given.

Taylor Iron & Steel Co., High Bridge, N. J. Bulletin No. 114 briefly describing the application of "Tisco" manganese steel to crusher and pulverizer parts.

C. W. Meadowcroft, Sr., 4702 Large St., Frankford, Philadelphia, Pa. Circular illustrating the ball high-speed rotary riveting hammer, with foot lever, bench style.

O. N. Beck, 11 Queen Victoria St., London, E. C., England. Circular of elastic corrugated tubes for expansion joints, heating and smoke tubes, superheaters, condensers, etc.

Detroit Fuse & Mfg. Co., Detroit, Mich. Bulletin No. 25 descriptive of "Detroit" switches for motor-operated machinery which are "foolproof, fireproof and fumeproof."

Peters Bros. Mfg. Co., Algonquin, Ill. Circular of "Peters" abrasive metal saw for cutting high-speed steel, brass, copper, iron pipe tubing, and all metals; price, $16.50.

National Scale Co., Chicopee Falls, Mass. Folder advertising the National counting machine for parts such as bolts, screws, nuts, etc., used in quantities in manufacturing establishments.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 7004 illustrating and describing Cameron steam pumps, remarkable for the small number of working parts used in their construction.

Treadwell Engineering Co., Easton, Pa. Booklet on steel castings, defining what steel castings are. The information contained will be useful to any user or prospective user of steel castings.

Bethlehem Steel Co., S. Bethlehem, Pa. Catalogue of crucible steel products comprising high-speed steel, carbon steel, die products, forged disks and blanks, special alloy steel, spring steel, etc.

Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia, Pa. Catalogue on the Hess-Bright DWF ball bearing hangers for lineshafting, illustrating installations and giving data on power saving.

Wells Bros. Co., Greenfield, Mass. Circular of the "Little Giant" tap grinder which provides means for sharpening taps up to 12 inches in length and, with special arm, to 15 inches in length; price, $75.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Descriptive leaflet No. 2496 on Westinghouse outdoor type OISC transformers; circular No. 1194, on Westinghouse type Q direct current generators.

National Automatic Tool Co., Richmond, Ind. Catalogue of automatic adjustable multiple spindle, vertical and horizontal drilling machines with variable spindle speeds, for drilling, reaming and tapping.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin descriptive of the Shepard line of cage controlled monorail electric hoists for use in steel mills, foundries, machine shops and factories.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 141, illustrating and describing alternating current motors, Form R, induction type, designed for operating from 25 cycle polyphase alternating current circuits.

Pennsylvania Railroad Co., Philadelphia, Pa. Booklet on the subject of corn culture, intended for farmers, students in agricultural schools and others interested in the promotion of higher agricultural efficiency.

Standard Pump & Engine Co., Cleveland, Ohio. Catalogue No. 12 of "Standard" pumping engines, and "Standard" water supply systems adapted to shallow wells, cisterns, lakes, rivers, etc.; also to deep wells.

S. F. Bowser & Co., Fort Wayne, Ind. Catalogue of the Bowser oil filtration and circulating systems which filter the oil, precipitate impurities, separate and automatically eject water and provide for the storage and use of refuse oil, etc.

Deane Steam Pump Co., 115 Broadway, New York. Catalogue of duplex horizontal double acting power pumps, giving brief descriptions of various types of these pumps, together with complete tabular data relating to capacity and sizes.

General Electric Co., Schenectady, N. Y. Bulletin No. 4931. "Electricity in the Shoe and Leather Industry"; bulletin No. 4939. "Electric Hoists"; bulletin No. 4947, "Edison Mazda and Gem Lamps for Standard Electric Railway Service."

Alvan Mfg. Co., Newark, N. J. Leaflet illustrating and describing the "Rex" universal test indicator for the use of toolmakers, machinists, etc., on bench lathes, engine lathes, planers, shapers or milling machines. The error is multiplied fifty times, and the capacity is 0.020 inch.

Wells Bros. Co., Greenfield, Mass. Tables of tap drill sizes for U. S. standard, S. A. E. standard and machine screw threads. The tap drill sizes are based on the formula $X = N - \frac{3}{4}(2D)$ in which X equals tap drill diameter, N, diameter of tap over top of thread, and D depth of thread.

B. F. Sturtevant Co., Hyde Park, Mass. Catalogue No. 190 of steam turbines, describing the new type Sturtevant turbine and calling attention to its advantages. Catalogue No. 200 describing the Sturtevant aeronautical motor which is of the four-cycle type with four and six cylinders arranged vertically.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue "J," 1912, covering pillar cranes, hand wrecking cranes, mast jib cranes, pillar jib cranes, bracket jib cranes, hand bridge cranes, and transfer tables. The catalogue is profusely illustrated, showing cranes installed in various industrial plants and for various services.

Wisconsin Engine Co., Corliss, Wis. Circular of the Adams-Wisconsin kerosene gas engines, built in sizes from 50 to 200 H. P., under the M. Rumely Co. patents. These engines use kerosene instead of gasoline, being provided with special carburetors that gasify cold kerosene the same as gasoline is gasified in an ordinary carburetor.

CONTENTS FOR JULY

The first column of page numbers applies to the Engineering and Railway Editions: the second to the Shop Edition.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 62 descriptive of Dr. Th. Horn's tachometers and tachographs, covering a great variety of styles, ranges and purposes for practically all conditions of industrial and engineering service and including precision tachographs for recording minute variations in speeds of machinery.

Stow Mfg. Co., Binghamton, N. Y. Catalogue of flexible shafts and other portable apparatus for drilling, tapping, reaming, counterboring, etc.; also center grinders, portable grinders, scratch brushes, universal joints, multi-speed electric motors, electric grinders of the floor and portable types, track drills, rail grinders, hand buffers, electric bench grinders, electric breast drills, etc.

Thomson Electric Welding Co., Lynn, Mass. Catalogue of electric welding machines operating by the resistance or Thomson process which is principally employed in butt welding, T- and angle-welding, cross welding, lap welding, seam welding, etc. A line of machines adapted to a large variety of welding operations is illustrated, and data on size, weight, capacity, etc., are given.

American Tool Works Co., Cincinnati, Ohio. Pamphlet describing methods employed in the manufacture of lathes, planers, shapers and radial drills in Cincinnati, by the company. The tests applied are shown. The pamphlet should be found of much general interest to superintendents, foremen, mechanics and all interested in any way in machine tools.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 2458 on Westinghouse type-T direct current turbo-generator, consisting of a steam turbine and generator mounted on a common base. The leaflet gives a description of the various characteristics and construction in detail of the steam turbine, and views of the component parts of the various elements, etc.

John M. Rogers Works, Inc., Gloucester City, N. J. Catalogue of measuring instruments of precision, manufactured after the Richards system; also solid adjustable blade reamers, solid reamers, adjustable blade hollow mills, adjustable thread cutting tools, steel mandrels, etc. The catalogue includes complete metric sizes and prices of all tools manufactured by the company.

Modern Machine Tool Co., 4657 Spring Grove Ave., Cincinnati, O. Circular of the "Modern" flat turret lathe embodying improved automatic chuck, automatic roller feed, novel belt clutch, improved friction clutch and improved feed box. The lathe has a capacity for bar stock up to 2¼ inches diameter, and 26 inches length. The swing over the bed is 20 inches and over the carriage, 14 inches.

Fahrig Metal Co., 34 Commerce St., New York. Circular of "Fahrig" anti-friction metal, composed of tin and copper combined by a special process. This metal is especially valuable for the bearings of automobiles and gas engines. It has superior anti-friction qualities and can be used in the form of die castings, sand castings or poured bearings, as may be required to suit the condition of manufacture.

Pennsylvania Railroad Co., Philadelphia, Pa. Booklet entitled "The Pennsylvania Railroad and Industrial Safety," containing extracts from the proceedings of the American Museum of Safety, New York, January 17, 1912, when the Traveler's Insurance Co's medal was awarded to the Pennsylvania Railroad, "as the American employer who, in 1911, did the most to protect the lives and limbs of its employes."

Van Dorn & Dutton Co., Cleveland, Ohio. Circular illustrating uses of the Van Dorn & Dutton Co., hard-service portable electrically-operated drills and reamers, the examples showing application to car work, structural work, manufacture of steel furniture, motor cars, drilling armor plate, erecting lineshafts, boring holes in timber, drilling staybolt holes in boilers, erecting elevators, repairing stationary engines, etc.

General Electric Co., Schenectady, N. Y. Bulletins No. 4880, on railway signal volt ammeters; 4910, on oil break switches; 4925, on combined unit-series mercury arc rectifier outfit; 4938, on Type H transformers; 4949, on direct-current portable instruments; 4950, on Washington, Baltimore & Annapolis 1200-volt direct-current railroad installation; 4951, on street lighting with Edison "Mazda" series lamps; and 4952, on series incandescent street lighting systems.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich. Bulletin No. 10 descriptive of the "Hoskins" electric muffle furnaces, type FC, for the efficient heat-treatment of tool steels, made in two sizes having chamber dimensions 6½ inches wide by 5 inches high by 12 inches deep, and 12 inches wide by 8 inches high by 18 inches deep, respectively. Among the advantages claimed are even heating, accurate temperature, atmospheric control, absence of oxidizing gases, rapid heating, high thermal efficiency, etc.

Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo. Pamphlet entitled "The Present Status of the Diesel Engine in Europe and a Few Reminiscences of the Pioneer Work in America," by Dr. Rudolf Diesel, the contents comprising a lecture delivered before the Associated Engineering Societies of St. Louis, April 13, 1912. The growing importance of the Diesel internal combustion engine makes the pamphlet of much interest to engineers and others concerned with the economical generation of power.

American Swiss File & Tool Co., 24 John St., New York. Catalogue, fifth edition, of "American Swiss" files, fully illustrated, with price list in distinctive heavy type. A separate sheet accompanying the catalogue compares "American Swiss" list and "American Standard" list, this comparison being important to buyers of high-grade files. The inside front cover concerns trademarks, and the inside back cover briefly takes up the three epochs in file making beginning with a well-known quotation from the Bible. The engravings of files are carefully made showing the kind of cutting exactly. File users generally will find the catalogue interesting and valuable for reference.

Bristol Co., Waterbury, Conn. Catalogue No. 1000 on Bristol's recording gages for pressure and vacuum, containing 64 pages, 8 by 10½ inches. The catalogue lists all of the Bristol recording pressure and vacuum gages except round form models 50, 52 and 56. These gages are furnished with charts graduated in pounds per square inch, in ounces per square inch, in inches head of water, in feet head of water, in atmospheres, in inches head of mercury, in centimeters head of water, in decimeters head of water, in tons, in kilograms per square centimeter, in millimeters head of mercury, in millimeters head of kerosene, in centimeters head of water, in millimeters head of water, etc. The preceding partial list gives some idea of the extent of development of the recording gage, exemplified by the product of the company.

International Oxygen Co., 115 Broadway, New York. Bulletins on the I. O. C. oxy-hydrogen platinum melting processes; the Holder pressure generator for generating acetylene gas; welding torches for welding metals; high-pressure cylinders for gas, made in 100, 150 and 200 cubic feet capacities, respectively; report of tests of cells for the electrolytic production of oxygen and hydrogen made by the Electrical Testing Laboratories, New York; oxy-hydrogen and street railway construction, being extracts from paper read by Mr. Henry Mozley before the convention of the Municipal Tramways Association held at Glasgow, September 27-29, 1911; and bulletin containing tables on weights of gases, variation of pressures in cylinders with variation of temperature, quantity of gas remaining constant; quantity of gas in cylinders under various pressures, temperature constant; purity of oxygen; and calculation of thermometer readings, etc.

TRADE NOTES

Crocker-Wheeler Co., Ampere, N. J., opened an office in the Title Insurance Bldg., in Los Angeles, Cal., April 1.

Morrow Mfg. Co., Elmira, N. Y., is building a one-story brick addition, 50 by 180 feet for an automatic turret lathe department.

Superior Machine Tool Co., Kokomo, Ind., is building an addition to its plant to afford necessary facilities for its increasing business.

THE TRUTH
ABOUT
HOLLOW SET SCREWS

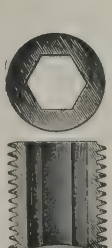
Pioneers in the promotion of new things are to be pitied. The study, the anxiety, the worry and expense of marketing anything new may bring their measure of success, but surely will bring (on any article of merit) competition, fair and unfair.

Many years ago we began the sale of Hollow Set Screws and while a Hollow Set Screw is not new, yet our method of producing them was new and produced a very much better screw than can be made from the solid bar, drilled and broached. In these solid bar screws, the surplus metal at the point at first appears to be advantageous, but in reality it is disadvantageous for the reason that the uniform thickness of our screws made from flat steel "died" out, permits a longer hold on the wrench and, therefore, a far better opportunity for tightening, while in the solid screw which is drilled and broached, it is necessary to turn in the surplus metal (resulting from the broaching) to the bottom of the hole, thereby partially filling the hole with nothing but waste material which has absolutely no holding power at all.

The H. S. & Co. Screws are made from sheet steel, stamped or "drawn up." Proper tests prove beyond a doubt that this method makes a stronger and tougher screw than one milled from the solid bar, owing to the position of the fibres of the steel. Well known proof of this is found in the comparative values of semi-finished nuts—those milled from solid rod not being as strong as the stamped goods; the same is illustrated also in wood, the plank grain being infinitely stronger than the cross grain product.

We invite comparative tests of the H. S. & Co. Hollow Set Screws with any other screws made having a hole or socket, and will supply FREE SAMPLES for this purpose, to reputable concerns.

SEND FOR CIRCULAR No. 3055.



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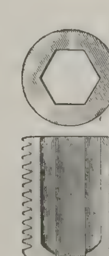
HARDWARE, TOOLS AND SUPPLIES

New York, Since 1848 **4th Ave. and 13th St.**



Blakeslee Forging Co., Southington, Conn., will erect a new forge shop 30 by 160 feet, three stories high; also an annealing shop 32 by 72 feet, one story high.

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has awarded the contract for the construction of a new machine shop 68 by 184 feet, one story high.

Frevert Machinery Co., 38 Vesey St., New York, the business of which has been conducted since its inception in 1906 by H. F. Frevert, has been enlarged and papers for incorporation under the laws of the State of New York have been filed.

Lumen Bearing Co., Buffalo, N. Y., is making an addition of 1800 square feet to its plant to take care of aluminum casting work. The company reports a prosperous year up to date, orders received being in excess of those reported for corresponding periods in the past.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York, has moved its Winnipeg branch offices into new quarters at 92 Arthur St. The new place is a six-story and basement building, and will be occupied throughout by the company's offices and store-rooms.

Brown & Sharpe Mfg. Co., Providence, R. I., announces that its works will be closed from August 2 to 19 for the annual vacation. During this time the offices will be open as usual and orders for machine tools, machinists' tools and cutters will receive the same attention as at any other period of the year.

Wells Bros. Co., Greenfield, Mass., manufacturer of taps and dies, has opened a store in Boston at 163 Oliver St. A comprehensive stock of all screw-cutting tools is carried, and quick deliveries will be made, thus affording better service to the trade in Boston and vicinity. Mr. John E. Chipman is manager of the new store.

Watson-Stillman Co., 192 Fulton St., New York, announces that the following officers were elected at a directors' meeting, May 15: President, E. A. Stillman; vice-president and secretary, A. F. Stillman; treasurer, J. P. Bird; chief engineer, Carl Wigtel; superintendent, Frank Lary. A new branch office is to be opened at Philadelphia soon and the shop facilities are being improved to meet increasing business.

Baldwin Chain & Mfg. Co., Worcester, Mass., has appointed Mr. Charles D. Schmidt its local representative in Greater New York City. An office and storerooms have been established at 416 Broadway, and Mr. Schmidt will give his attention to the prompt delivery of orders for the local trade. The company makes sprockets as well as chains, and Mr. Schmidt is prepared to furnish sprockets and chains for replacements on standard commercial cars.

Universal Machine Screw Co., Hartford, Conn., recently opened a New York office in charge of Mr. C. D. Schmidt, manager, corner Broadway and Canal St. (entrance 276 Canal St.) which will expand the facilities required for the increasing business of the company. The company manufactures the "Universal" five-spindle automatic screw machine and also operates a large number of these machines in its own plant, producing standard and special screw machine products from steel or brass. Mr. Schmidt, the New York manager, has been an important factor in the machine screw product field for a number of years.

E. F. Lake, Bayonne, N. J., has merged his consulting metallurgical business with the metallurgical engineering firm of Nixon & Raab under the name of Lake, Nixon & Raab, 156 Fairview Ave., South Orange, N. J. Die-casting machinery alloys and processes, and heat-treatment and carbonizing of steel will be specialized on. All kinds of physical tests and chemical analyses will be given to various metal products, and advice will be given as to the best methods and machinery used in the melting of all alloys, casting alloys, galvanizing, coloring and plating, or otherwise working and treating either ferrous or non-ferrous metals or alloys.

Van Dorn & Dutton Co., Cleveland, Ohio, has opened several new agencies for the sale of its portable tools only. Stock will be carried in the following places: 67 Main St., San Francisco, Cal., W. B. Wilson, district manager; Security Bldg., Los Angeles, Cal., J. L. Davidson, district manager; Candler Bldg., Atlanta, Ga., W. F. Davis, district manager; Alfred Herbert & Co., Ltd., England, Ireland, Scotland, Wales, France, Belgium, Spain and Portugal; Frank Saunders, Sydney, Australia. Australia and New Zealand. The company reports a largely increased business. A full line of electric grinders will be brought out in the near future.

Newark Gear Cutting Machine Co., Newark, N. J., has again found it necessary to enlarge its works, to take care of increasing business. The assembly room has been enlarged so that the main building now extends from 66-68 Union St. through to 67-69 Prospect St. The three-story brick building at 69 Prospect St. is now occupied by the offices, drawing-room, and pattern-shop; while such portions of the main building as were formerly occupied by these departments will now be given over to the machine shop. The address of the office is now 69 Prospect St., Newark, N. J. Mr. Henry E. Eberhardt, president of the company, reports that at present the plant is running at normal time, with full working force. The demand for gear-cutting machines has been increasing, especially for the Eastern trade.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

MACHINERY
Railway Edition for Locomotive Construction and Repair Shops
August, 1912

ASSEMBLING A LOCOMOTIVE BOILER

By RALPH E. FLANDERS*

THE construction of a locomotive boiler presents many difficulties that are not encountered in building other types, because it must be shaped to conform with the requirements of locomotive design. Some of the sheets, especially around the firebox, are so irregular in shape that considerable skill is necessary in order to properly form and rivet them together. There are also difficult joints to make, and the firebox end must be carefully braced to withstand the high steam pressures and prevent distortion or explosion. Owing to these difficulties, a high degree of skill is required in locomotive boiler construction, and, incidentally, the work is very interesting just because it is difficult.

Fig. 1. End View of the Boiler Shop, Juniata Shops, P. R. R.

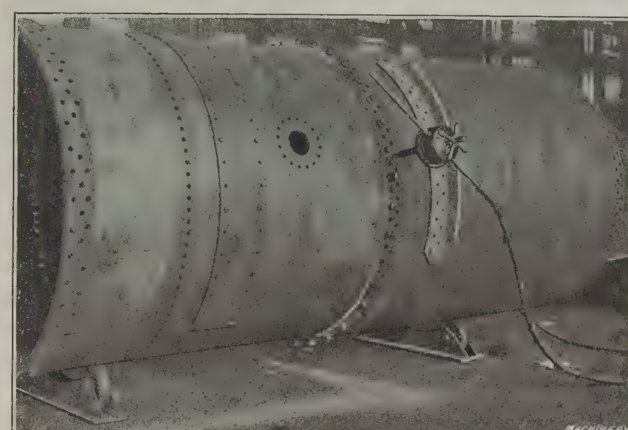


Fig. 2. Reaming Rivet Holes in Circular Seam

The method of erecting a locomotive boiler, as described in this article, represents the practice at the Juniata Shops of the Pennsylvania R. R., which, as most everyone knows, are located at Altoona, Pa. The subject will be treated in rather a general way, instead of describing in detail the exact method of assembling any one type of boiler. Special reference will be made, however, to the design having a Belpaire firebox, owing to the extensive use of this construction at the present time. The Belpaire firebox, as is well known, has a roof-sheet which is parallel with the crown-sheet, so that these members can be tied together with stays that are at right-angles to each sheet. This construction gives a flexibility which is very much needed, owing to the distortion that results from the steam pressure and the expansion due to the heat of the fire.

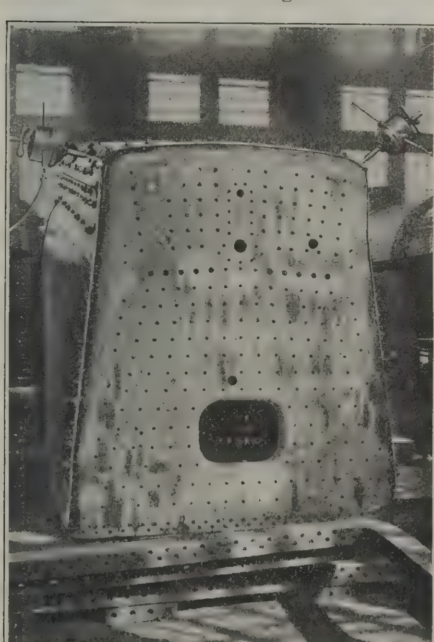


Fig. 3. Back End of Boiler bolted together prior to Riveting

Fig. 4. Back End of Boiler being riveted in Riveting Machine

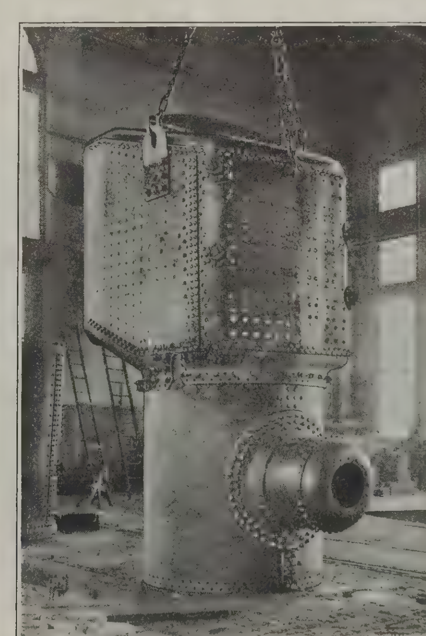


Fig. 5. Back End bolted to the Dome Course prior to Riveting

Prior to the erection of a boiler, all of the sheets are laid out and bent to the proper form. The required outline is first transferred from sheet steel templets. Practically all the rivet holes are then punched and drilled and the edges are planed or sheared to give a good surface for calking. The edges are beveled slightly, except where a butt-joint is to be made. The method of bending the sheets depends, of course, on their shape. Those for the cylindrical part of the boiler are rolled to the proper diameter, whereas the sheets of irregular shape are formed and flanged in hydraulic presses equipped with suitable dies. A detailed description of the way the different sheets are laid out, punched, trimmed, bent,

* Address: Springfield, Vt.

and flanged was previously published in the November, 1910, number of MACHINERY, railway edition.

The Riveting Machines

After the parts of the boiler have been made, we have next to consider the assembling and riveting of these parts together to form the finished structure. The riveting is done by hydraulic machines which are served by a pump and accumulator plant in the central power station. The pumping plant includes units of various capacities, so that the service can be maintained economically under varying conditions. The work

Fig. 6. Riveting the Side- and Crown-sheets of the Firebox

is presented to the riveters by a pair of special, electric cranes running on tracks provided for them in the riveting tower. Fig. 1, which is an end view of the boiler shop, shows the appearance of the riveting tower from the outside. The crane for each riveter is controlled by the operator of the riveting machine. The various hydraulic valves and electric controlling handles for the riveters and cranes are within easy reach of the riveting pit, as shown to the left in Figs. 4 and 6, so that the workman has full control of all the operations, except swinging the boiler shell about its axis, this being done by two helpers who insert short bars in the rivet holes for use as handles. Besides these two helpers, each riveting machine has its rivet furnace boy and helper for putting the rivets in the holes. It may be mentioned here, parenthetically, that to keep any or all of these men from falling into the riveter pit, an adjustable sheet-steel platform is suspended in

Fig. 7. Tube-sheet, Crown-sheet, and Firedoor-sheet being assembled

the pit with chains and can be set to any height to agree with the work in hand.

Riveting the Front Sections

The first operation on the boiler proper is that of riveting the longitudinal seams of the barrel sections. The shell to be riveted is suspended on a three-chain sling attached to a crane hook, and prior to driving the rivets, the joint is held temporarily by a few bolts. After the smokebox has been riveted on the longitudinal seam the ring for connecting it to the slope-sheet is assembled and then the flue-sheet is riveted to this ring. The smokebox with the ring and tube-sheet attached, is then lowered onto the slope-sheet to which it is temporarily bolted. These two parts are then lowered into the gap of the riveting machine and the circular seam is riveted together. In bolting up and riveting all joints, the holes that are supposed to match each other are inspected for alignment before the riveting operation, and reamed if necessary. The separate sections are also aligned with each other by means of center-lines which have previously been scribed upon them. Fig. 2 shows how the holes are reamed. An air motor is used and the two sections are mounted on rollers thus permitting the barrel to be easily turned to the most convenient position.

In designing a boiler, it is customary to have the number of rivets in the circular seams, equally spaced around the circle and divisible by 4. It is then possible, from the rivet holes, to lay out center-lines on the top, bottom, and sides of the sheets. These center-lines on each sheet, are accurately matched with each other when bolting the sections together, prior to reaming and riveting, and it is upon the accuracy of this work, that the accuracy of the finished boiler largely depends. To further preserve the accuracy of the circular joints, it is not the custom to drive first one rivet and then the next, clear around the circle, as this is likely to cause the two sections being riveted to "creep" onto each other; but instead, a rivet is driven here and there around the circle, after which the temporary holding bolts are withdrawn and the remaining rivets are driven.

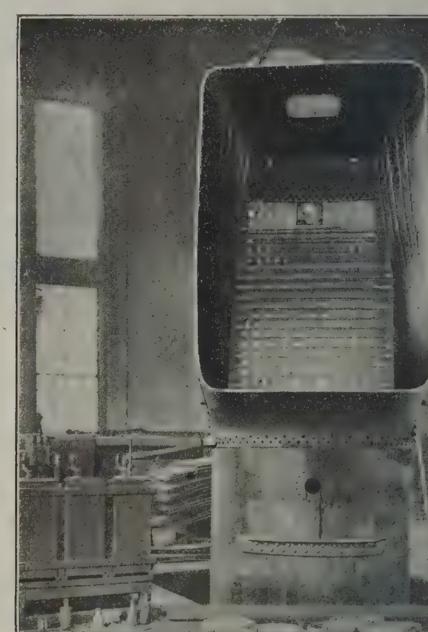


Fig. 8. Rear Half of Boiler Lowered into Pit for Riveting Throat- and Neck-sheets

Building up and Riveting the Back End

The back end of the boiler is first temporarily erected on the foundation ring or "mud ring," as it is often called. First, the side- and roof-sheets are fitted in place on the foundation ring. All of these sheets come to the boiler erecting department with the rivet holes punched, excepting a few holes that can be drilled to better advantage after the parts are assembled. The work of the riveter, prior to riveting, consists, therefore, simply in bolting the sheets together, temporarily, and then bracing them this way or that, to make the measurements correspond with those given on the drawing. When the parts have been bolted together in this way, the foundation ring is removed and whatever reaming may be necessary is done, as indicated in Fig. 3. This structure, which forms an outer shell over the firebox, is then taken to the riveter to be fastened together. It is suspended from the firedoor end, as shown in Fig. 4, so that the sides can enter the gap of the riveting machine.

Meanwhile, the foundation ring has gone back to the fitting floor to have the firebox mounted on it. The tube-sheet, firedoor sheet and crown-sheet are first fitted as shown in Fig. 7, the parts being braced in one way or the other, as may be required, to bring them to the dimensions specified on the drawing. The side-sheets of the firebox are then fitted in and all the sheets are bolted together. The holes are then reamed and the seams riveted, as indicated in Fig. 6, which shows the longitudinal seam joining the crown- and side-sheets being riveted. The firebox is suspended from the crane by the crown-sheet, and the stake of the riveter, which "backs up" the rivet, enters through the grate opening. This view also clearly shows the handles used for controlling the electric crane.

It is not possible to use the machine for all the riveting

operations on the firebox. The firedoor and flue-sheets can be riveted to the side-sheets, as well as the crown-sheet to the side-sheets, but it is not possible to rivet the crown-sheets and firedoor and tube-sheets together. This latter operation, therefore, has to be done by hand.

The outside throat-sheet is next attached to the side-sheets, and with the particular style of boiler shown in the illustrations, a neck-sheet is riveted to the crown-sheet. These two sheets, that is, the throat- and neck-sheets, are flanged at the front to form a circular opening for the dome course. The next operation is that of connecting the firebox end to the dome course, to which, in the meantime, the dome has been riveted. After these parts are bolted together, as indicated in Fig. 5, a three-chain sling is attached to the firedoor end, and the two sections are lowered into the riveting pit, as shown in Fig. 8 for riveting the circular seam. While this work has been going on, the stay gang has been putting in the various firebox stays, which are needed to hold the various members together when subjected to pressure. The location of these stays is clearly shown in Fig. 9, which is a view looking from the dome-course section, toward the firebox end.

Fig. 9. View toward the Rear showing the Stays

Assembling the Different Sections

After the different sheets have been joined, as described, the larger units thus formed are assembled. First the firebox and foundation ring are inserted in the back end of the boiler, which is turned on its side for this purpose. These parts are then bolted to the outer shell, care being taken that the water space between the inner and outer sheets conforms to the required dimensions. After the firebox has been carefully set with reference to this point, the temporary clamping bolts are tightened and the whole back end is taken to the machine to have the row of rivets around the foundation ring driven. Next, the rivet holes for the firedoor are drilled through the flanges of the inner and outer sheets, and these flanges are riveted together. This riveting is a rather difficult job as it has to be done either with hand hammers or a pneumatic hammer compact enough to enter the firedoor opening. It is also somewhat difficult to back up the rivet with a "dolly bar," but this can be done by using a special form which reaches around inside the water space.

Before the firebox end is completed, it is necessary to brace the inner and outer sheets by staybolts. A great many of these bolts are required and different forms are used. Those which tie the inner and outer sheets together are, for the most part, plain threaded bolts which have tell-tale holes drilled in the outer end as required by law. These tell-tale holes, as is well known, are drilled deep enough to extend beyond the inner side of the outer sheet, so that in case the bolt is fractured at this point (which is the place where most breaks occur) a warning will be given by the jet of steam which is allowed to escape.

In addition to these plain staybolts, what is known as the flexible type is also used in certain parts of the firebox. The position of the flexible bolts is shown in Fig. 10 by the large heads or caps. These bolts, instead of being screwed into both sheets and riveted over at the ends, are screwed into the inner sheet only, and have a spherical head at the outer end, which is seated in a bushing screwed into the sheet. A cap is also screwed over the outside of this bushing, thus forming a socket for the spherical head and preventing the escape of steam. The advantage of this construction is that when the bolt is moved by the expansion or contraction of the inner sidesheet, the bolt will turn in its socket instead of bending, as in the case of the solid type. In this way the danger of a fracture is lessened. This flexible bolt is used in parts of the firebox where the expansion is so great that solid rigid bolts would be dangerous. The taps used for threading these holes are, of course, varied to suit the different styles of bolts used. The holes for the regular solid bolts, are threaded by a long tool which is a tap and reamer combined, so that when it is pushed through by the air drill, the holes are lined up with each other as well as threaded.

The front and back sections of the boiler are now ready to be joined. The gap of the largest riveting machine would be deep enough to permit riveting this seam in the machine, were it not for the front flue-sheet. This flue-sheet might, however, be put in place last, but it has been found advisable to rivet these two sections by hand since other operations on the boiler can be performed simultaneously. Fig. 11 shows the two sections just before they are joined together. The two sections are lined up by the center-lines previously referred to, after which they are bolted together and the holes reamed. The rivets are then driven by pneumatic hammers, a man inside the boiler holding a dolly bar against the rivet, while an outside man operates the hammer.

Another important operation connected with boiler assembly is that of putting in the flues and expanding them in the front and rear tube-sheets. These flues, which have previously been reduced at one end, are inserted from the front of the boiler. They are put in by two workmen, one being in the firebox and the other at the smoxebox end. After inserting the first or bottom row, the ends of succeeding tubes slide along the top of those already in place, and the workman in the firebox has only to reach in with a bar just before the flue strikes the sheet and guide it into its hole. After the tubes are all inserted, they must be expanded and beaded to make a steam-tight joint. The well-known Prosser expander is used for this purpose. This expander consists of a set of three rollers mounted in a head and expanded outward by a taper pin, as the head is rotated by an air drill. This outward movement of the rolls, as the taper pin is forced inward, enlarges the tube until it is a tight fit in the hole, thus making a close joint all around. This rolling operation is all that is required at the smokebox end. At the firebox end, however, a copper ferrule is placed between the flue- and the tube-sheet, prior to the expanding operation. These copper ferrules are used to prevent corrosion, which might take place under the influence of the intense heat to which the rear ends of the flues are subjected. After the ferrules are in place, the tubes are

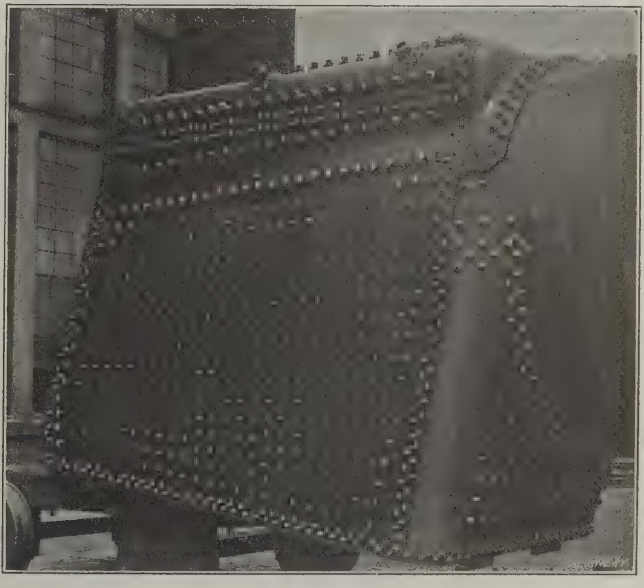


Fig. 10. Appearance of Firebox after the Staybolts have been inserted

rolled out with the Prosser expander until they form a steam-tight joint, and then the rear ends are beaded or rounded over. This beading is done by a special tool operated by the pneumatic hammer. This tool forms the bead by turning over the edge of the tube all around. In this way, an extra good joint is secured at this point and the front and back tube-sheets are firmly tied together.

While some of the operations previously referred to are being performed, the workman also calks the seams of the various riveted joints. Calking is done by a wedge shaped tool having a round nose which is driven against the beveled edge of the upper or overlapping sheet, by a pneumatic hammer. It it were not for this calking operation, the joints would leak like a sieve, because, while the rivets hold the parts together very securely, they do not take care of the unevenness in the joint. By calking, however, the edge of the overlapping sheet is compressed or driven back until a steam-tight joint is obtained. Calking is a very important part of boiler work and when it is poorly done, much trouble often results.

Miscellaneous Operations

There are, of course, a large number of miscellaneous operations on the boiler which cannot be referred to in an article of this length. These include such work as drilling and tapping openings for the washout plugs around the mud ring, and similar operations of a minor character. In addition, there is the work of mounting the fittings, such as the throttle dry-pipe, etc. This, however, is not done in the boiler shop but in the erecting shop. In connection with this work, mention should be made of the extremely accurate work done in pipe fitting. The pipes are cut to length and bent to shape within such close limits that they will go into place without further adjustment, this being the regular practice. The possibility of fitting pipes in this way, depends not only on the accuracy of the cutting and bending of the pipe itself, but also in the building of the boiler. All the pipes required for a certain design of locomotive, have corresponding wire templets of the exact length and shape required. The various pipes are bent with reference to these templets and they are not supposed to be altered afterwards. The methods employed by these pipe fitters seemed crude to the writer, at first sight, as no bending machines are used, but, instead, the open forge and hand vise. The pipes are heated and then gripped in the vise and bent by hand to conform to the templets. Upon making inquiry, it was learned that a pipe-bending machine had been tried for this work but was found to be slower than the hand method. Owing to the inconvenience of storing bent piping, and because of other considerations, it has been found unprofitable to bend the pipes in lots, the practice being to bend all of the pipes for one locomotive before proceeding with the next. On this account, the great number of changes of adjustment required when a machine is used, was found to consume all of the time saved by the machine. Probably pipe fitters less skillful and accurate than those here employed, would find that even under these conditions, they could produce work up to the required standard more rapidly by machine methods than by hand.

Fig. 11. The Boiler just before the Front and Rear Sections are riveted together

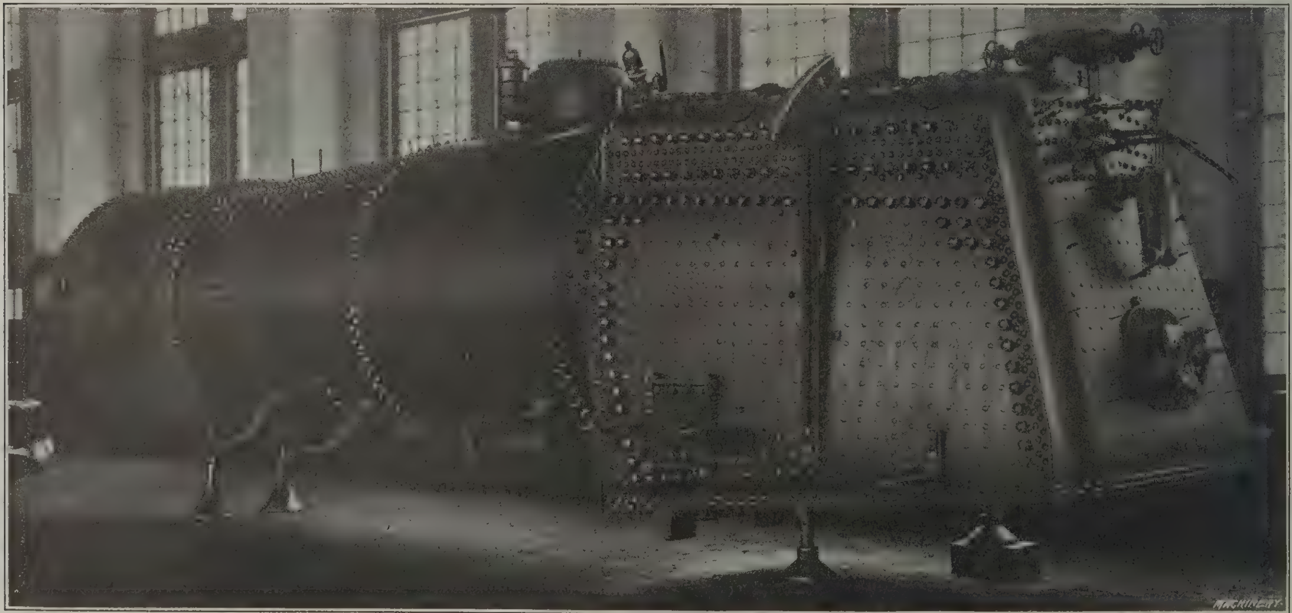


Fig. 12. The Completed Boiler ready for the Erecting Department

A Boiler Inspection Kink

In the course of this description, mention has been made two or three times of the fact that separate sections of a boiler are aligned with each other, prior to riveting, by center-lines laid off on the laying-out table. Incidentally, these center-lines

form a first-class indication of the accuracy with which the boiler has been assembled, the accuracy being checked by comparing these center-lines with those marked off on the side of the boiler at the time the locomotive was erected. When laying off these erecting shop lines, the horizontal center-line of the boiler is first located and marked on the sides of the smoke-box flange. The center of the boiler at the back end is then found, and horizontal lines are stretched along the side of the boiler. These lines are then chalked and "snapped," thus marking a center-line which extends the full length of the boiler, as shown quite clearly in Fig. 12. By comparing these center-lines with those previously made in the boiler shop on the separate sheets, the accuracy of the boiler erection can be determined.

TOOLS FOR PERFORATING LAMP BURNER PARTS

By CHARLES DOESCHER*

MANY kinds of dies have been described by the trade papers in the past, but very little has been said of the dies used for perforating the sides of cylindrical work. The punches and dies used for this work are similar to blanking punches and dies, except for the modifications occasioned by the fact that the metal fed over the face of the blanking die is flat, while that fed over the face of the perforating die is circular in form. Circular perforating tools are used in connection with this class of work because the nature of the work is such that it cannot, on account of both commercial and mechanical considerations, be carried out in any other way.

Fig. 1. Examples of Perforated Cylindrical Work, made by the Scovill Mfg. Co., Waterbury, Conn.

In describing the perforating of cylindrical work, the writer does not claim that the tools and methods in every case are the very best possible, but those in successful commercial operation at the present time are illustrated and described. The writer extends thanks to the E. W. Bliss Co., of Brooklyn, N. Y., for cooperation in the preparation of this article, and also to the Scovill Mfg. Co. of Waterbury, Conn., for the loan of the samples of perforated work shown.

Operation of the Perforating Tools

In Fig. 2 is shown a set of perforating tools together with a perforating attachment set up in a Bliss press ready for perforating a shell similar to the one shown in Fig. 4. The shell is first slipped over the die-holder (Fig. 5) in such a manner as to allow the elongated slot *A* in the bottom of the shell to engage with the projecting tongue of the driving arbor. The press is then tripped and the punches, at the first stroke of the press, cut out two of the irregular shaped perforations *B* in the shell. On the upward stroke of the press, a pawl *A*, Fig. 2, by the aid of a ratchet *B*, ratchet shaft *C* and the bevel gears, revolves the driving arbor, which rotates the shell a part of a turn. As the slot in the bottom of the shell is engaged with the tongue of the driving arbor, the shell is indexed with the arbor before the punch descends again. These operations are continued until the press, in this case, has made fourteen continuous strokes, when it is automatically stopped and the perforated shell removed. The stopping of the press is effected by cam *D*, which automatically releases the driving clutch when the required number of strokes has been made. The construction of the tools and the manner in which they are made will be treated later.

In Fig. 6 is shown another set of perforating tools for perforating the gallery fence of a lamp burner shown in Fig. 7. The gallery fence of a lamp or gas burner holds the lamp chimney or globe in place by the spring pressure exerted by the perforated part. The metal must be hard in order to impart the required spring pressure and is, therefore, on the better grade of burners, burnished before perforating, which not only hardens and toughens the metal, but also produces a brilliant finish. On the cheaper grade of burners, the shells from which the gallery fences are made are passed through an extra re-drawing operation, the shells not being annealed, but left hard. The difference in the diameter of the shell before and after re-drawing is about 1/32 inch, while the difference in the thickness of the metal is about 0.0005 inch. This treatment of the metal not only imparts the required springi-

*Address: 1029 West Main St., Waterbury, Conn.

ness, but also makes the perforating operations easier, as hard metal is more readily perforated than soft.

The tools used for perforating the gallery fence shown in Fig. 7 are somewhat different in construction from those shown in Fig. 2. The ratchet *C*, Fig. 6, is keyed to the driving arbor, and when the tools are set up in the press they are set with the face of the die-holder turned towards the right, instead of facing the operator. The perforating operation, however, is similar to the one already described. The effect of the successive strokes of the press is indicated in Fig. 7. At the first stroke of the press, the four shaded areas at *F* are punched out. At *G* can be seen the appearance of the shell after the second stroke. In order that no burr or fin may be left on the top points of the scallops, the die is made so that the punch will cut a trifle past the center of the point as shown at *H*. The shell is rotated towards the left by the driving arbor, and a simple holding device, not shown in the illustration, is used for holding the shell in place on the arbor.

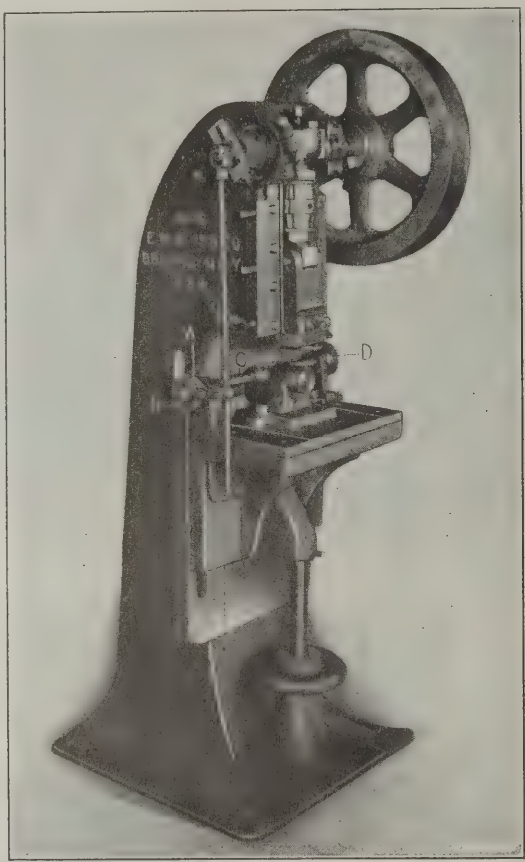


Fig. 2. Bliss Press with Attachment for Perforating Shell shown in Fig. 4

At attachment for holding work in place while it is being perforated is shown in Fig. 3. This attachment is used in connection with the tools for perforating the sides of large narrow rings. The tool equipment consists of a perforating punch *A*, and a large die-holder *B* for holding the dovetailed perforating die *C*. The die-holder is held in die-bed *D*. The perforating attachment, which rotates the shell, is placed directly back of the die-bed and is operated by the adjustable connection *E*, fastened to the gate of the press. After the ring is slipped over the die-holder, handle *F* is given part of a turn to the right which, by means of the spiral grooved arbor *G*, causes the circular disk *H* to come in contact with the ring, thus holding it in place. This circular disk rotates with the ring and is attached to arbor *G* by a pin in the hub of the disk which engages with a circular groove in the arbor.

Construction of Perforating Tools

In Fig. 8 the perforating die for the shell in Fig. 4 is shown held in a dovetail channel in the die-holder. The die-holder is preferably made of a cheap grade of tool steel, and is held in the die-bed as shown in Fig. 5. The dovetail method for holding the dies is probably the best, and is the one most commonly used. The sides of the dies are beveled at an angle of from 5 to 10 degrees. For work such as shown in Fig. 4, the die is tapered lengthwise on one side with a taper of about 1 degree, and is driven into the die-holder from the back and left flush with the shoulder of the holder, so that when in position, the die-bed prevents it from shifting back. When it is possible to do so, a pin or a fillister head screw may be used to prevent the die from shifting endwise. The shape of the shell and the design to be perforated sometimes governs the taper of the sides of the dies. This, for example, is the case where shells such as shown in Figs. 10 and 12 are perforated, when a greater angle than 1 degree must be used on account of the irregular shape of the die-holder and dies.

The longitudinal cross-section of the die-bed, die-holder and driving arbor used for the shell in Fig. 4, is shown in Fig. 5. Section *A* shows how the arbor is milled at the neck *A* in order to allow the scrap punchings to drop through. A section of the tongue of the arbor which engages the slot in the end of the shell, by means of which it is rotated, is shown at *B*. This tongue is tapered as shown, to facilitate the putting on and taking off of the work. A scrap escape hole *C* is drilled in the die-holder at an angle as shown, so as to prevent the scrap punchings from coming in contact with the shell while it is rotated around the die. An escape hole drilled in this manner can only be used on short shells and when the scrap punchings are small, or, if they are large, when they are few in number. Hole *D* in the die-bed permits the scrap punchings to readily fall out of the way.

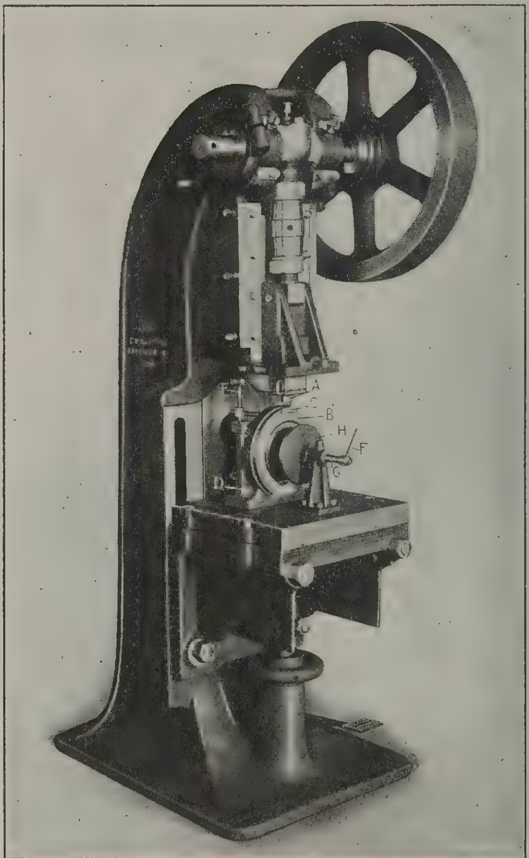


Fig. 3. Perforating Attachment with Special Device for Holding Shell in Place

The construction of the tools shown in Fig. 6 is somewhat different. Two small pins *E*, which are used in the face of the driving arbor, act as driving pins for rotating the shell. These enter into pierced holes in the bottom of the shell as shown at *B*, Fig. 7. The pawl which operates the indexing ratchet is fastened to part *B* in Fig. 6, which is made to fit the shoulder of the ratchet and works back and forth in order to provide for the required indexing. The back-and-forth motion is imparted to *B* by fastening a handle *F* to an adjustable connecting-rod which is, in turn, fastened to the crankshaft of the press. Part *D* is a brass friction which takes up the backlash of the driving arbor. This friction is fastened to the die-bed by a screw at *G*. The hole in the center of the friction fits the shoulder on one end of the

ratchet. The brake or friction effect is applied by screw *H*. Part *A* acts as a steadyrest for the driving arbor, and is fastened to the die-bed by screws *J* and *K*.

The cam fastened to the end of the driving arbor causes the press to stop automatically by coming in contact with a lever connected to the driving clutch. The driving arbor is relieved at *L* to prevent the congestion of the scrap punch-

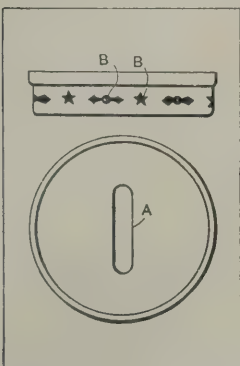


Fig. 4. Example of Shell to be perforated

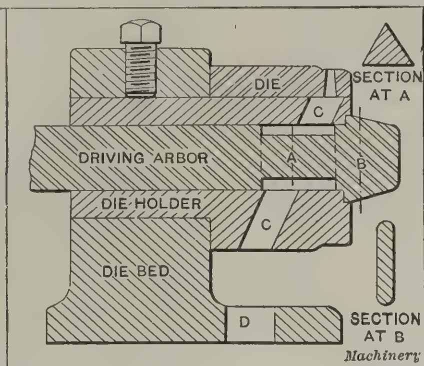


Fig. 5. Section of Die Bed, Holder and Die for Perforating Shell in Fig. 4

ings. The hole for the driving arbor in the die-holder is also recessed at this place in order to give the scrap punchings, which, in this case, are rather large, ample room to pass the arbor. When the device is in operation, a shutter *M* closes up the bottom of the scrap escape hole in the die-holder. When the shell is slipped over the latter, the shutter is forced up and thus acts as a trap, preventing the punch-

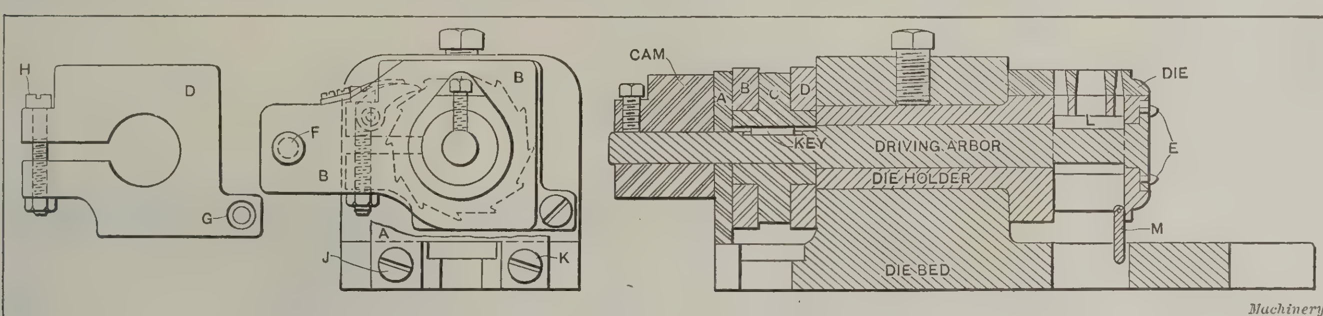


Fig. 6. Section of Die Bed, Holder and Arbor for Perforating Shell in Fig. 7

ings from dropping through into the inside of the shell. If the punchings were allowed to drop through and should cling to the perforated holes, they would cause the shell to jam and prevent it from rotating. When the perforated shell is removed from the die-holder, the shutter drops down of its own accord, thereby allowing the scrap punchings to drop out.

Perforating Shells of Tapered and Irregular Shapes

In perforating shells of tapered and irregular shapes the same general methods of procedure as already described are used, with the exception that the die-holder is held in the die-bed at an angle of 5 to 70 degrees or more with the bottom of the die-bed, the angle depending on the shape of the shell and the perforations to be made in it. In Fig. 9 is shown a die, die-holder and die-bed for work of this kind. The angle at which the die-holder is set should be such that if the outer ends of the two extreme holes in the perforating die are connected by a straight line, this line would be parallel with the bottom of the die-bed, as indicated in Fig. 10, where the points *A* and *B* are on the line which should be parallel with the base of the die-bed.

In Fig. 9 may also be seen the shell which is perforated by the die. The shell is rotated around the die by the tongue of the driving arbor engaging in an elongated hole in the bottom of the shell. The arbor is relieved at *A* in the usual manner to allow the scrap punchings to escape. No shutter is used, as the open end of the shell does not come near the scrap escape hole. The ratchet *B* which is operated by a pawl, not shown, is keyed to the driving arbor, while the friction used for controlling the backlash bears upon the shoulder of the ratchet as indicated. This shell has two rows of perforated holes, fifty-two holes in each row. Eight holes at a time are cut, or four holes in each row. The reason that four holes in each row are cut at each stroke, instead of five, six or eight, is, in the first place, that the number of holes cut at each stroke of the press must be such that the total number of holes in each row is a multiple of it. In the second place, it is not possible to get good results if the end punches are too far away from the center of the work, as these punches would strike a glancing blow. These holes would be somewhat elongated and "burry" instead of being clean, round and free from burrs. In this case, four holes in each row is as much as is practicable. Of course, if the holes are small in diameter and close together, a greater number can be cut at one time than when they are larger and further apart. If the diameter of the shells is large, a greater number of holes can also be cut at one time than with shells of smaller diameter, other conditions being equal.

In Fig. 11 is shown another set of perforating tools set up in a Bliss press. These are used for perforating the sides of the tube shown at *A* with a series of rows of small holes. These tools are of a somewhat different type from those already described. No driving arbor is used, but the shells are rotated direct from the ratchet which is placed in front of the die-bed. There may be several reasons for using this construction: When the bottom of the shell is to be left intact, no driving arbor can be used; sometimes the required shape of the shell is such as to prevent the use of a driving arbor; when the scrap punchings are so large and so numerous as to prevent them from dropping through if a driving arbor is used, or when that part of the shell that is to be perforated is very small in diameter, it may also be impossible to use a driving arbor.

Referring again to Fig. 11, it will be seen that another set of perforating tools similar to the one set up in the press is shown to the left. This is used for perforating the shell shown at *B*. The ratchet and pawl are shown at *C* and *D*.

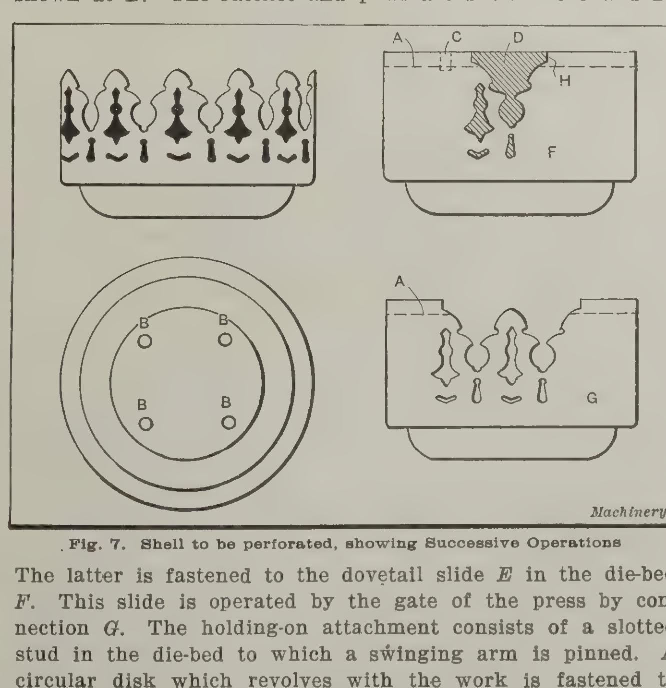


Fig. 7. Shell to be perforated, showing Successive Operations

The latter is fastened to the dovetail slide *E* in the die-bed *F*. This slide is operated by the gate of the press by connection *G*. The holding-on attachment consists of a slotted stud in the die-bed to which a swinging arm is pinned. A circular disk which revolves with the work is fastened to this arm, as is also the small handle directly in front of the

attachment. This handle is used by the operator to swing the arm up and out of the way preparatory to removing the perforated shell from the die-holder.

A method commonly used in connection with perforating tools for rotating the shell to be perforated is the dog-notch method. A dog *C*, Fig. 10, is fastened to the ratchet by screws or dowel pins. The end of this dog fits a notch *D* in the shell, called the "dog-notch." The shell is slipped over the die-holder in such a manner as to cause the dog-notch in the shell to engage with the dog on the ratchet. In this way the ratchet can index the shell directly around the die-holder.

There are also a number of other methods used for rotating shells to be perforated. Besides those already described, one may make use of an irregular shaped hole in the bottom of the shell in connection with the driving arbor. Sometimes an irregular shaped hole is required in the bottom of the shell, and in such a case the tongue of the driving arbor may be made to fit this hole, which affords a good driving means. Sometimes use is made of a coaster brake device fastened to the ratchet. The tools used in connection with this device are similar to those already described, having the ratchet in the front of the die-bed, as shown in Fig. 10, with the exception that instead of using a dog, a device working

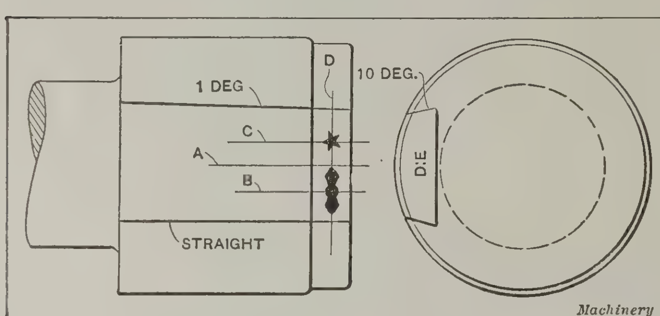


Fig. 8. Die in Position in Die Holder

on the principle of a coaster brake, such as is used on an ordinary bicycle, is fastened to the ratchet. With this device, no notch in the shell is required, as the open end of the shell is simply slipped into this device and given a part of a turn, causing it to be tightly gripped. The press is then tripped and the shell rotated around the die in the usual manner.

In cases where a dog-notch is used and where there is a tendency on the part of the shell to slip in between the dog and the die-holder, which would prevent the shell from being

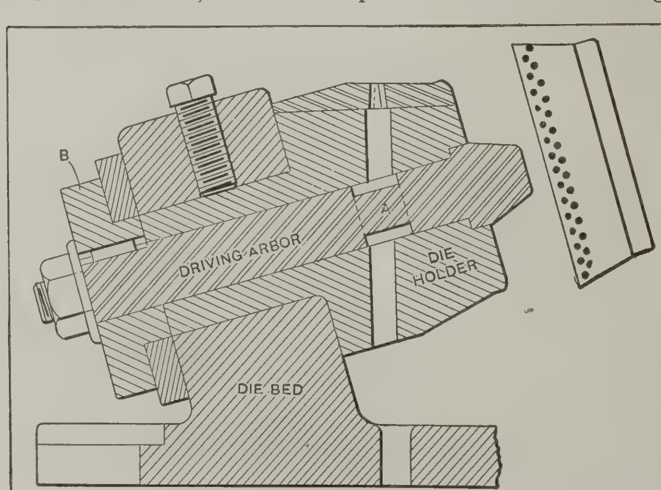


Fig. 9. Die, Die Bed and Holder for a Tapered Shell

properly rotated, the die-holder is turned down as shown in Fig. 10, and the dog is made to just clear the holder. This prevents the shell from slipping in under the dog.

The perforating die shown at *H* is held in the die-holder in the usual way, and is tapered lengthwise at a suitable angle as indicated. In order to afford a support for the die when in use, the bottom of the dovetail channel upon which the die rests is worked out so as to conform tó some extent to the shape of the bottom of the die. This is done on dies where the holes are close together, so as to support the narrow bridges that separate the irregular shaped holes in the die. The best way to do this work is to first work out an open space under the dovetail channel. This space is used for holding the scrap punchings that are prevented from dropping through by a shutter. In working out this space

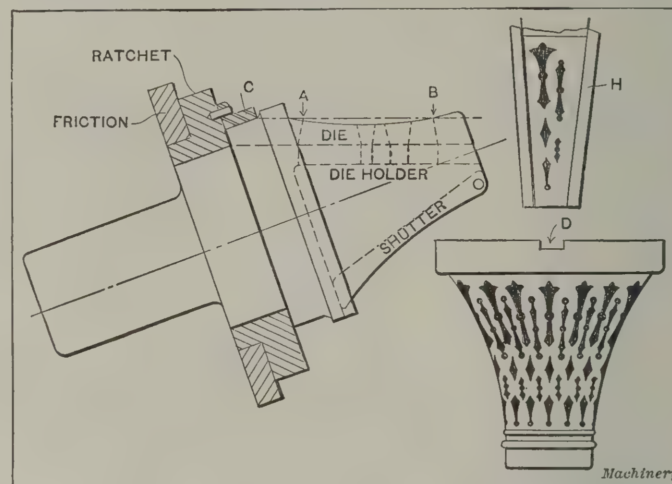


Fig. 10. Die and Holder for Perforating Shell shown to the Right

enough stock is left under the dovetail channel to support the die properly, as indicated in Figs. 10 and 12, after which the openings through which the scrap punchings from the die drop are worked out. The shutter which is shown closed in Figs. 10 and 12, swings open on the shutter pin as soon as the perforated shell is removed from the die-holder.

The construction of the tools in Fig. 12 is similar to that of those just described. At the right is a plan of the die, showing the manner in which the die is tapered lengthwise, which in this case is six degrees on each side. When

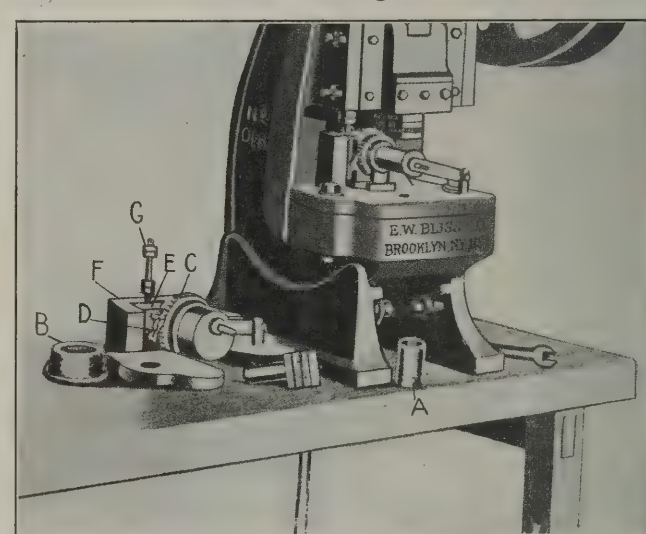


Fig. 11. Tools for Perforating Special Cylindrical Shells

the tools shown in Figs. 10 and 12 are in operation, two rows of holes are cut at every stroke of the press until the shell has completely rotated around the die and all the required rows of holes have been punched out. No device is used with these tools for holding the shells in place while they are rotating around the die, because the position of the die-holder in the die-bed makes it easy for the operator to keep the shell in place.

It sometimes happens that a perforated shell of the general type shown in Fig. 7 is required, with the exception that the bottom is left intact and therefore cannot be used in connection with a driving arbor for rotating the shell. In such a case, the shell is dog-notched and rotated in the manner already described, with the exception that the locating of the dog on the ratchet preparatory to perforating the shell forms an important part in the successful operation of the tools. The reason for this is that when cutting out the scallops of the shell, the dog-notch *C*, Fig. 7, which is used for rotating the shell must necessarily be cut away from the

shell, and must, therefore, be placed in such a position that it will come in the center of the large scrap punching which will be cut out at the last stroke of the press, completing the operation. If the shaded portion shown at *D* in Fig. 7 is the punching resulting from the first stroke of the press, and if the blank is rotating from right to left, then the dog-notch must be located at *C*, central between the two scallops completed by the last stroke of the press, after the whole shell has been perforated.

In order to prevent the punch *A*, Fig. 14, which cuts out the scrap punchings *D*, Fig. 7, from coming in contact with the dog, a short slot is milled in the center of the face of the punch at the back end near the ratchet, so that the punch will clear the dog when that part of the shell containing the dog-notch is cut out.

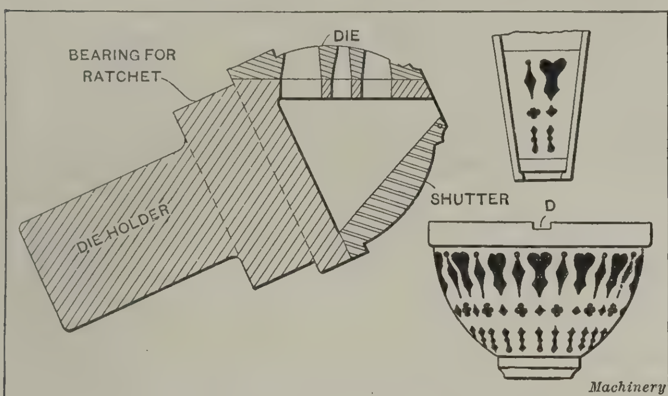


Fig. 12. Die and Holder for Perforating Shell shown

Lay-out of a Perforating Die

Preparatory to laying out the die shown in Fig. 8, the die-blank is carefully fitted to the dovetail channel in the die-holder, after which it is turned up in the lathe in place and highly polished. It is then removed from the die-holder and blued by heating, and again driven into the die-holder, after which it is ready to be laid out. The die-holder is then mounted in the milling machine, the index head in this case being set for twenty-eight divisions, as there are fourteen perforated holes of one design and fourteen of another. With a surface gage and by aid of the index head, the center lines *B* and *C* are scribed. Line *A* is merely drawn to show the center of the die, and the center of each one of the holes in the die should be an equal distance from this line. Center line *D* is next scribed the required distance from and parallel with the face of the die-holder.

In laying out the hole on the center line *B* a small circle of the exact diameter of the circular opening in the center is first scribed. The diamond-shaped ends are next laid out and scribed. The star-shaped hole on the center line *C* is laid out from a master punch which conforms to the required size and shape. In cases where the required number of shells to be perforated does not warrant the making of a master punch, the dies are laid out from the star-shaped punch that is used in connection with the die.

In working out the die, the central hole from which the star design is made is first drilled and taper-reamed from the back to the size of the teat on the master punch, which is equal to the diameter of the circle passing through the bottom of the grooves in the star. The teat of the master punch is then entered into the die and the punch set and clamped to the die so that a point of the star is on line *C*. The outline of the punch is then scribed on the face of the die, after which the die is worked out and fitted to the punch. In order to facilitate matters, the punch is used as a broach after the die is filed to shape. In working out the other hole in the die, on line *B*, a hole is first drilled and taper-reamed from the back for the circular opening in the center. Two holes are drilled and reamed in the center of the diamond-shaped ends. The surplus stock between the drilled holes is then removed and the hole filed to the desired shape.

There are two ways in which a die such as that shown in Fig. 13 may be laid out. One is to lay out the die on a milling machine in a manner similar to that already described. The other, which is most commonly used, is to lay out the die by scribing the design on its face from a master shell which is slipped over the die-holder and has the shape to be perforated upon it already worked out.

The master shell itself is laid out as follows: The shell is fastened to the die-holder by a few drops of soft solder to prevent it from moving. The die-holder is then mounted in the milling machine. The index head in this case is set for twenty-four divisions. In Fig. 13 is shown the laying-out of the die, but the same method applies to the shell. With a surface gage used in connection with the index head, the lines *A*, *B*, and *C* are scribed on the shell. Lines *A* and *C* represent the centers of two adjoining scallops, and line *A* is also the center for the two holes *I* and *H*, while line *B* is exactly in the center between two scallops and constitutes the center line for hole *G*. The lines *E* and *D* are next scribed on the shell, the former representing the height of the ears of the projecting scallops, while the latter shows the height at which the lower curved portions of the pointed scallops converge. After these construction lines are scribed on the shell, the design is readily laid out. The shape of the design is then worked out by drilling and the surplus stock is removed by means of a jewelry saw. The shell is then filed to the desired shape and when completed should be a duplicate of the portion cut out by the first stroke of the press, as shown at *F* in Fig. 7. In filing out a design, care should be taken to file out all the holes central with the center lines *A*, *B* and *C*, and also parallel with a plane passed at right angles to the center of the design, through the shell, in order that the holes may be at their exact required position on the inside of the shell.

It will be noted in Fig. 13 that the large hole *F* in the die is extended past the line *D;* this is done in order to make sure that the large scrap punching *D*, Fig. 7, will be completely cut from the shell. This is especially necessary when the shells vary in length. The dotted line *A*, Fig. 7, is drawn so as to more clearly show the length of the twelve pointed scallops, and their relation to the top of the shell.

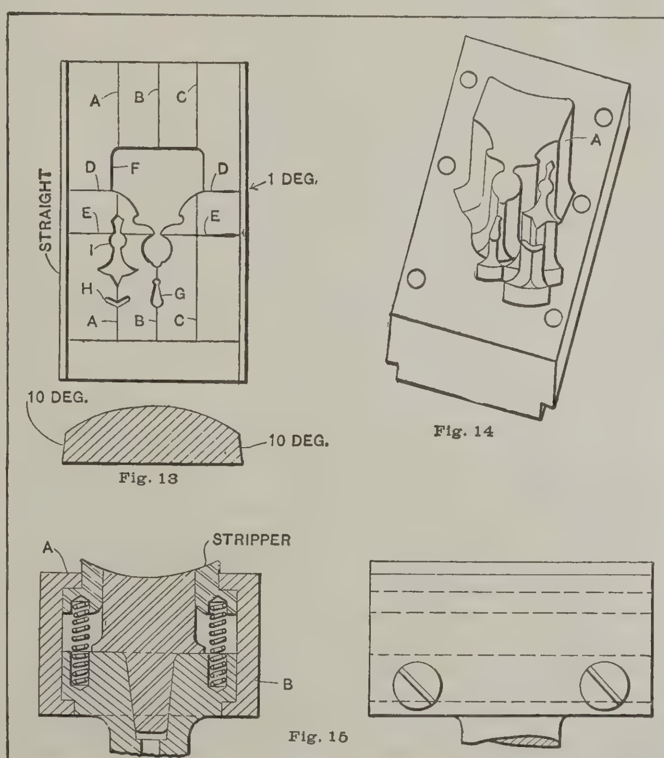


Fig. 13. Laying out a Perforating Die. Fig. 14. Perspective View of Perforating Punch. Fig. 15. Punch Holder and Stripper, showing Punch, Fig. 14, in Section

In drilling and working out the surplus stock in the die Fig. 13, the same general methods that are used for working out an irregularly shaped blanking die are used. First, remove as much of the surplus stock as possible by drilling. When drilling out the surplus stock in the hole *F*, the smaller of the two circular openings between the scallops is first drilled out and taper-reamed from the back to the finish size.

After this, the hole is plugged with a small taper pin that is filed to fit it, and the large hole is drilled and taper-bored in a lathe. The round corners at the opposite end of the hole are then drilled out. These corners are left circular in order to add to the strength of the die and to prevent cracking of the die in hardening. The remainder of the hole is drilled and worked out in the usual way. In working out the small holes G and H, the opposite ends are first drilled and taper-reamed to the finish size, after which other holes are drilled and reamed and the surplus stock is removed with a small broach or jewelry saw preparatory to filing out the die. Hole I is drilled out and the surplus stock removed in a similar manner.

Filing Out the Die Shape

A die used for perforating the sides of cylindrical work is rather awkward to hold, either in the vise or in die-clamps while being filed out, owing to the fact that the face of the die is circular in shape and the sides are dovetailed. For this reason, a die-holding fixture, shown in Fig. 16, is used to hold the die in the vise, die-clamp, or filing machine

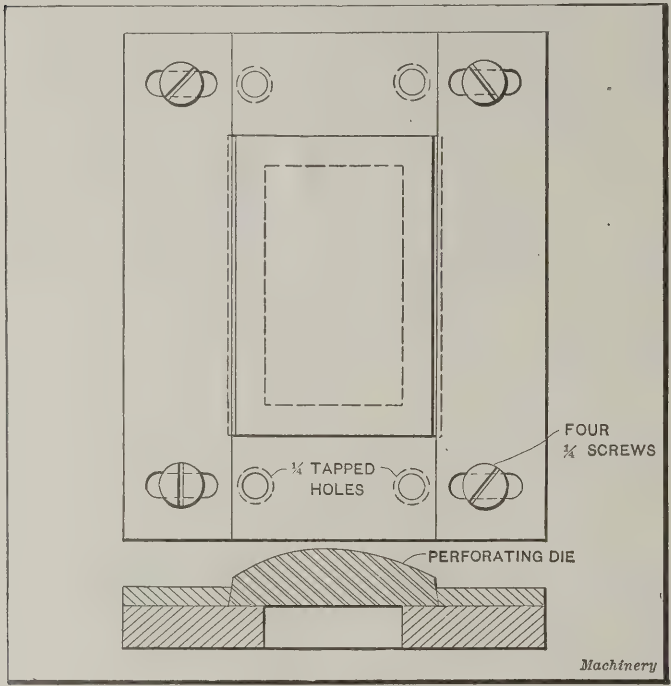


Fig. 16. Device for Holding Perforating Dies while Filing

while it is being filed out. The device shown is adjustable to accommodate various widths of dies.

The most essential points to be remembered when filing out a perforating die are: Use a coarse file for the rough filing and finish with a smooth one. Take care to have the clearance filed straight in order to prevent the congestion of scrap punchings in the die; perforating dies as a rule are not very strong and are often cracked and broken because of neglect on this point. The clearance should not be filed over 1½ degree, in order to make the die as strong as possible; in cases where the holes in the dies are close together even less clearance is necessary, and a very narrow wall that separates two holes is filed almost straight on each side, with just enough of a taper to clear. Care must be taken when filing to prevent the back or the sides of the file from running into that part of the die that has already been finished.

Making the Punch for a Perforating Die

The punch used with the die shown in Fig. 8 is comparatively simple in its construction. It consists of the usual form of punch-holder into which the two perforating punches are driven. The star-shaped punch, after it is fitted to the die and hardened, is driven into the punch-holder in such a position that when it is entered into the die the sides of the punch-holder will be in a straight line and parallel with the die-bed. The tools are then set up in a hand or foot press so that the die and star punch are in proper alignment with each other. The foot treadle of the press is then disconnected from the gate so that the gate which holds the punch-holder in place can be withdrawn from the press without disturbing the punch-holder or the ways upon which the gate slides. The other punch, in its unfinished state, is then driven into the punch-holder and the face is coated with a 1/16-inch thickness of soft solder. The gate of the press is then slipped back into place and the impression of the outline of the die is transferred to the solder on the face of the punch. The punch-holder is then removed from the press and the punch driven out and milled to conform to the soft solder outline of the die, after which the punch-holder is put back into the press, care being taken to see that the star-shaped punch is in proper alignment with the die. The milled punch is then put back in place and gradually sheared and fitted to the die. Each time after the punch has been lightly sheared into the die, the fins and surplus stock are removed and the punch is again entered and sheared a trifle deeper, until it enters the die at least ¼ inch.

The hand or foot press is very convenient to use when fitting perforating punches to their dies, because the construction of the press makes it possible to handle the gate conveniently and to keep the punches in proper alignment with the die.

In making perforating punches such as shown in Fig. 14, the punch-holder is first machined to the desired shape and size, after which the taper hole for the shank of punch A is reamed. The shank of the punch is then turned and fitted to the punch-holder and driven into place. The face of the punch is made to conform to the outside diameter of the shell and is then clamped to the face of the die and the outline scribed on it, after which it is milled to shape and sheared and fitted to the die. Before scribing the outline of the die on the face of the punch, care must be taken to see that the punch is set in the proper relation with the die, so that when the finished tools are set up in the press, there will be no necessity for elongating or widening the slots in the die-bed used for clamping the die to the bed of the press, due to the punch not being laid out central with the die.

After the first punch A has been fitted to the die, the holes for the other three punches are laid out so that the cutting part of the punches will be as nearly central with the shanks as possible. Holes are then drilled and reamed for the shanks, and when this is done punch A is hardened. The reason that this punch is hardened before the other punches are fitted to the die is that if the punches were all sheared and fitted together and then punch A should spring in hardening, it would cause great difficulties in again bringing the punches into proper alignment with the die. After punch A has been hardened and driven back into the punch-holder, the shanks of the other three punches are turned up and fitted to the respective holes into which they are afterwards driven. The shanks of these punches may be made either straight or tapered, but should be a good driving fit and should have shoulders bearing against the punch-holder.

Before the punches are driven into place, the die and punch A are set up in the foot press and properly aligned with each other. The gate of the press is then withdrawn, the three punches are driven into place, and the faces coated with soft solder. The gate of the press is then slipped back into place and the outline of the die transferred to the punches, after which they are driven out and milled separately in the milling machine. Sometimes the punches cannot be driven out from the back of the punch-holder, because if the holes for these punches were drilled through they would run into and weaken the shank of the holder. In such cases holes are drilled from the side to meet the shank holes, in order to allow a taper drift to be used for starting the punch so that it can be removed.

After the punches have been milled, they are driven back into the punch-holder and are sheared and fitted into the die, as previously described. The punches, of course, are lined up perfectly with the die so as to enter into their respective holes as one single punch. After the punches are hardened they are sharpened by holding the punch-holder in a special grinding fixture and drawing the punches back and forth across the face of a wheel of about the same diameter as the shell to be perforated. It will be seen in Fig. 14 that the base of the punches is strengthened by milling the punches so that there is a liberal fillet between the shoulder

of the punch and the milled-out shape. This also tends to prevent distortion in hardening.

The Stripper

The stripper serves three purposes: it strips the metal from the punch; it supports the small punches by preventing them from springing; and it tends to keep the perforated shell in shape by preventing it from bending or becoming "kinked up." The commonly used stripper construction is shown in Fig. 15. The face of the stripper conforms to the outside diameter of the shell. It is drilled and worked out so that it is a sliding fit on the punches. The shoulder part of the stripper bears against the bottom lugs of the side pieces *A* and *B*, which are fastened to the punch-holder and prevent the stripper from being forced off the punch. Six spiral springs exert the required pressure on the stripper. When setting up the tools in the press, the stripper is forced back about ⅛ inch and two pieces of, say, No. 31 drill rod are placed between the stripper and the bottom lugs of the side pieces, which keeps the stripper out of the way while the punch and die are aligned with each other.

In conclusion, it may be mentioned that perforating dies of the type described are sharpened on universal grinding machines. Owing to frequent sharpening it is sometimes necessary to raise them slightly by putting shims of sheet steel under the dies. These shims are drilled and filed out to conform to the holes in the dies, in order that the scrap punchings may drop through.

* * *

INTERESTING DEVELOPMENT IN HIGH-EFFICIENCY GENERATORS

In speaking before the American Society of Swedish Engineers, Brooklyn, N. Y., on "Generating Apparatus used for Wireless Telegraphy and Telephony," Mr. E. F. Alexanderson, of the General Electric Co., Schenectady, N. Y., described an interesting type of machine which he has developed for obtaining very high frequencies. In the generator described, a steel disk resembling the rotor of a steam turbine and having six hundred slots, is used. This steel disk rotates with its edge between the pole faces of the stator, at a speed of 20,000 revolutions per minute. Brass plugs are riveted into the space between the steel teeth in order to reduce the air resistance. The diameter of the steel disk is 12 inches. The generator is driven from an electric motor by gearing similar to that used for reducing the speed in De Laval steam turbines, except that in this case the gearing is used for increasing the speed. With this machine it is possible to obtain 100,000 alternations per second and with the aid of a special winding and 800 polar projections on the disk, 200,000 alternations per second have been obtained. High-frequency generators of this type will probably prove especially valuable in wireless telephony, the success of which depends largely upon the possibility of producing currents of high frequency. The development is also of great value in the wireless telegraphy field as it makes possible the sending of messages over greater distances, and also provides a means for non-interference with other wireless apparatus, as it is possible to tune the various instruments so as to receive only certain messages, in a way not possible with the lower frequencies produced by the spark system.

* * *

The discovery of means for burning explosive gases, that is, gases mixed with air just sufficient for perfect combustion, described in the May number, was, it appears, erroneously attributed to Prof. William A. Bone of Leeds University, Leeds, England. Prof. Charles E. Lucke of Columbia University, New York, described the same process, in effect, in a paper presented before the American Society of Mechanical Engineers in 1901. Prof. Bone's work, which showed the possibility of attaining temperatures from 2900 to 3600 degrees F. on the surface of porous firebrick with great economy of gas, appealed more to the popular mind as having direct application to cooking and heating. Hence the great interest in the idea.

* * *

Repeated melting of manganese bronze gradually lowers the ultimate strength and elastic limit as well as the hardness of the metal.

SOME TOOLS USED IN THE MANUFACTURE OF SMALL STEEL BALLS*

By A. G. BLACK†

Very small steel balls—say of from 1/32 to 1/16 inch in diameter—are handled in a somewhat different manner when being manufactured than are the larger sizes. The reason for this is simply that more delicate machinery is required on account of the small sizes dealt with. The best idea of how small a 1/16-inch ball really is may be gathered from the fact that there are 28,840 balls of this size to a pound, or about 1800 balls to an ounce. Comparing this with 1/2-inch balls, we find that there are only fifty-five in a pound, or less than four in an ounce.

In the following will be described the methods that were used in a factory with which the writer was connected several years ago, for making balls of small sizes.

The forgings were made from annealed crucible steel wire, the diameter of which was about 0.002 inch smaller than the diameter of the finished ball. The stock was upset enough in the forging operation to make the blank about 0.010 inch

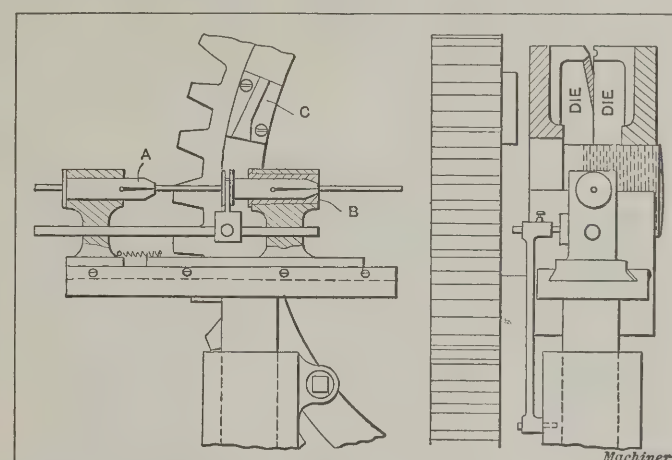


Fig. 1. Diagrammatical Outline of the Main Features of the Ball Blank Rolling Machine

larger than the finished ball. The forgings were made in a Simonds forging machine, of the same general type as described by Mr. Grant in the February number of MACHINERY, in the article entitled "The Manufacture of Steel Balls." The machine was remodeled, however, to use the platen style of die as shown in Fig. 1, this being accomplished by cutting off the extending projection on the large driving gear and mounting one-half of the circular die on the hub of the gear, the other half being mounted on the shaft that projected through the center of the hub and revolved in the opposite direction. A gas jet was located near the point on the dies where the stock entered. In this way the stock was heated to the required heat for rolling.

The wire was furnished in a coil and fed off from a reel, an automatic feeding device being provided having one stationary, spring chuck *A*, Fig. 1, and one sliding spring chuck *B*, similar to those used on automatic screw machines. A cam *C* was provided on the side of the main driving gear to open and close the sliding chuck. When the stock fed into the dies, the cam opened the chuck and also carried it back against the action of a spring for another feed, and locked it ready for the next cycle. The stationary spring chuck held the stock from moving while the rolling operation took place. The machine could cut off and roll 75,000 blanks per day.

After the forgings were made, the blanks were passed between two large hardened revolving plates in order to remove any fins or inequalities in the blank. They were then hardened before grinding, which latter operation was done in a machine similar to the dry grinder described by Mr. Grant, except that the machine was smaller. The writer also added an improvement which consisted of a spring suspension of the upper ring which rotated the balls as indicated in Fig. 2. Four coil springs *A* were mounted between the upper ring

* See "The Manufacture of Steel Balls," MACHINERY, February, March, and April, 1912.
† Address: 53 Westford Ave., Springfield, Mass.

and a plate above it as shown, the upper ring being driven from this plate by four stud bolts. In this way it was possible to place any amount of pressure required upon the balls. With this arrangement the emery wheel and the rings would last much longer, because of the reduction of wear, as the upper ring was allowed to spring away from the wheel when a new set of blanks, which were not absolutely round, were first put into the grinder.

Another improvement consisted in making an adjustable emery wheel fastening for preventing the emery wheel from running out of balance, due partly to the inequalities of the wheel itself and partly to the wear of the spindle bearings.

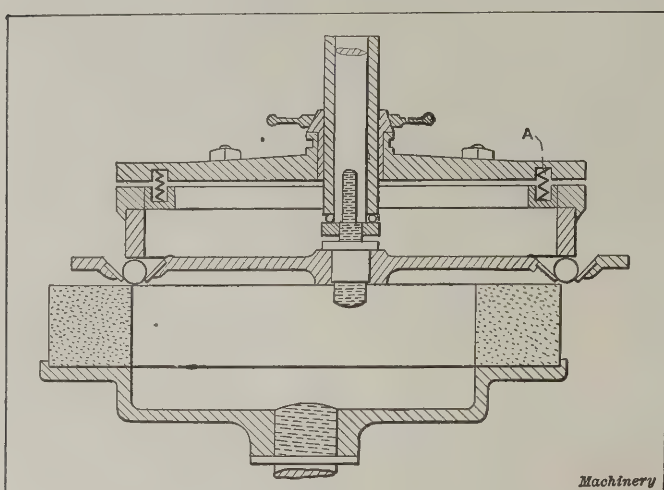


Fig. 2. Spring Balanced Dry Grinding Machine

An arrangement was introduced consisting of four wide jaws in the wheel plate, as shown in Fig. 3, which gripped the edge of the wheel in a manner similar to that of a lathe chuck, but which had surface enough to cover a fair portion of the wheel diameter. In this way, the wheel could be adjusted and balanced every time a new wheel was mounted.

The balls were dry ground to within 0.002 inch of the finished size, after which they were lapped with emery and oil, using a set of cast-iron rings. These were fitted to sensitive bench drill presses arranged in banks of six, attended by one operator. After the oil finishing grinding, the balls were polished and inspected. This last operation was done by an auto-

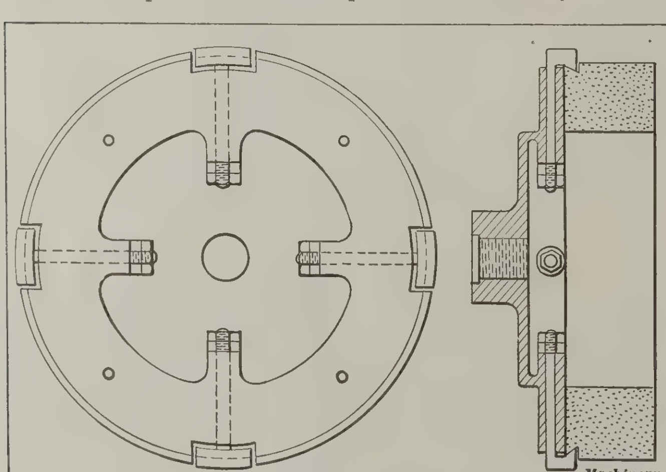


Fig. 3. Faceplate and Chuck-jaws for Holding Grinding Wheel

matic device which the writer designed and built, the outlines of which are shown in Fig. 4.

The principle of this machine was to feed the balls from a hopper under a fixed magnifying glass about 2¾ inches in diameter, focused to suit the operator. The balls would then remain under the glass for six seconds. The operator held a steel magnet in each hand, and with her elbows or arms resting on the table at each side of the glass lens, was ready to pick out any balls which appeared defective to her. If they were all perfect, she would merely wait until the balls turned half a revolution, exposing the other half for six seconds more. Then, in order to expose the periphery whch had not yet been directly under the inspector's view, the balls were turned one-quarter of a revolution so as to bring the part but imperfectly seen in the two previous operations squarely under the glass; then another half turn was made and in that way all the parts of the balls were exposed and could be carefully inspected. After this, the feeding plate would draw out from under the glass and the balls would fall into a drawer, after which the plate would be returned to the hopper, bringing out another lot of balls ready to be inspected. This last operation required also six seconds, which gave the operator an opportunity to temporarily rest her eyes.

The various movements were timed by a cam. When changing from one size of ball to another it was only necessary to slip off one cam and put in another adapted for the desired size, and also to change the feed plate. The device permitted of inspecting balls ranging in size from 1/16 to 1/2 inch diameter. The method was very efficient and six girls were able, in this way, to handle the work which required twenty inspectors to do in the old way. The method was also more positive, and the chances of defects slipping by the inspector were not as great, as each ball was fully exposed to view from all sides.

Some of the cam motions mentioned, as, for instance, that for feeding the balls from under the hopper, were constant

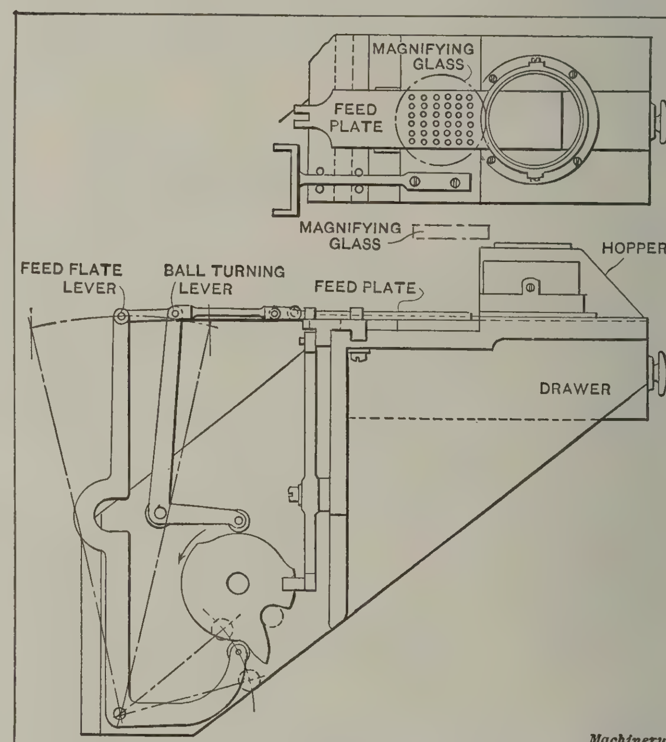


Fig. 4. Main Features of Ball Inspecting Machine

for all sizes of balls, but the cam operating the sliding plate that rolled the balls over was different for different sizes, as the plate had to travel further for the larger balls than for the smaller. The lens of the magnifying glass was large enough so that one could see 64 one-quarter-inch balls conveniently, and as there were often but one or two of these balls to be picked out at each movement, the operator had plenty of time, and with both hands free could pick them out very rapidly. A lever was also provided to throw out a clutch mounted on the driving pulley hub, so that the operator could stop the machine immediately, if necessary.

One difficulty that had to be overcome consisted in the balls clogging and refusing to roll out from a small opening. This difficulty was overcome by bridging over the outlet by a partial baffle; then the balls would easily feed out in the shallow depth under the bridge where they were always free to roll out and drop down an incline. This prevented clogging and no agitator was found necessary. The device was never patented because the president of the concern with which the writer was employed believed that if a patent was applied for the principle would become known to all ball manufacturers, and they would work out the same idea in a somewhat different manner. The gaging was done by a machine similar to that illustrated by Mr. Grant.

WATCH CASE MANUFACTURE—2

Before a watch case is fitted up, that is, on a hinged case, before the cap, back and bezel are joined, it is necessary to fit and solder the pendant into the case center. The majority of pendants on watch cases are made from rolled-plate in two pieces, but some are made in one piece by a number of successive press operations. The pendant is used for holding the bow and the stem setting mechanism.

The crown *b* shown in Fig. 8, which is used for operating the setting mechanism, is also made from rolled plate. The press operations on this part have previously been described in the December, 1909, number of MACHINERY, so that a short summary of the most important operations will be sufficient. The first operation is to make a blank and draw it up into a

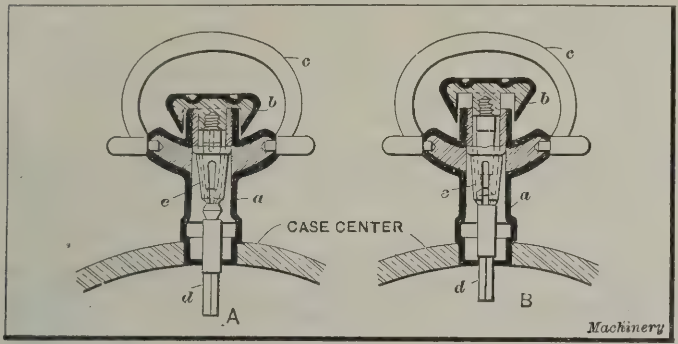


Fig. 8. Pendant Set in the "Up" and "Down" Positions

cup, both operations being accomplished at the same time in a double-action press. This cup is then cut to the desired length in a small sawing machine, after which it is passed through a corrugating die. A core of the required shape, which has been made in an automatic screw machine and corrugated in a die in the punch press, is then inserted and the two parts—cup and core—are placed in a swaging die. The upper part of the die is so formed as to shape one end of the crown, while the lower die forms the other end.

After the crown is completely formed, it is taken to an automatic screw machine where it is counterbored, drilled and tapped to fit the pendant and pendant set. This machine is equipped with a magazine attachment which was illustrated in an article entitled "Magazine Attachments—1," in the February, 1912, number of MACHINERY. This, with the exception of polishing, completes the operations on the crown.

The bow *c*, Fig. 8, or ring, as it is sometimes called, is made from either solid gold or gold-plated stock, drawn out into wire. Bows made from solid gold are used on solid gold watch cases, and also on some filled cases. The operations followed in making the solid bow are simple and need no description. It might be well, however, to state that it is first blanked from the flat sheet about 1/16 inch thick to approximately the desired shape, then the center is pierced out, and finally, it is completely formed in an embossing die held in a hydraulic press. The flash is then trimmed in a trimming die and the inside ends of the bow milled on a milling machine to fit into the holes in the pendant.

The operations for making the bow from drawn wires are a little more difficult. The material from which the bow is made is first blanked out and drawn up into a cup, and then by successive drawing operations, it is extended to such a length that it can be completely drawn in a draw bench. The drawn wire is then cut up into pieces of the desired length and drawn up in dies. After this operation, the bow is bent around to the desired shape in a simple bending fixture. As bows are generally plain and have no small crevices to polish out, the polishing is very easy.

Construction and Operation of the Pendant Set

On watch cases provided with a pendant set, it is necessary to pull out the crown before the hands can be rotated independently of the motion transmitted to them by the gear train. Some means, however, has to be provided so that the crown cannot be easily pulled out, or the utility of this simple device would be destroyed. This is accomplished by screwing a stem *d*, Fig. 8, provided with a cone shoulder into the crown, and also screwing a split "chuck" *e* into the pendant *a*. Now before the crown, which is shown "down" at *A* can be pulled out, the split chuck *e* has to be expanded as at *B*, by the cone shoulder on stem *d*, the necessary pull being sufficient to prevent the setting mechanism from being operated accidentally.

The stem *d* presses on another squared stem which is used in operating the setting mechanism (see "Setting Mechanisms" in the May number of MACHINERY), and when stem *d* is pulled out by the crown as shown at *B* it allows the setting mechanism to operate the hands.

Polishing Watch Cases

A watch case, as a rule, is given a very high polish and is free from scratches and imperfections. The methods employed in polishing a watch case are interesting, and as they differ slightly from other polishing work, it might be well to give a short description of the materials used and the order of the operations. After the case is jointed and assembled, it is rough polished on a rag wheel with dry tripoli, also called "rottenstone," on it. For additional rough polishing, a hair brush is used and lard oil and tripoli are applied as an abrasive. The second polishing of the inside of the cases is accomplished with an elk skin polishing buff supplied with rouge and alcohol. The outside of the case is polished with a rag wheel and rouge. The center of the case is brushed with a hair brush and hard rouge.

The third polishing is done after the case has been pinned and fitted. The inside of the back and cap are polished with elk skin, soft rouge and alcohol, the outside of the case being

Fig. 9. Hand-operated Engine Turning Machine

polished with a rag wheel and hard rouge. All plain parts and shields are polished with rouge and elk skin, after which an additional polishing is accomplished with soft rouge; then the cases are washed in ammonia water and soap and dried. The drying is done in a heated drying box. After being dried the cases are cleaned with chamois and then sent to the inspector who examines them to see that everything is perfect. The case also passes through numerous other inspections during the course of its manufacture.

Engine Turning

Engine turning, another name for engraving by machinery, consists in cutting various designs or patterns on the backs of a watch case or bezel. Thousands of patterns are cut, and the designs vary considerably. Some types of patterns, of course, require slightly different methods for their production

and in many cases patterns can only be cut on certain types of machines, or hand engraved. There are at least six distinct types of engine turning machines employed on this work. Three of them, the most interesting ones, will be described in the following.

Hand-operated Engine Turning Machine

The engine turning of the straight-line variety cut in the backs of watch cases is accomplished in the hand-operated machine shown in Fig. 9. The back or bezel, whichever it may be, is held in a chuck *A*, which, if desired, can be rotated by hand or can be indexed by thumb-screw *B*. The screw on which thumb-screw *B* works, has a worm formed on its lower end meshing with a worm-wheel on the head. This device is brought into play when it is desired to cut lines crossing each other at right angles or any other angle.

For producing straight-line work on this machine, the vertical slide carrying chuck *A* is simply moved up and down by the operator, by means of the hand-crank *C*. The motion from this crank is transmitted by grooved pulleys, belting and chains to the vertical slide *E*. This slide is kept in the "up" position by a weight attached to a string *F*, which runs over the grooved pulleys *G*.

The table *H*, carrying the tool-slide *I* in which the tool *J* is held, has a circular adjustment, so that the center line passing through the point of the tool is always at right angles to the face of the back being operated upon. This adjustment is controlled by the knurled thumb-screw *K*, which is rotated by the operator a slight amount after each cut. The tool-slide *I* is advanced to bring the tool in contact with the work by hand, the operator gripping the spring "handle" *L* by the first finger and thumb. The depth to which the tool advances into the work is governed entirely by the pressure given to this slide; and it requires considerable experience before an engine turner can produce lines of a uniform depth. It is simply a matter of "fine touch," as no stop is provided for the forward movement of the slide. The slide is returned by a spring which is compressed when the slide is advanced. The work is viewed while under progress through the magnifying glass *M*.

Various patterns are secured by irregular faced strips *N* held vertically in the slide *O*. This slide can be moved to bring any desired pattern into operation by means of a hand-wheel, not shown. The patterns impart an oscillating movement to the head (which is also equipped with a horizontal slide) at the same time that it is moved up and down by the hand-crank *C*. The spacing of the lines is effected by a pawl and ratchet, not shown, which move the slide carrying tool *J* along, giving any desired width of spacing.

Electrically-operated Engine Turning Machine

The engine turning machine illustrated in Fig. 10 is electrically operated and is used for producing the "barley corn" engine turning, as it is called. The back that is being engine turned is held in a split chuck *A* which is tightened on the work by a knurled nut. The entire mechanism is driven from a shaft under the machine, which, in turn, derives power from the countershaft through belting.

The spindle *B*, which carries the work and is rotated by spur gears from the lower shaft, is mounted in an oscillating head *C* called a "cradle." This head receives its oscillating motion from a cam held on the lower shaft, which is provided with a series of projections and depressions that impart the oscillations to the head. The "electric pattern" *D*, as it is called, is driven by spur gears from spindle *B*. The tool-slide *E* that carries the holder in which a cutter is retained is also operated from spindle *B* through spur gears, a universal joint and bevel gearing.

The electric pattern *D* is made by engravers who cut out the portion to be "barley-corned" and fill the depression with a non-conductor of the electric current. A steel needle *F*, under spring tension, runs or is pressed against this pattern and is fed in from the outer circumference towards the center at the same rate of travel that the tool makes across the face of the work, the latter also being traversed in the same direction.

The tool-slide *E* which is operated in the manner previously described, carries a taper guide which through a roll, lever and crank, forces up the rod *G* carrying needle *F*, at the same time as the tool is fed from the outside circumference to the center of the work. This system of levers and cranks constitutes a pantograph arrangement which can be changed to reduce the pattern for any size of watch case. The roll is kept in contact with the pantograph form, so that the motion transmitted to the cutting tool will conform to the shape of the back, by means of a string *H* to which a weight is attached.

In operation, as the needle *F* passes over the non-conductor on the pattern *D*, the electric circuit passing through the armature *I* is broken so that plate *J* flies back, and in so doing operates the tool-slide *K* through lever and crank connections, thus forcing the tool into the work. When the needle *F* passes over the brass portion of the pattern the circuit is closed and the reverse action is imparted to the tool-slide *K*, that is, the tool is withdrawn from the work. This

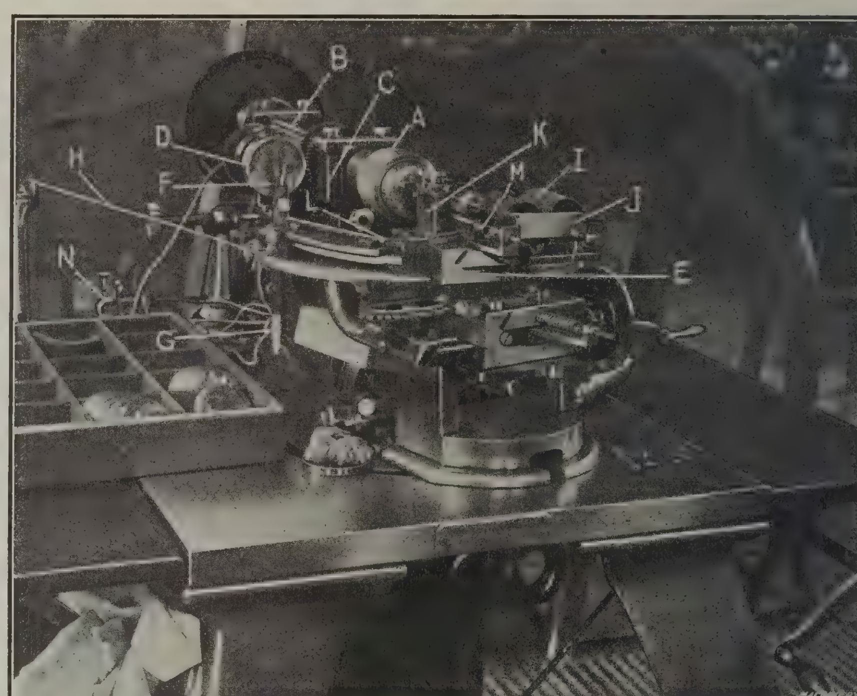


Fig. 10. Electrically-operated Engine Turning Machine

action is repeated until the engine turning is completed, when the machine is automatically stopped.

The tool-slide *K* is withdrawn to remove the work by a handle *L* which, when pulled back, brings back the slide and releases it from the tension of the spring *M*. This spring has sufficient strength to keep the tool in contact with the work, when the electric circuit is broken. The barley-corn effect is governed, of course, entirely by the cam on the shaft under the machine, but the pattern can be made either coarse or fine as desired, by altering the change gears that transmit motion from the spindle *B* to the main tool-slide *E*.

Swiss Brocade Machine

The interesting machine shown in Fig. 11 is for "brocade" or "Swiss machine" work, as it is called, which is simply a special class of engine turning resembling in appearance the regular work on currency bills, which is produced by a geometric lathe. This brocade machine was designed and built in Switzerland and is a marvel of mechanical ingenuity. As an engine turning machine its possibilities are practically unlimited, and it is doing away with a large amount of the work previously accomplished by skilled engravers. The work, when being operated on, is held in a split chuck *A* by a knurled nut. The power for operating the entire mechanism is transmitted from a countershaft by round belting running over grooved

pulleys C, D and E, up to the main driving shaft at the rear, not shown. This shaft drives the front shaft F, which through change gears G operates the spindle carrying the work. This spindle can be centered, that is, located in the desired relation to the other mechanism when starting a pattern, by means of the screw and worm-wheel H; this turns around the sleeve or spindle carrying the work.

This machine is supplied with two pattern plates I and J. Plate I is made of hard rubber and is called the outline pattern plate, while plate J is made of cast brass and is called the filling-in pattern plate. Plate I is rotated by a spur gear held on a shaft at right angles to the rear driving shaft, and is driven from the latter by bevel gears. Plate J is also driven from the shaft which is at right angles to the rear driving shaft, through bevel gears and change gears K.

The faces of plates I and J are provided with the desired patterns and transmit up-and-down oscillating movements to the tool carrier M. The movement is transmitted by steel points held in vertical brackets N (only one can be seen), which are fastened to a dovetail-shaped bar operated by a pantograph arrangement. From this bar, motion is transmitted through a universal joint and a shaft running parallel with and under the tool-slide M. As tool-slide M is fulcrumed at a point directly under the point of the cutting tool, it is consequently given an up-and-down oscillating movement by means of this shaft and levers connected to it. By changing the position of the ends of the universal joint, the tool O can be put into the work to any desired depth.

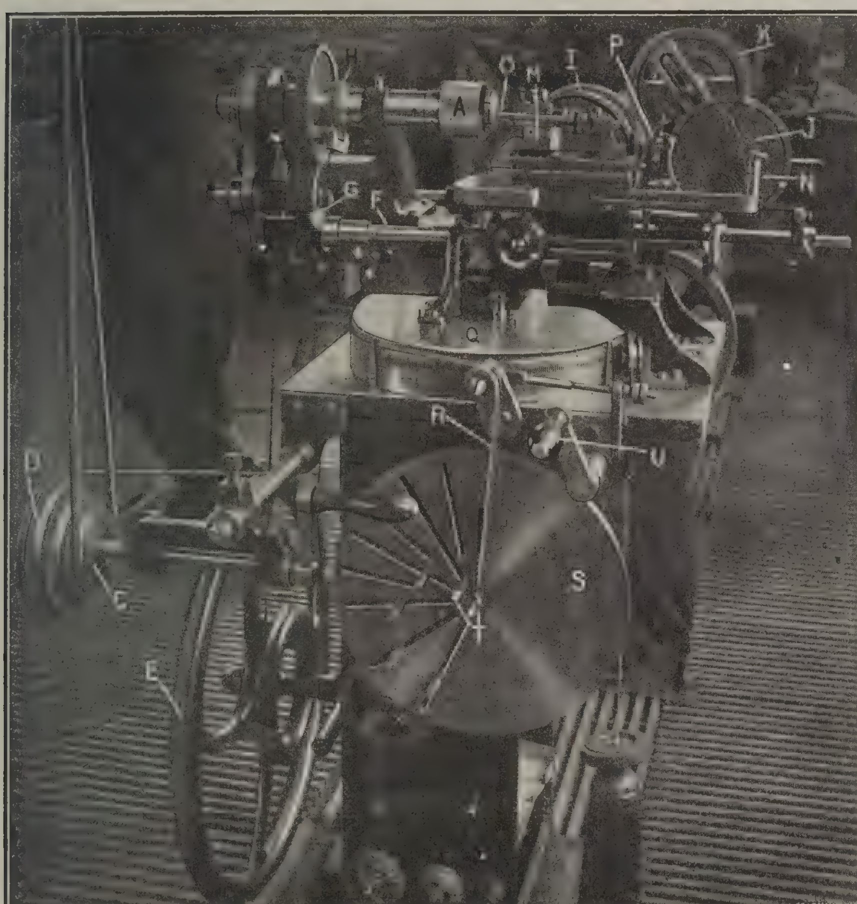


Fig. 11. Swiss "Brocade" Machine, which produces Special Designs of Engine Turning

The ratio of the gears driving the filling-in pattern, to those operating pattern I, can be changed so as to alter the pattern of the work. Barley-corn filling-in cams P are also provided which have a series of indentations and projections distributed around their peripheries. These cams have slightly different patterns, and any one of them can be brought into operation as desired. The cams are held on a shaft which is driven from the holder carrying plate I, by bevel gears, the rear face of the plate-holder being formed into a bevel gear. Through a steel pointer, not shown, these cams P also give a slight oscillating movement to the tool-holder M carrying the cutting tool O, which produces a neat barley-corn pattern in the bottom of the depressions, where neither of the other two patterns act.

The work-holder head is mounted on a circular table Q, which is rotated to swing the head to conform to the shape of the back by a wire rope R. This rope is wound partly around the table and is fastened to it by a dog, and is also fastened to dogs T held on the faceplate S. This faceplate is provided with a series of radial slots in which dogs T are located, the latter being adjustable to any position. It is also provided with a spur gear at the rear, and is driven through change gears from the main driving shaft. As the faceplate rotates, it unwinds the wire rope from table Q, and consequently pulls the latter around, which action swings the head carrying the work. The table is graduated and a pointer is provided so that it can always be started from the same point, after it has been swung around by the hand-crank U to insert a new piece of work in the chuck. The unwinding of this wire R imparts a movement to the head which approximates closely an involute curve.

The principle employed in driving the front shaft F for rotating the work is both interesting and novel. From the preceding description, it will be seen that the work-holder must swivel through an arc, and also be rotated at a constant speed irrespective of its position. This is accomplished by double-face miter gears called "A gears." These gears roll on each other and the center of contact is always directly in a vertical line passing through the cutting point of the tool O. If this were not the case the pattern would not be accurately reproduced.

A pantograph arrangement of levers compensates for the size of the case being brocaded, and the position of the dogs T is altered to provide for the changes in the shape of the back. The slide on which the pantograph arrangement of levers, tool-slide M and pattern plates I and J are held is traversed by a worm and worm-wheel from the rear driving shaft. The cutting tool starts at the outside circumference of the case and works in towards the center. The machine is automatically stopped when the work is completed by a bracket held on the slide carrying the pantograph arrangement, which comes in contact with an adjustable stop screw in a lever held under a latch. This bracket pushes the lever from beneath the latch and shifts the belt on the countershaft, thus stopping the machine.

Special Designs and Colored Gold

Many watch cases are furnished with elaborate designs such as plated work of colored gold, and gilded. The gold-plated patterns are cut out in punch presses and soldered onto the back of the watch. The patterns are made in all sorts of color, which is accomplished by alloying coloring matter with the gold when melting. Most of the designs cut on the Swiss brocade machine are gilded in an electric bath, colored gold being used as the annode. The part of the back not to be gilded is coated with shellac, which is removed in hot water after the work has been gilded.

* * *

Some time ago there was exhibited before the French Academy of Science a small dynamo, the total weight of which is claimed to have been only one-fifth ounce. This machine measured about 0.6 inch in height and length. The diameter of the armature was about one-quarter inch, and the magnet was wound with silk-spun wire 0.002 inch in diameter. The total length of the field wire was about five feet. The collectors and brushes were constructed exactly as in large dynamos. When run as a motor, the machine consumes about two amperes at two and a half volts and runs at a very high speed, making a humming noise like a large insect.

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MECHANICALLY-GUIDED WELDING AND CUTTING MACHINES

The mechanically-actuated oxy-acetylene torch for cutting shapes from iron and steel plates, described in the July number, is one of the most interesting developments in metal working apparatus brought out in the past decade. The oxy-acetylene torch fed with an excess of oxygen becomes a cutting tool of extraordinary efficiency, making a narrow clean "saw" cut of any desired pattern at a speed in thick plates that cannot be equalled by any existing machine tool. Mounted on a pantograph frame, the torch is made to follow a pattern traced on a drawing, and the rate of traverse is fixed by an electrically driven feed wheel. Being capable of cutting steel three inches thick, the apparatus should obviously be of great value in die making.

The use of a gas flame as a cutting tool evidently is capable of still greater development when the torch is guided and traversed mechanically. The flame is used at its highest efficiency, and the shapes produced require a minimum of finish to meet the requirements of many lines of metal-working. The process can be regarded as another of the auxiliary processes of which grinding, drawing, extrusion and swaging are examples, that extend the economical possibilities of metal working, and thus directly promote the usefulness of the so-called "standard" machine tools in those fields for which they are best adapted.

* * *

TOOLMAKING AND EFFICIENCY

In these days of interchangeable manufacturing, when the tool designer and toolmaker are chief factors in determining the kind and quality of accessory equipment provided for manufacturing, and, therefore, to a large extent in determining the efficiency of the production departments, their attitude toward efficiency assumes great importance. The production of fine tools, jigs and fixtures is to some degree an artistic job, requiring men who love the work and exercise their ingenuity because they love it rather than for the wages paid for the work. To men of this disposition some of the principles of higher efficiency in shop management as applied by enthusiastic organizers are very distasteful. This mental attitude of the expert toolmaker, as expressed in the following paragraph, taken from a recent letter, is important:

"I have been through the mill—made master plates, and all classes of tools for the finest and most accurate instruments.

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Too much is said by most writers regarding speeds, cuts, angles of tools, etc., for their articles to be of value to a toolmaker. A toolmaker is not working on a premium basis, nor is the nature of the work such that a table of speeds could be compiled that would be worth a row of pins, and a table of angles, etc., simply confuses a young toolmaker and especially one who is endeavoring to get the rudiments of toolmaking by study."

While it is undoubtedly true that the data so useful to the machine shop in promoting efficiency have little direct application to the toolroom, we believe that toolmakers generally should have a clear idea of shop conditions and the importance of speeds, feeds, cuts, cutting angles, etc. A toolmaker who has been a machinist and has developed the artistic quality and skill of the toolmaker is likely to be more practical and efficient from the production standpoint than one who has been a toolmaker all his life. Toolmakers should guard themselves from becoming absorbed in their specialty to the exclusion of the practicalities of the shop. Too much concentration on one thing makes for narrowness, and the narrow man is not a desirable development in any walk of life.

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SAFETY APPLIANCES AND THE WORKMAN

Some years ago, when the agitation for safety devices in work-shops began to be carried on in a systematic manner, it was directed mainly towards the manufacturer, exhorting him to install devices to safeguard his workmen, and this agitation has in the last few years produced the desired effect with many large concerns. But as these devices became more numerous it was found that in many instances the problem was not solved, for a second difficulty arose—that of inducing the workmen to make proper use of the safeguards installed. Men who have been accustomed for years to working around dangerous machinery not provided with adequate protective devices, are liable to develop a spirit of bravado and ridicule new devices intended to safeguard them. Instances are recorded where workmen have deliberately removed the safeguards, claiming that they were unhandy and hindered them in their work. In some cases, no doubt, safeguards may have been improperly designed and caused inconvenience to the workmen, but it is probable that in the majority of cases the objections of the workmen have been due to prejudice towards innovations.

In order to counteract this opposition of the workmen towards safety devices, it is necessary that the management should educate them in the proper use of such appliances. A notice such as the following does not reflect credit upon its originator: "Use the accident guards; if any workman does not intend to use these wherever possible, he will please report to the office for his pay." Instead of securing the cooperation of the workman in preventing accidents, such a notice will merely arouse his antagonism. One firm that has been remarkably successful in reducing the number of accidents in its shops has made use of an entirely different method. When new safeguards were placed on the machinery, their men were thoroughly instructed how to work without being inconvenienced by the appliance. They were given an opportunity to complain if they found that the safeguards interfered with their work; and, if practicable, the design was altered to suit the conditions. In this way, the cooperation of the worker was secured, and security against accidents was increased. There is, perhaps, no condition where cooperation between the management and the workmen is more necessary, nor where it results in a better understanding between employer and employes, than when they meet on common ground, in an endeavor to prevent accidents in the shops.

ELIMINATE THE HUMAN FACTOR

On July 4 forty people were killed outright and many injured by a rear-end collision on the Lackawanna Railroad at Gibson near Corning, N. Y., where an express running at full speed crashed through the rear cars of a passenger train. This train was protected by a flagman and by automatic block signals, but these were not seen by the engineer of the express, probably because of a fog which prevailed at the time. The present "safety" system is reasonably safe, so long as the employes are alert and watchful, but it is not proof against carelessness or negligence. The block signal may be set for danger, but so long as the engineer stands between it and the throttle, there will be wrecks and loss of life. To prevent them, the elimination of the human factor is necessary.

There are various inventions for automatically stopping a locomotive in case of danger, and if none of them are perfect they can probably be made as nearly so as the semaphore, by experiment and use. An expression of public opinion may overcome the indifference of railroad managers to this improvement.

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A NEGLECTED FUNCTION OF ENGINEERING SOCIETIES

In another part of this number a brief review of the history and activities of the British Engineering Standards committee is given, from which it appears that the British engineering societies recognize as one of their most important functions, the compilation of data for the standardization of specifications for engineering work, machine details, etc. Very little of this kind of work has been done by the engineering societies in the United States. The American Society of Mechanical Engineers has done very useful service in bringing about the standardization of machine screws; but important as this work has been, it is insignificant when compared with the great need and the unlimited opportunity for the standardization of hundreds of details in the mechanical engineering fields.

The British engineering societies have set a fine example, and by the successful accomplishment of their work have proved that it is possible to formulate certain standards upon which all manufacturers can agree. Our engineering societies are neglecting a great opportunity by not devoting themselves to work of this character. No other body is so well fitted to render this important service as a national engineering society and it should be considered a duty by all of them. The important work of the national engineering bodies can never be done at the conventions, because these are, and probably always will be, largely social functions; but a vast amount of matter of permanent value would be available to the engineering profession if the papers presented at these meetings were crystallized into permanent records by being used as an aid in preparing standards for mechanical practice. In addition, the engineering societies would then become a kind of clearing house for mechanical information, where data relating to standards of all kinds could be readily obtained, and where the reason for the adoption of these standards could be ascertained.

At the present time, there seems to be no one subject to which the engineering societies could devote themselves with greater profit than to the establishment of engineering standards. There is in the mechanical engineering field, at least, a hopeless confusion as to the established practice with relation to many details of machine design and shop practice. No other body is better fitted than the national engineering societies to clear away this confusion.

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At one of the busy machine shops in the heart of the city of Boston where the machinists prefer to take but one-half hour for their luncheon and thus make their day one-half hour shorter, the management allows the men to go to luncheon at 11:45 returning to work at 12:15; thus the men are enabled to get into the luncheon rooms and restaurants just before the rush hour commences, which insures them prompt service and good lunches.

INDUSTRIAL ADMINISTRATION AND SCIENTIFIC MANAGEMENT—2

CAUSES OF INDUSTRIAL INEFFICIENCY

By FORREST E. CARDULLO*

So far this article has considered only the broad aspects of industrial administration. In order to get a better idea of the objects of scientific management, the methods which it is likely to adopt, and the obstacles which it must overcome, I propose to classify and describe some of the causes of inefficiency in our industrial life. In studying the causes of inefficiency we will discover the remedies which a proper system of administration should apply, and develop some of the principles underlying scientific management. I do not claim that all the faults which I will describe are prevalent in every industrial plant not under scientific management. I will admit that most of them can be eliminated without the complete adoption of scientific management. I do know, however, that they are astonishingly prevalent in our industrial life, and that neither conventional nor systematic management has succeeded in uprooting them.

The causes of inefficiency may be divided into three classes: The first are those causes which are chargeable primarily to the employer, the second those which are chargeable primarily to the workmen, and the third those which are chargeable primarily to our political and industrial system.

Those causes of inefficiency which are chargeable primarily to the employer may, in turn, be divided into two classes. Those of the first class arise from a lack of knowledge. They can be remedied by showing the management the possibilities of better methods. Those of the second class arise out of moral defects on the part of the employer, and will require more than a change in the system of management or full information of the conditions of the plant in order to eliminate them.

Mental Laziness

The first and most prolific source of inefficiency is mental laziness. Most of us dislike to think. While a good many of us will devote a spare hour now and then to the consideration of some interesting subject, no man will, if he can avoid it, devote two hours a day, not to mention eight hours a day, to the task of devising and comparing methods of work. That kind of thing is entirely too strenuous to suit the average officer of administration. In the average plant, each officer places upon the shoulders of his underlings the burden of detail for which he himself ought to be responsible. When work is to be done, the manager "puts it up" to the superintendent. The superintendent, in turn, puts it up to the foreman, the foreman to the gang boss, and the gang boss to the workman. Upon the workman devolves the task of devising the methods and of planning the details of the work. Now as I will show later, the workman is no fonder of thinking than the management, and performs his task in that way which involves a minimum of mental effort. He is not to be blamed for so doing, because he has merely followed the example of the management. It is the duty of the management and not of the men to study the work, to discover the most efficient methods, and instruct the men in those methods. When, because of lack of instruction, the men fail to perform their work in the most efficient manner, it is the fault of the management and not of the workmen. Conventional management is fundamentally wrong, in that it compels the workmen to originate the methods, and leaves to the management only the task of criticism.

When the management of an industry is reproached for laziness in not properly directing the workmen, the officers of administration will usually reply to this effect: "These workmen which we hire are supposed to be competent men. They are experts in machine molding, tool dressing, lathe work, or whatever it is that we hire them to do. They have devoted their lives to these lines of work, and know a great deal more about it than we do. When a man receives a job, he can devote his entire attention to that one job. His task is easy, because he has to think of but one thing at a time. If we

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devised the methods of work, we would have a thousand jobs to figure on each day. They could not receive the same amount of attention that they get now, nor would that attention be as satisfactory, since we are not experts, and the men are. When you ask us to direct the workmen in the details of their work, you are demanding of us an overwhelming and impossible task."

In answer to this argument, it is only necessary to say: First, while the workmen are usually much more capable than the management, this is due to the lamentable ignorance of the management, and not to the extraordinary knowledge of the workmen. It is practicable for the management to acquire and apply knowledge which it is impossible for the workman to have. Second, many shops that are eminently successful do direct all of the acts of their workmen. Third, when the workmen devise the methods of doing work, they are handicapped by being obliged to use such tools and machines as the management provides, while, when the management devises the methods, they can and will secure the proper tools and machines for doing the work.

Prejudice against So-called Non-productive Labor

A second source of inefficiency is a dislike on the part of most managers to employ a considerable executive staff to direct the efforts of their workmen. The management balks at such a staff, and claims that "non productive" labor is a necessary evil if you have to employ it, and an unnecessary evil if you can do without it. In the old days draftsmen were regarded as an unnecessary evil, and the designing was done by rule of thumb and the head patternmaker. Experience has shown that Johnny Pencilpusher is not an evil, nor is he unnecessary, and that it pays to employ him. Accordingly he is now classed as "productive" and not as "non-productive" labor. The men who direct the work of the shop are just as necessary as the men who make the designs, yet it is difficult to persuade the average manager that a large executive staff is desirable even when you can show him that a gain will result from its employment. The attitude toward such a staff is well shown by the name "non-productive," so often applied to this class of labor. The labor of the planning department is just as truly productive as the labor of the drafting department, the machine department, or the erecting department. A new attitude in regard to the employment of indirect labor is a pre-requisite to greater efficiency in many of our shops.

Timidity of Capital

A third fault of management is timidity. Capital seems to be ruled by fear quite as often as by judgment. Men dislike to risk their money in something which they feel is not absolutely sure to bring adequate returns. They especially dislike to risk money in any investment which is of such a character that they cannot recover the principal in case they decide to give up the enterprise, even though adequate returns are almost certain. Managers often hesitate to spend money for new tools or equipment until other firms have tried the tools or equipment and found them to be successful.

Probably one of the best examples of this is the difficulty which Mr. George Corliss had in selling his engines at a reasonable price, when they were first brought out. It will be remembered that in some cases he had to take for his pay the value of the coal which his engine could save in a given period of time, and was under bonds to take out his engine and reinstall the old one in case the purchaser decided that the new engine was unsatisfactory. Just as Mr. Corliss' customers were fearful of spending money for an improved type of engine, and insisted on making a contract which was, in reality, unfavorable to themselves, so the present-day employer is fearful of assuming the expense incident to proper management, even though it can be shown that great gains ought to be realized from proper administration.

Lack of Foresight

This brings us to a fourth fault of management, which is lack of foresight. The management, in performing the work of today, fails to make allowance for the needs of next week, or the growth of next year. Plants grow in haphazard fashion. Equipment is added without making plans for the future. No attempt is made to insure that there will always be a corps of trained workmen and a staff of able foremen. The lack of definite and far-reaching plans for future work is not felt at the time that such plans should be made, but is felt later.

Mental Inertia and Lack of Adaptability

A fifth fault of management is one which may best be described as "mental inertia." Managers tend to follow methods which have been satisfactory in the past, but which changing conditions have made unsatisfactory for present requirements. Whenever a new invention of any importance is introduced into a shop the conditions of work are greatly altered. The introduction of high-speed steel is a case in point. When the time required for machining work is cut down to a third of that formerly required, the amount of crane service for a given number of machines is trebled. The foundry and forge shops must be made very much larger in order to furnish the stock required by the machine shop. The amount of storage room required for stock and for finished product is greatly increased. The relative importance of different items of cost is radically altered, and the nature of the problems of administration are greatly changed. Notwithstanding these changes, we will find that in most cases the management will attempt to get along with the least possible change in equipment, and in methods of work and administration. Many men resist change simply because it is change, in spite of the fact that the change may be desirable.

One of the best examples that comes to mind of the mental inertia that prevents the adoption of new ideas is the general disregard of Mr. Taylor's discovery that the use of a heavy stream of water at the cutting point of a roughing tool, increases the permissible speed of cutting by forty per cent. If the machines of a shop are engaged on roughing work for one-third of the time, by the use of such a stream of water their output will be increased by thirteen per cent. In a shop in which 100 men are employed on machine work, this will mean a reduction in the cost of machining of about $20,000 per year. To install a system for distributing soda water to all the machines in such a shop, and for returning and purifying the water, will certainly not cost more than $20,000, yet, so far as the writer is aware, there is only one shop in which such a system has been installed, even though it would unquestionably pay one hundred per cent on the investment. This is an example of bad management arising from mental inertia, which occurs in almost every shop. When the subject is brought up in any plant, the management fortifies itself in its obstinate attitude, by advancing as arguments statements which are untrue, for instance, that the system costs more than it is worth, that the soda water destroys the machines, or that it is always giving trouble. Were the management to give the matter proper study however, it would find that practical experience has demonstrated that the benefits realized are so great that their shops cannot afford to operate in any other way.

Lack of Study of the Industry

A sixth and probably one of the greatest of all causes of inefficiency is the fact that the management very seldom makes a careful study of the industry. In the few cases where a careful study is made, it is usually done for the purpose of improving the materials used or the quality of the output, or increasing the amount of work turned out by the use of a given method.

It is of equal or even greater importance that the methods themselves should receive the same careful study. Probably the best example of a scientific study of methods of manufacture is the work of Mr. Taylor on the art of cutting metals, to which reference has already been made. It is probable that a similar study of methods would result in equally important developments in other lines of industry. Such studies are not made for three reasons. In the first place, managers do not realize the need of such studies nor the advances which are possible. In the second place, very few men are capable of making such studies. In the third place, inertia opposes the changes which would result from such studies, and timidity hesitates to expend the money necessary to carry them out. Very few managers would have the courage to commence an investigation whose final cost would be $800,000 and which would take twenty-six years for its completion, and while the management of some very large industries might be willing to

take a chance on an investigation of this kind, even the most sanguine would deride the possibility of such an investigation producing such valuable and far-reaching results as have followed from Mr. Taylor's experiments. When all is said and done, it will be found that most managers want someone else to do the experimenting, feeling that by so doing they can participate in the profits of such work without sharing its expenses.

Systems of Rewarding Labor

A seventh source of inefficiency in many industrial plants is the system of wage payment adopted. It would be hard to devise wage systems better calculated to limit efficiency than the two which are in most common use; namely, the day wage plan, and the piece-work plan with frequent cuts. Under the day work plan, the man receives no reward for his efficiency, he is instead punished for inefficiency. This is a method which is fundamentally wrong, and only to be employed when no other method is possible. When a man receives day wages, he is paid for the time which he spends at his work. The first question which arises in connection with this system of wage payment is: What wages ought a man to get? The answer is he ought to get all he can. He is selling a commodity, labor. He asks for it the highest price he can get, and is justified in so doing. His labor is measured by time and the value of the labor performed in a given time has nothing to do with the payment which he receives. The only thing which limits him is the fact that if he does not do a satisfactory amount of work, he will be discharged. What constitutes a satisfactory amount of work, neither he nor anybody else knows. The whole thing works out very much as it would if a man when buying a quart of milk, were to insist simply that there be some milk in the quart measure, and the matter of how much milk there was to be in the measure, should be left with the milk-man, with the understanding that the milk-man would lose his customer in case the amount of milk was not satisfactory to the purchaser.

When you discuss with the average workman the question of proper wages and the proper amount of work to be done in a day, he will tell you that his motto is "a fair day's work for a fair day's pay." Different men, however, have very different ideas as to the amount of work which constitutes a fair day's work. Some employers think that it is all the workmen can possibly accomplish. Some workmen think it is the least that they can accomplish and still not get fired. Most workmen think it is work they can do when working steadily at the gait that habit and temperament have fixed in their cases. Most employers think it is the amount of work which their most honest and industrious employe normally does. When there is such a great diversity of opinion as to what constitutes a fair day's work, it will naturally be seen that there will be great diversities in the efficiencies of different men and different shops.

When a piece-work plan is adopted, the management usually knows very little about the possibilities of the work. If the management fixes what the men think to be a reasonable piece-rate, the men will soon so increase their output that they will be making exorbitant wages. The management will then cut the piece-rate, and after the men have experienced a series of cuts as a result of successive increases in efficiency, they will discover that the management does not propose to pay them more than a certain amount of money, and will work just hard enough to secure a trifle less than the maximum amount they can secure without experiencing a cut.

If, on the other hand, a proper piece-rate is established in the first place (*i. e.*, one by which the men can earn fifty per cent to one hundred per cent more than a regular day's wages when they have reached their best efficiency), the men will believe that it is impossible to earn reasonable wages under the proposed piece-rate, and will decline to accept it.

"Holier than Thou" Spirit of Some Employers

An eighth cause of inefficiency is one which is happily becoming less frequent. It is a disposition on the part of some employers to regard their workmen as being of a lower order of humanity than themselves. I have talked with such men on more than one occasion. Among their associates they were highly regarded for their kindness of heart, but I have heard them speak of their workmen as "beasts" and "ignorant brutes." No man who regards his employes in that light can be persuaded to adopt scientific management nor can he bring the efficiency of his plant to a high standard, because such feelings will unconsciously affect his attitude in dealing with his employes, arouse their antagonism, and destroy that feeling of cooperation which is the essential basis of high efficiency.

On the other hand, even though the employes of such a man are ready and anxious to cooperate with him, his attitude will prevent him from doing many things which would utilize such potential cooperation to advantage.

Avarice of the Management

The last source of inefficency of which I will speak is avarice on the part of the management. Avarice reduces wages, cuts piece-rates, purchases inferior materials and equipment, employs unskilled labor, skimps on supplies and makes unjust exactions of its employes. Avarice refuses to expend money for the collection of information, for increasing the facilities of work, and for improving the efficiency of administration. Avarice hampers the administrative staff at every point. Avarice is the sin of the board of directors and the stockholders, and not of the superintendent and his staff. Scientific management often requires a large staff of clerks and costly experiments when it is being introduced into a new line of work, and this effectually prevents its adoption by the avaricious employer.

Not only will avarice prevent the adoption of scientific management in a great many cases, but it is also very likely to give scientific management a black eye by adopting some of its methods, without adopting its spirit. An avaricious employer finds himself coming out second best in competition with one who utilizes scientific management. He attempts to appropriate the experience of his competitor in the same spirit in which he imitates his trademarks, copies his designs, and steals his methods of work. Now while it is possible to imitate a trademark or steal a method, it is not possible to imitate or to steal the scientific habit of mind or the spirit of fair play, which lie at the basis of scientific management. The reward and instruction are just as essential to scientific management as the discovery of a method of work, but the avaricious employer cannot be made to see this. When his neighbor has discovered a method of work better than that which his workmen employ, he will attempt to force his workmen to accomplish the same results without teaching them the new method and without offering them the reward to which they should be entitled, and his attempts will therefore always end in failure. While there is no question but that scientific management will continually discover new and improved methods, processes and materials, and while these improvements will gradually find their way into shops which do not employ scientific management, the extraordinary performances possible under scientific management will never be achieved in the shops of the avaricious employer because knowledge alone will not lead workmen to increase their efficiency.

I have not by any means exhausted the list of causes for inefficiency which arise from faults of the management. It would be as easy to name a hundred as to name nine, but the task is not agreeable. I have endeavored merely to point out the fact that such faults exist, that they can be remedied, and that before scientific management can be applied to an industry, they must be remedied.

Causes of Industrial Inefficiency due to the Workmen

While most of the causes which lead to inefficiency are chargeable to bad management, I would not have it inferred that the workmen are free from blame in the matter. I know of many shops in which the blame rests almost wholly on the workmen. In one that I have particularly in mind, the management is keenly alive to the possibilities of improvement. They could today increase their output fifty per cent, and would gladly increase their wages in the same proportion, if the workmen would cooperate with them. Time and again they have attempted to make changes leading to higher efficiency, but in every case the opposition of the workmen was so strenuous that they were convinced that it was the part of wisdom to accept the inevitable and to permit the inefficiency which they deplored. Were they to insist on a change of

methods, it is quite likely that labor troubles would force their plant into bankruptcy on account of their limited capital.

The Natural Pace of Workmen

The first source of inefficiency chargeable to the workmen is their disinclination to work at any other than their natural pace. If a man is allowed to work as he pleases he will soon settle down into a certain pace which suits his temperament and nervous organization, and will keep to that pace without very much variation from day to day. I may call this his natural pace. It is perfectly possible for such a man to work very much faster without tiring himself, and if he is properly trained and given adequate inducement, he will adopt the faster pace, and make it his habit to work at that faster rate. I may call this faster pace his proper pace. In order to illustrate the relation of the natural to the proper pace, I would like to compare them to the natural gait which a horse takes when his driver allows him to go at his own free will, and the proper gait which an experienced driver will set for the horse, in order that he may accomplish the best results. A careful and experienced driver will get a great deal more work out of a horse if he urges him to travel at the proper gait. Notwithstanding this, the horse will be no more tired at the end of the day when driven at the proper gait, than he would be had he traveled at his natural gait. The faster gait does not mean undue wear and tear, and the horse will maintain good health and vigor just as long when working for a careful driver who makes him work, as he will if he works for an indifferent driver who allows him to do as he pleases.

A man differs from a horse in two ways. In the first place he cannot be driven, and in the second place, a reward offered him for extra labor must seem to him to be reasonable. It is not difficult to get a man to change his pace if you offer him an adequate reward. If, however, he finds that the reward is not always forthcoming, *i e.*, if he finds a piece-rate being cut or a premium reduced, or if he feels that the reward is inadequate, he will not respond. He cannot be driven by threats of discharge or by fines, and he cannot be coaxed by broken promises or gold bricks.

Lack of Ambition

A second source of inefficiency is lack of ambition. While most men will be stimulated by a proper reward, there are some classes of labor which cannot be reached in this way. Some workmen do not accomplish as much or as good work when well paid as they do when poorly paid. In certain sections of the South contractors find that when negro laborers are paid seventy-five cents a day they will work a full week, when paid $1 a day they will lay off one day in the week, and when paid $1.50 a day they will lay off half the time. The reason is that these men are not ambitious. Four dollars and a half a week supplies their needs, and when they have earned that amount they do not care to work any more. It is needless to remark, however, that the average artisan is not of that character. He is ambitious, and invariably responds to a suitable reward, unless he believes that in so doing he is acting against the best interests of himself or his fellow workmen.

Mental Laziness of Workmen

A third source of inefficiency lies in the fact that the workman does not like to think any more than the superintendent, the foreman, the manager, or the board of directors. He prefers to work without thinking when it is possible. Few men are physically lazy, but nearly all men are mentally lazy. The only way that a man can work without thinking is to do the job the way in which he or someone else has done it before. When he has to do a new job, he must do some thinking, but usually it will be found that the workman will adopt the method which requires on his part the least mental effort for its origination. Very seldom is the method adopted the best one. In the course of his work, ideas will come to the workman. Sometimes these ideas are good. If the ideas make it easier for him to perform the work, that is, if the new method is in accord with his temperament and habits, the idea is put into practice. If the idea makes it harder for him to work, that is, if it requires him to do something disagreeable or not in accord with his habit, the idea will be rejected. An investigation of methods of work will usually show that men who are physically restless will often adopt difficult and tiresome methods of work on account of their temperament. Men who are physically lazy will adopt easy-going and slipshod methods of doing work. In every case the workman seeks to conform the method to his temperament, in order that the mental and nervous effort which he must make in accomplishing the work shall be a minimum.

Fallacy of the Arguments against a Good Day's Work

A fourth, and possibly the most prolific source of inefficiency is the belief held by many workmen, and unfortunately, taught by many union officials, that in doing efficient work men are displacing other workmen and lowering wages. There can be no greater economic fallacy than this. One illustration alone will serve to make clear the falsity of the argument that a man who works efficiently reduces wages and the opportunities for labor. Let us suppose that on account of the increased efficiency of the workmen, the cost of making cement is materially reduced, and the output greatly increased. Of course, if the demand for cement were fixed at so many barrels per year, some cement makers would be thrown out of employment, but with the increased output and diminished cost there will come an increased demand for cement, and there will be a greater amount of concrete construction. Instead of reducing the number of men employed, it is quite possible that a larger number of men will be employed in manufacturing cement, and it is certain that a very much larger number of men will be employed in concrete work. If these concrete workers, in turn, become more efficient, cheapening the cost of concrete construction, the use of concrete will be stimulated, more cement makers will be employed, new factories, warehouses and bridges will arise, and finally every branch of industry will be stimulated by the improvement. The workman who increases his output is a benefactor, not alone to his employer, but to every man in the community. His increased efficiency will result in higher wages, and more general prosperity.

The facts in the case are so simple and so easily understood that it is strange to me that every workman does not understand and appreciate them. If all workmen were twice as efficient, the annual value of the products of labor would be twice as great as at present. The products of labor are distributed among the community (somewhat inequitably it is true), and the share which each member of the community can get will be proportional to the total amount to be distributed. Any increase in efficiency means that there will be more goods to be divided, that every one will get a larger share, and that the community will be benefited. It is impossible in an article of this character to go into the subject of economics, but the more the subject is studied, the more clearly the advantages of increased efficiency will be seen. As a matter of fact we can only reach that millenium when poverty, disease and unhappiness will disappear, by the straight and narrow path of increased industrial efficiency, and anything which impedes that efficiency is in reality as great a crime against humanity as the poisoning of a well, or the adulteration of drugs.

Enmity to Employers

A fifth source of inefficiency chargeable to workmen is a feeling of enmity against their employers. A great many workmen are unable to see the community of interest between the workman and the employer. Some workmen act as if they believed that the two were at war, and that anything done to injure the employer was a benefit to labor.

Now there will always be discussion and bickering between capital and labor as to how the wealth created by their joint effort should be divided. There can, however, be no discussion over the point that each must have a share, and that the amount of wealth which they can divide between them, and the size of the share to which each is entitled, will be great or small according as they are more or less efficient.

Any sensible man can see that the more efficient the workmen are, the more prosperous their employer will be, the better able he will be to extend his works and employ more labor, and the higher wages he will be able to pay. Until all feeling of enmity between capital and labor is replaced

by a knowledge of mutual need and appreciation of mutual interest, and a desire for mutual success, not only efficiency, but also prosperity, must suffer.

Causes due to Political and Industrial Systems

Those sources of inefficiency which arise out of the imperfections of our political and industrial system are just as important as are those due to faults of management or of workmen. Unlike the latter, however, it is impossible for either the management or the workmen to correct the faults we are about to consider. It is not usual to discuss such matters in a technical paper and on that account this phase of industrial administration will be dealt with in the briefest possible manner, confining the discussion to a description of the causes, and not to a discussion of legal remedies. Everyone studying the industrial history of this country will be struck with the fact that we have alternate periods of feverish activity and of deadly dullness. In so-called "boom times" factories are run twenty-four hours a day, efficiency and quality of workmanship are sacrificed to output, our railroads are crowded to the limits of their capacity, untrained and inefficient men find ready employment in all trades, ill-considered plans for industrial expansion are hastily carried into effect, inferior and unsatisfactory equipment is eagerly purchased and installed because no other kind is available, and the general efficiency of our industrial system suffers a severe decline.

As a result of this inefficiency a "period of business depression" sets in, men are discharged, plants lie idle, wages fall, men are forced to move at great expense, and to seek new employment for which they are not trained, and again inefficiency is the order of the day. Now there is no reason why these alternations of activity and dullness should occur, except that our methods of conducting business are wrong. Proper laws, proper methods of banking, improved business customs, and a rational development of our natural resources and methods of communication will very nearly eliminate such conditions.

Certain industries, however, are subject to seasonal variations of opportunities for work. Agriculture and the canning industries are examples. Other industries are subject to seasonal variations in the demand for their products. The automobile industry and the manufacture of Christmas goods are examples. Where the supply of raw materials for an industry is subject to seasonal variations, nothing can be done except that such an industry may be operated in connection with another industry so that the workers and possibly a portion of the plant may be efficiently employed, practically all the time. Where the demand for the products of an industry is subject to seasonal variations, the industry may run steadily throughout the year if an accumulation of stock is permitted. The amount of capital tied up in the stock will usually, in such a case, be less than the capital otherwise tied up in the plant, since a plant which turns out a given product in three months will have to be four times as large as one which turns out the same product in a year, working the same number of hours per day. There is also the possibility of operating such an industry in connection with another industry, possibly of a like character, in such a way that both the plant and the workmen may be efficiently employed throughout the year.

We must all recognize that one of the causes of inefficiency at the present time is the struggle which is going on in the business and political world over the question of whether capital shall be used for the benefit of those who nominally own it, or whether it shall be used for the benefit of the community. Originally the position sanctioned by law was that capital belonged absolutely to the one owning it, and that he might use this capital in any way that he saw fit, except that he might not employ it in levying war on the sovereign, or in committing a criminal act. We are gradually coming to the view that capital must be used for the benefit of the community, and while we believe that the nominal ownership and the detailed administration of industrial enterprise should be left to individuals, we are coming to insist that a business shall be conducted efficiently, that in case the business is not regulated by competition the profits shall be reasonable, and that the methods of making and marketing the products shall be those which will further the well-being and efficiency of the community as a whole, rather than the profits and self-satisfaction of the owner of the business. While we are engaged in this process of changing the fundamental principles of law and of business, we must expect that inefficiency will be more or less the order of the day.

One of the economic sins of the present day which is very effective in destroying efficiency, is foolish and wasteful competition. The construction of parallel and competing lines of railway when one line is adequate to serve the traffic is a case in point. The installation of two telephone companies in the same city, of competing street car and electric railway lines, the duplication of generation and distribution plants by two electric power companies, and competition in other so-called "natural monopolies" are other examples. There are certain kinds of industrial work in which competition is undesirable and inevitably leads to inefficiency, and laws which permit or encourage such competition place a premium upon such inefficiency.

Another cause of inefficiency is frequent and sudden changes in laws, customs, fashions, and social conditions. For instance, a bounty, subsidy, or extraordinarily high tariff may cause the factories and workmen of an industry to be transferred from Europe to America. This transfer means a considerable temporary loss, and in case American conditions are not naturally favorable to the development of the industry, it causes a permanent loss. A few years later the abolition of the tariff or the bounty may cause the plant to be re-transferred to Europe and the workmen to be thrown out of employment, with a further loss. Similarly, a change in the direction or amount of traffic in a given district, the development of new resources, the sudden growth or decline of a transient industry and many similar things may affect the efficiency of a given plant, or even a whole industry. Often these changes are entirely beyond human control, or are incident to increased efficiencies in other and more important lines.

* * *

SHERMAN LAW HELD TO APPLY TO RESTRAINT OF TRADE BY PATENTS

The Supreme Court of Massachusetts, in an opinion of the full bench handed down July 3, advanced the application of the Sherman law to embrace combinations in restraint of trade by reason of patent rights held by corporations. In a suit of the United Shoe Machinery Co. against Euclid I. Chappelle, an inventor who worked for the corporation for $12 a week, the corporation endeavored to force Chappelle to transfer certain patent rights under a contract of employment. Chappelle offered to show that the company was a monopoly and doing business in restraint of trade and contrary to the provisions of the Sherman act, but Judge Hardy refused to admit the testimony. Counsel for Cnappelle took exceptions to his rulings and appealed to the Supreme Court. The decision holds that the lower court erred in not admitting such evidence. Chief Justice Rugg, who wrote the opinion, finds that the question of whether the United Shoe Machinery Co. is an illegal combination in restraint of trade and had monopolized trade and commerce between the several States must be governed ultimately by the Supreme Court of the United States. The opinion states, however, "that no word or phrase in the Sherman anti-trust act reveals an intent to exempt the owners of patents from its sweeping provisions against monopolistic combination."

"We are unable to perceive," stated the court, "any underlying reason for supposing that by implication growing out of economic or business conditions such an exemption was intended. There appears to be no inherent natural distinction between owners of patents and owners of oil which would justify the application of the statute to one and not to the other. The conclusion seems to follow that the comprehensive condemnation of the act against every person who monopolizes interstate commerce by combination with others includes holders of patents as well as others."

* * *

Most men need to ream out their mental cavities occasionally to enlarge their calibre.

CHARTS FOR HORSEPOWER TRANSMITTED BY GEARING AND BELTING*†

By CHARLES E. EVANS‡

The accompanying illustration and the Data Sheet Supplement show a number of charts which the writer has found convenient and useful. Two of the charts in the Data Sheet Supplement give the horsepower transmitted by spur gearing, one of them being used for circular-pitch gears and the other for diametral-pitch gears. When using these charts one can choose the fiber stress most suitable for the material and work in question. The charts do not give values directly proportional to the pitch line speed, but values that are relatively lower for high speeds as compared with low speeds. The light upper dotted line in the charts shows the form the upper curve would take if the horsepower were taken as directly proportional to the pitch line speed.

Gears having a large number of teeth have a stronger tooth form than gears with a small number of teeth, and provision has been made in these charts to cover this point, but if it is not desired to determine the results with such refinement as this arrangement makes possible, the values for a 12-tooth pinion can be used for gears of any number of teeth, thus reading straight across the chart at the right-hand side. The horsepower transmitted by gears of different width of face from that specified can be obtained by proportion.

The following examples are traced in dotted lines on Charts I and II in the Data Sheet Supplement:

A 12-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 2.3 horsepower with a fiber stress of 3000 pounds per square inch.

A 20-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 4.1 horsepower with a fiber stress of 4000 pounds per square inch.

A 12-tooth pinion of 1½-inch circular pitch and 4-inch face, running at a pitch line speed of 100 feet per minute, will transmit 3.3 horsepower with a fiber stress of 3000 pounds per square inch.

A 20-tooth pinion of 1½-inch circular pitch and 4-inch face, running at a pitch line speed of 100 feet per minute, will transmit 5.8 horsepower with a fiber stress of 4000 pounds per square inch.

The chart contained in the accompanying engraving gives the horsepower transmitted by belts or friction gears. When using this chart one can choose a tractive force per inch of width consistent with the problem in question. An example traced on the chart in dotted lines indicates that a 6-inch belt running at a speed of 3000 feet per minute will transmit 33 horsepower at a stress of 60 pounds per inch of width of belt.

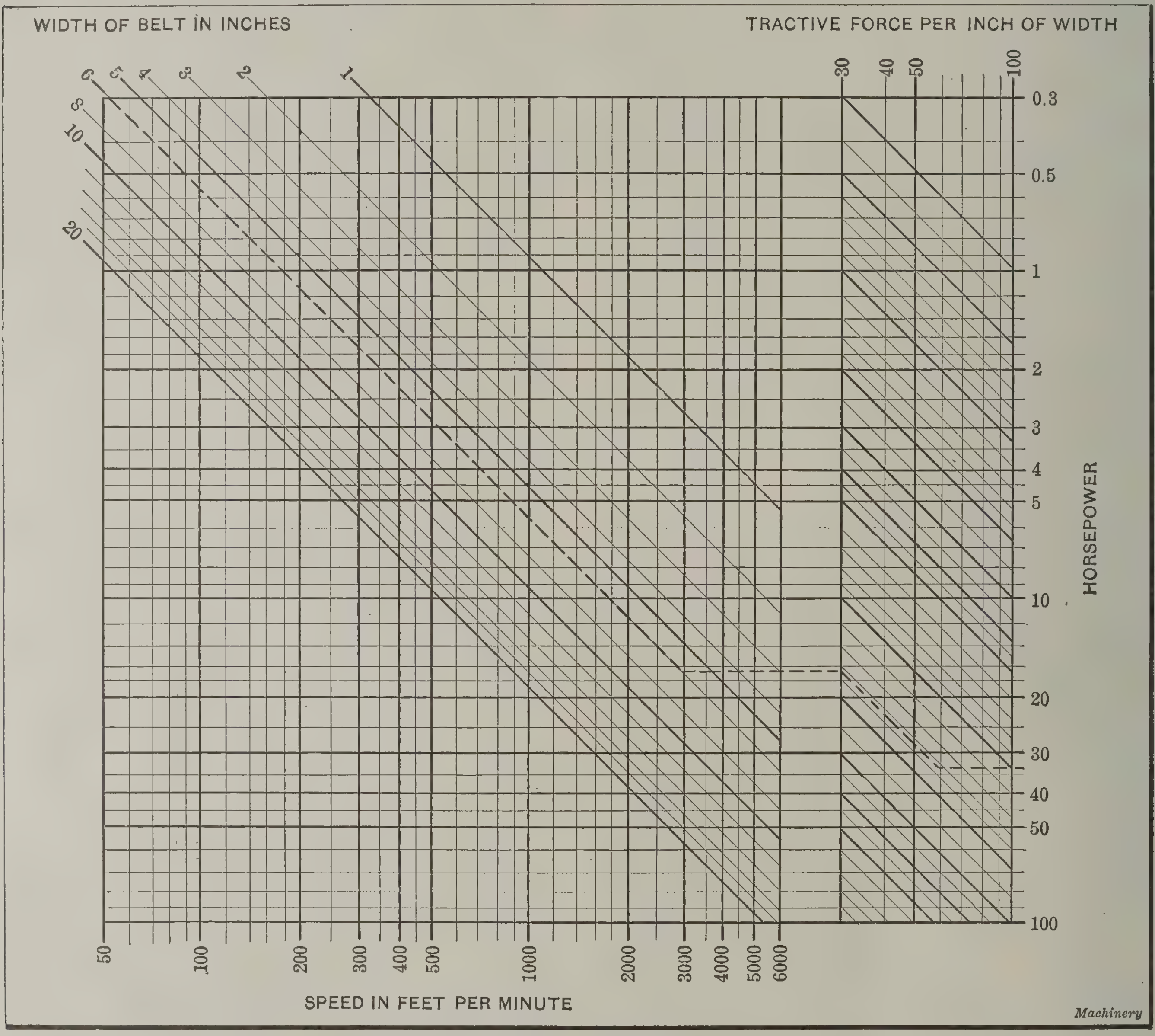


Chart for Finding the Horsepower transmitted by Belting

*With Data Sheet Supplement.
†For additional information on this and kindred subjects previously published in MACHINERY, see "A New Gear Chart," December, 1911, engineering edition; "Horsepower Transmitted by Leather Belts per Inch of Width," September, 1906; "Horsepower Transmitted by Belts," July, 1906, engineering edition. See also MACHINERY'S Data Sheet Book No. 5, "Spur Gearing," pages 21 to 23, and 26 to 29; Data Sheet Book No. 19, "Belt, Rope and Chain Drive," pages 14 to 16; Reference Book No. 15, "Spur Gearing," Chapter IV, "Strength and Durability of Spur Gears"; and Reference Book No. 52, "Advanced Shop Arithmetic for the Machinist," Chapter VI, "Horsepower of Belting."
‡Address: Fifth Ave., near Ohio St., Aurora, Ill.

Charts III and IV in the accompanying Data Sheet Supplement are auxiliary diagrams for finding the pitch line or rim speed in feet per minute. Chart III gives this when the diameter and the revolutions per minute are known. The example traced on the chart in dotted lines indicates that a gear or pulley having a diameter of 3.4 inches and running at 500 revolutions per minute has a pitch line or circumferential speed of 445 feet per minute; or if the diameter is 34 inches and the speed 50 R. P. M., the pitch line speed is 445 feet per minute; in other words, the chart can be used for other dimensions than those actually given if proper care is taken with regard to the position of the decimal point.

Chart IV gives the pitch line speed of a gear when the pitch, the number of teeth and the number of revolutions per minute are known. The example traced on the chart by dotted lines indicates that a 13-tooth pinion of 3-inch circular pitch, running at 100 R. P. M., has a pitch line speed of 325 feet per minute.

* * *

HINTS TO EXPORTERS

By ERNST VOEGELI*

From time to time American journals have published instructions relating to the proper crating of machines for export. This is a very important subject, but there are some other points almost as important which are frequently overlooked. Details, which at first sight may seem to be of little or no importance, sometimes cause considerable trouble and damage. With the present-day competition between different firms and different industrial nations, every reasonable precaution should be observed in order to avoid inconvenience to the customer.

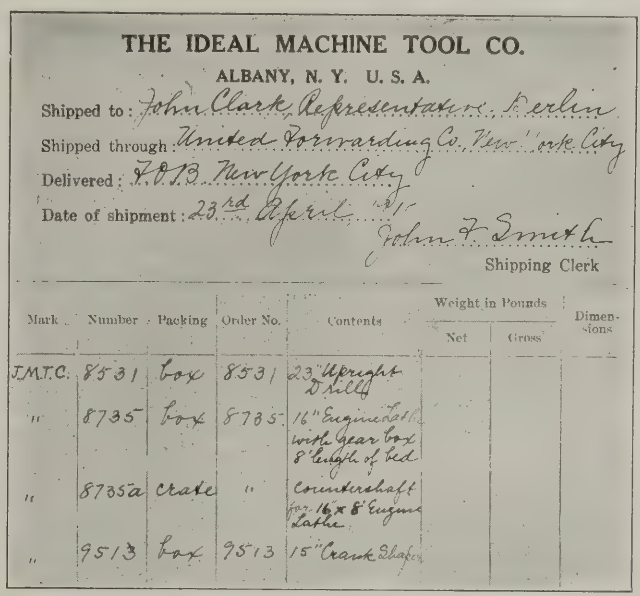
A very important point is that machines should be carefully greased before shipping. Solid crating will prevent breakage, and careful greasing will prevent rusting. The machines are often exposed for several days to the mist or fog at the harbors, and sometimes sea water may come into direct contact with them. The boxes may lie for some time in the open air, not even protected against rain. Hence, if not carefully greased, the machines will rust, and it is extremely unpleasant for the customer to receive high-priced and high-class machines in this condition. When badly rusted, the polishing and cleaning almost always injures the accuracy of the machines to some extent, and this may be detrimental to the reputation of the manufacturer of the machine. It is a fact that a good many machines arrive in Italy badly rusted.

Another important point is to have the boxes distinctly marked. Having almost daily had to do with the forwarding of American, German and English machines, the writer has observed that many American firms make mistakes in this direction. They place the address of their customer in large black letters on the box or crate. However, the customer is not always also the receiver. The customers of American manufacturers, on the other hand, are mostly agents and dealers, but the machines ordered by them are sometimes sold in advance and are to be shipped direct to the user's factory. Thus only a small part of the machines ordered are delivered to the address printed on the box, the larger part being forwarded to the ultimate buyer by the customer's forwarding agent. In that case, the addresses on the box are useless.

Difficulties are met with especially when different machines are arriving at the same time for the same machine dealer. Of these machines some are already sold and are to be forwarded direct to the buyers' addresses. The machines may originally have been shipped by different manufacturers in America, but they are all delivered to the forwarding agent at an American harbor, generally in New York City or Boston, and this forwarding agent sends all the machines at approximately the same time to the European forwarding agent. This agent, therefore, only knows that the American agent has shipped a number of machines, but he does not know who are the original shippers. The machine tool dealer gives the European forwarding agent instructions to ship some machines to one firm, others to another firm, and, perhaps, a third lot to still another destination, while a small part of them will be delivered to his own address.

How, now, is the forwarding agent to distinguish the different machines? There is no way to do it if all the crates are sent to one address. It is not possible to risk having the forwarding agent open the cases and distribute the machines according to the machine tool dealers' descriptions. Some machines might seem very much alike to one not familiar with them, and mistakes would easily be made. The writer knows from his own experience that such mistakes have occurred, simply for the reason that the box bore nothing but the address of the machine tool agent. In one case, where two machines were thus substituted for each other, the agent had to pay a penalty for delay in delivery, as well as the additional freight charges, to straighten matters out. In another case, the delay very nearly caused the customer to refuse the machine and to buy another from an agent who had it in stock for immediate delivery, but this latter machine was made by a competing firm in another country.

In order to avoid such inconveniences, it is suggested that the crates be marked in some way to avoid mistakes. This method is already followed by some of the American firms



THE IDEAL MACHINE TOOL CO.

ALBANY, N. Y. U. S. A.

Shipped to: John Clark, Representative, Berlin

Shipped through: United Forwarding Co. New York City

Delivered: F.O.B. New York City

Date of shipment: 23rd April '11

John F. Smith

Shipping Clerk

Mark	Number	Packing	Order No.	Contents	Weight in Pounds Net	Weight in Pounds Gross	Dimensions
I.M.T.C.	8531	box	8531	23" Upright Drill			
"	8735	box	8735	16" Engine Lathe with gear box 8' length of bed			
"	8735a	crate	"	Countershaft for 16" × 8' Engine Lathe			
"	9513	box	9513	15" Crank Shaper			

List sent by Manufacturer to Agent for Identifying Shipment

familiar with the export business, and is generally followed by German and other European firms. In place of the machine tool agent's address, it would be advisable to print on the box some distinctive marks and numbers, preferably the initials of the firm which ships the machine and the number of the order. If, however, the order comprises more than one machine, each crate should have a separate number so that every crate bears a distinctive mark. The Jones & Smith Mfg. Co., for example, may use the marks J. S. M. C. with a number. The probability that two or more boxes would bear the same identification marks is very small. These marks and numbers are to be repeated in the invoices, possibly together with the net and gross weights and the dimensions of every crate. This will allow the machine tool agent to give precise instructions to the forwarding agent for the delivery of the machines, and mistakes will be avoided. The writer would recommend a shipping list to be sent to the machine tool agent together with the invoices as soon as the machines are shipped, this shipping list being made up about as shown in the accompanying illustration. Of course this illustration only shows an example, and special conditions may require modifications; but the principle is illustrated.

Another thing worth mentioning is that very small packages containing small tools, catalogues or circulars are frequently sent by express to European countries. This is a slow and expensive way and should be avoided whenever possible. It is preferable to make, if necessary, a number of parcels and to send them by parcels post, or, in the case of catalogues and circulars, as printed matter. It will cost much less and the packages will arrive much earlier.

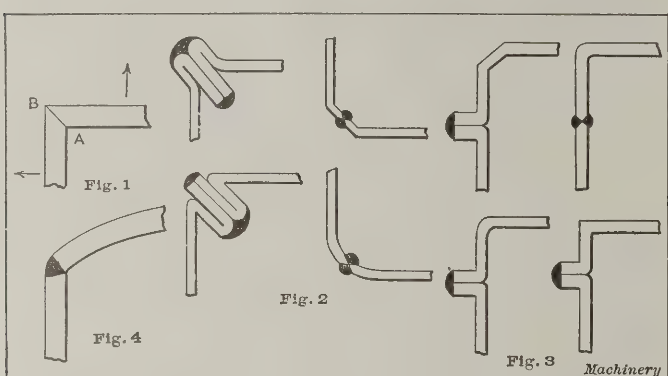
*Address: Via Morgagni, 28, Milan, Italy.

OXY-ACETYLENE WELDING OF TANKS AND RETORTS*†

By J. F. SPRINGER‡

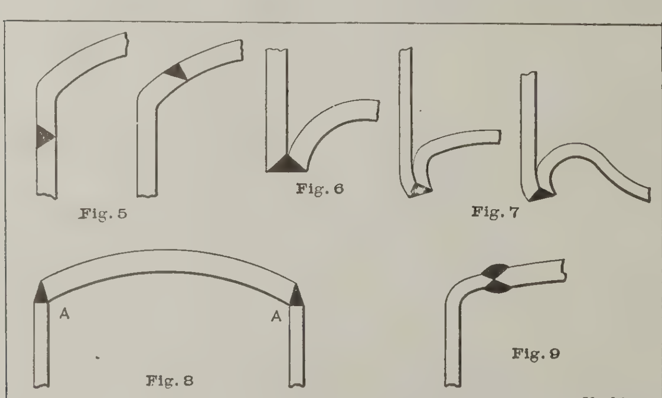
One of the most important applications of the oxy-acetylene welding process is in connection with the manufacture of tanks and cylinders from sheet metal. In this field the new process promises to supersede soldering and riveting to a very large extent. The advantage over soldering consists principally in the increased strength of the joint and the equality of the expansion and contraction of the metal in the seam and in the work. There is also much less likelihood of the occurrence of poisonous corrosions.

In constructing vessels of sheet metal which are subjected to alternations of high and low internal pressures, it is generally advisable to use special forms of joints at the corners or to avoid corner joints entirely. The stresses on the corner joints become very severe if the corners are of right-angled shape. If the corner is rounded, the effect of the internal pressure at the joint is reduced. In Fig. 1, for example, if the welded joint is made at the square corner *AB*, it will be located at the point where the stresses on it, acting as indicated by the arrows, will be most severe. By forming the joint in the various ways shown in Fig. 2, the weld will be



Figs. 1 to 4. Illustrations showing Various Methods of Making Welded Joints

considerably strengthened as compared with a weld that merely joins the two sides at the corner *AB* in Fig. 1. It is still better, however, to remove the joint from the corner altogether. In Fig. 3 are shown the methods used for doing this. The best method of all to relieve the welds of the excessive



Figs. 5 to 9. Methods of Welding Tops and Bottoms to Cylindrical Shells

corner stresses is, of course, to change the horizontal section to that of a circle.

Tops and Bottoms of Sheet-metal Vessels

One of the most difficult operations in the welding of tanks and retorts is the attaching of the tops and bottoms to cylindrical vessels. One of the first methods employed was that of making a joint as shown in Fig. 4. The welding was done from the outside and could be well finished. However, when the vessel was subjected to pressures from within, a combination of compressive and tensional stresses was produced at the weld, thus causing cracks. To overcome this difficulty, joints as indicated in Fig. 5, were made. Where the metal is quite thin, sufficient contact of the surface can be secured by bending the metal outward to form a kind of a flange. By using more welding material than necessary to produce a joint flush with the adjoining surfaces, a stronger weld can also be made.

In all these cases, the top or bottom is assumed to be convex on the exterior. Another method, shown in Fig. 6, is to make it concave on the outside. Such forms are especially suitable for bottoms. In Fig. 6 the rim of the bottom is bent and the edges of the bottom and of the cylinder are both beveled to provide a welding groove. Another method which does not necessarily include concaving is to bend up the rim of the bottom for a short distance, the dimensions of the piece being such that this rim snugly envelops the cylinder; the two may then be welded together.

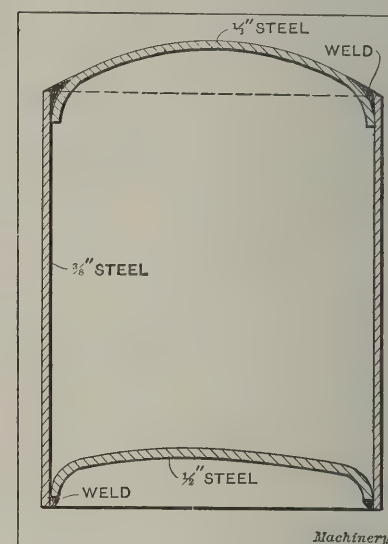


Fig. 10. Example of Tank welded by the Oxy-acetylene Process

The use of flat tops and bottoms should, of course, be avoided. The expansion and contraction of these during welding are different from those of the cylinder. The flat piece does not yield to the cylinder, and, hence, the work is likely to be distorted. The convexing and concaving of the tops and bottoms provides a suitable margin for yield. Two forms of bottoms are shown in Fig. 7, in both of which elasticity in the diameter is provided for. The bending in of the edges enables the cylinder wall to support the bottom when the latter is under pressure from within. In some cases it may be necessary to prevent diametral expansion of the cylinder when welding. A heavy removable band of metal in the form of a hoop may be used for this purpose. It is placed close up to the location of the seam. Most of the heat from the cylinder will then be absorbed and dissipated by this hoop.

An interesting example of the application of the foregoing principles is afforded by a large containing vessel constructed by Munk & Schmitz, Cologne-Bayenthal, Germany. This vessel is a cylindrical shell, closed at top and bottom, and is formed of sheets 0.40 inch thick in the cylindrical portion and 0.83 inch thick in the end portions. The vessel is 15 feet high and over 9 feet in diameter. All joints were made by the oxy-acetylene torch and the vessel successfully withstood, when tested, a pressure of 90 pounds per square inch.

General Considerations in Welding Tops and Bottoms to Cylindrical Vessels

If the joining of the top to the cylindrical shell were made at the precise point where geometrically the side of the wall joins the top, as shown in Fig. 8, an outward pressure exerted from within and tending to produce a spherical shaped bottom, would tend to make the angles at *A* more obtuse and would thus produce a tensional stress on the inner portion and a compressive stress on the outer portion of the weld. Hence, it should be carefully noted that this method of joining ends to cylindrical shells is objectionable, and that the methods shown in Fig. 5 should, in general, be adopted.

It is also very important in forming welds of the type described not to forget the effects of expansion and contraction. It is recommended that the weld be hammered during the cooling-off process. The hammering should be discontinued while the metal is still quite hot, and should not be continued below the point where a horse-shoe magnet attracts the iron; in fact, at this point, one has perhaps gone a little too far. Subsequent to the cooling, the region that has been exposed to the high temperature should also be well annealed. This

* For further information on autogenous welding, see "Modern Welding Methods," MACHINERY, December, 1911, and the previously published articles there referred to.

† This article was prepared with the cooperation of the Davis-Bournonville Co., N. Y., and is a chapter from a forthcoming book: "Oxy-acetylene Torch Practice."

‡ Address: 608 West 140th St., New York.

may be done by using two oil torches for gradual re-heating, one from the inside and one from the outside. Incidentally it might be mentioned that in performing the welding operation it is also often advisable to use two welding torches, in which case a weld of the double-V character, as shown in Fig. 9, will be produced. The bottom of such a vessel should be so arranged that the weld is not located where the weight of the vessel itself comes upon it.

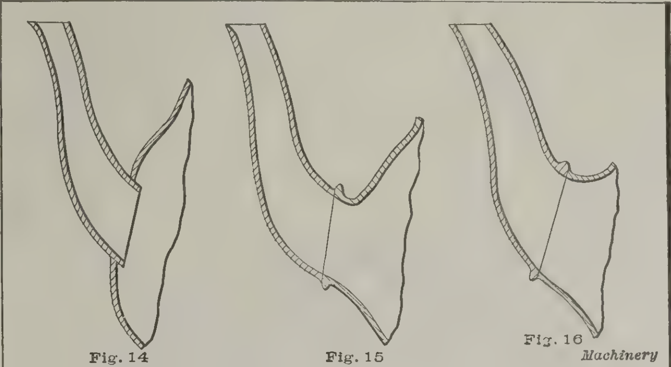
As an interesting practical example, the illustrations Figs. 11, 12 and 13 are shown, indicating the progressive steps in welding a cylindrical shell, as well as the welding of a top and bottom to it. A diagrammatical view of a section of the welded container is shown in Fig. 10, the work being done by the Vilter Mfg. Co., Milwaukee, Wis. It will be seen that the top is convex and the bottom concave, as viewed from the outside. The shell is of ⅜-inch boiler iron; the metal in the heads is ½ inch thick. The tank is 20 inches in diameter and 24 inches long. Both heads fit the inside of the shell as indicated.

After welding, this tank was tested at a pressure of 1200 pounds per square inch. For carrying out the test, a hole was drilled on one side of the shell and a nipple inserted after tapping. The tank was then connected with a hydraulic press pump. At 1100 pounds pressure the nipple started to leak, but there was no leak at the welded joints. A No. 7 Davis-Bournonville tip was employed in making the straight weld in the shell, and a No. 8 tip was used for the ends. The straight weld was made in 45 minutes at a cost of $1.62 (exclusive of labor, but including depreciation); the circular weld at the convex end required 2.67 hours and cost $6.99; the circular weld at the concave end required two hours and cost $5.24. At thirty cents per hour, the labor cost would be about $1.63, making a total cost of $15.48. These tanks are used at a maximum working pressure of three hundred pounds per square inch. A water cooled torch was employed in part of this work.

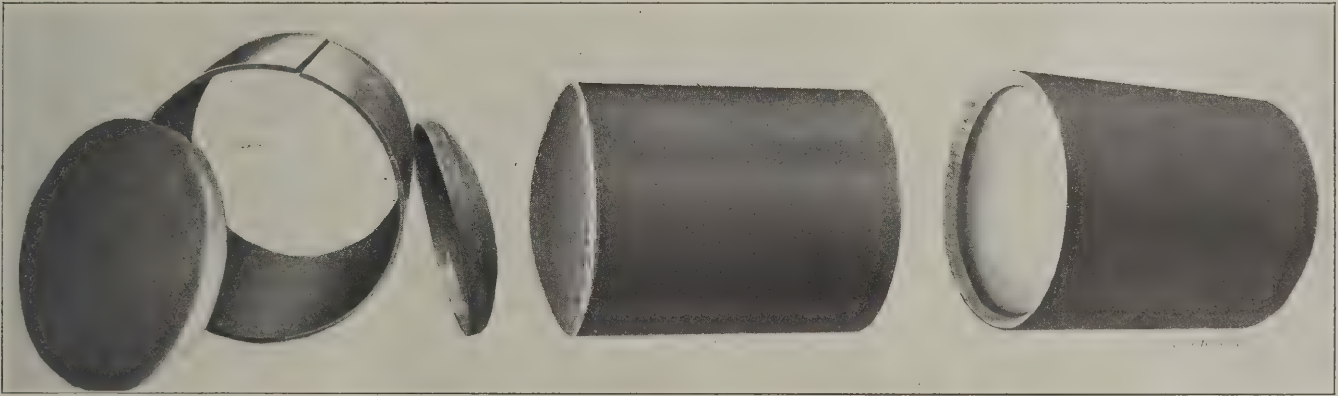
Autogenous Welding of Copper

While copper is normally tough and ductile, it enters a brittle stage when heated to about 1650 degrees F. This brittleness continues up to the melting point (at about 1930 degrees F). In order to weld copper it must be heated to this critical stage. At these high temperatures copper possesses a remarkable capacity for absorbing certain gases. If exposed to the atmosphere while at a white heat it absorbs oxygen. Another peculiar quality of copper is that when heated to a high temperature, quenching in water has a softening or annealing effect. Copper that has been highly heated and oxidized will, however, begin to fracture when one commences to hammer it, even if it has been annealed; hence, it is very important to prevent oxidation when welding, and by proper management of the outer flame of the oxy-acetylene torch the operator may succeed in preserving the new copper in the weld from oxidation. To make perfect work, however, it is necessary also to preserve the old copper, and here is where difficulties are met with. On account of the great heat conductivity of copper, a high temperature will be found for some distance on either side of the joint to be welded. Unless the operator can protect this outlying region, the results will not be satisfactory.

It is well known that phosphorus has a great avidity for oxygen. If, then, instead of a very pure copper we use a phosphor-copper alloy when welding, good results may be expected. A welding powder containing a percentage of phosphorus may also be used to secure a de-oxidation. Investigations along these lines are now being carried on in Germany, the exact results of which are not yet known, but it can be stated, in a general way, that good welding powders for copper can be made of such mixtures as borax, phosphor-natrium and prussiate of potash. The borax is not commercial borax, but that which has been subjected to a high temperature in a crucible and has then been pulverized. Boracic acid may be used instead of borax. The powder is prepared by mixing the boracic acid and the phosphor-natrium. Welding powders of this description form a film over the work and thus exclude the atmosphere. It is recommended when welding copper sheeting to spread the powder containing phosphorus for about 1½ inch on either side of the joint. This powder is then melted before the welding operation proper is begun. As there is some possibility of blowing away some of the powder when used in this way, it would seem desirable to apply it in the form of a paste.



Figs. 14, 15 and 16. Methods of Welding Spouts to Household Utensils



Figs. 11, 12 and 13. Progressive Steps in Making the Tank shown in Fig. 10

The Welding of Aluminum

The coefficient of expansion of aluminum is equal to twice that of steel and its melting point compared with that of copper and steel is rather low, being about 1215 degrees F. It is also comparatively weak in tension. Cast aluminum resists a tensional stress of about 10,000 pounds per square inch. Because of this weakness, and on account of its high rate of expansion and contraction, it is a difficult material to weld. As its heat conductivity is high, it is also difficult to localize the region of the high temperature. Oxidation of aluminum, however, can be avoided by the use of a proper flux.

While the total expansion and contraction from 100 degrees F. to the fusion point or welding temperature is about the same for cast iron and aluminum, because of the fact that the fusion point of cast iron is at a temperature about twice that of the fusion point of aluminum, the expansion and contraction, due to temperature changes, take place much more rapidly with aluminum, and the operator must use special care on this account. The low temperatures dealt with when welding aluminum make the pre-heating easier, but the operator must guard against not exceeding the fusion temperature. It is sometimes possible to make slight saw cuts here and there, and thus assist in making the effects of expansion and con-

traction harmless. These cuts, of course, must be repaired when the main operation is completed. Aluminum should never be welded without a flux. If welding is attempted without a flux, little globules consisting of aluminum within and a coating of alumina (oxide of aluminum) will appear. In order to eliminate these by heat, it would be necessary to raise the temperature to the melting point of the oxide of aluminum, which is about 5400 degrees F. A flux consisting of the following ingredients has been recommended: chloride of sodium, 30 parts; chloride of potassium, 45 parts; chloride of lithium, 15 parts; fluoride of potassium, 7 parts; and bisulphate of sodium, 3 parts.

When melting new metal from a rod, it is good practice to keep the rod constantly submerged in the molten bath of the metal in the welding groove, which for aluminum should be much larger than usual. If no powder is used, the oxidation is then confined to the upper surface. The main point to remember when welding aluminum is that the fusion point of this metal is very low; hence, the working flame should be kept further away from the metal than is usually the case

Fig. 17. Example of Welding Copper. Kettle is 5 feet 6 Inches in Diameter, 31 inches deep and used under Pressure. All Seams are welded on Both Sides

when welding cast iron and steel. The torch should be so adjusted as to furnish an excess of acetylene. There need be but little fear of carbonizing the metal, for the reason that the temperature of the work is comparatively low.

The Welding of Household Utensils

Some forms of household utensils, such as, for example, coffee and tea pots, cause considerable difficulties in their manufacture, particularly in connection with the attachment of the spout. Soldering has been used to a great extent in making these joints. However, the basic material of the solder is altogether different from the material united. The uses to which the vessels are put expose the joints to the action of acids, and galvanic currents are set up which injure the joint. Aluminum vessels are especially exposed to the action of these currents, because this metal is electro-positive to nearly all of the common metals. One means to obviate the difficulty is to bend the metal of the main vessel or body inwards at the hole for the spout. The material of both body and spout is then bent into a fold on the interior, no soldering material being used. The presence of this fold on the inside, however, is very objectionable. Even though it is closed when the vessel is new, the effect of repeated heatings is liable to open it, and the crevice becomes a trap for various small particles, which prevents effective cleaning. The oxy-acetylene welding presents the best solution of the foregoing difficulties.

When seeking to unite the spout and body by the oxy-acetylene torch, the worker is, however, confronted with several difficulties, especially if the sheet metal be aluminum. The expansion and contraction of aluminum, due to temperature changes, as already mentioned, is very rapid, so that the operator must guard against distortions of the work. The melting point of the metal is low, so that holes are apt to be made in thin metal. Heated aluminum is very readily oxidized with the result that a proper intermingling of the material is difficult. In view of these facts, it is recommended that the joint be placed away from the main body, that welding wire be dispensed with, and that a suitable flux be employed. In Fig. 14 is shown a joint which eliminates the necessity for the welding wire; the spout fits closely into the hole and is introduced far enough to protrude about 1/8 inch into the interior, the projection thus furnishing the welding material. There is considerable advantage, of course, in thus eliminating the handling of the wire as far as the worker is concerned, and another advantage is that the welding material is precisely the same as the material of the work. It is difficult, however, to operate on the interior, but this difficulty may be reduced by using a tip of special form. The appearance of the exterior, however, is good.

Another form of joint is shown in Fig. 15. Here the diameter of the hole is first made smaller than the interior diameter of the lower end of the spout. The material is then bent outwards to form a ridge of the same diameter as that of the spout end. The body and spout can then be butt-welded by using welding wire. It is preferable, however, to bend the edge of the projection from the vessel outward, thus supplying the needed welding metal, or the auxiliary metal may be provided by bending the edge of the spout outwards, a joint of this kind being shown in Fig. 16. In either case, the ring of metal protruding at the joint will not be thicker than 1/8 inch in a radial direction. In both cases, the interior is smooth.

* * *

COST OF MAINTENANCE OF GASOLINE MOTOR TRUCKS

An interesting paper was presented by Mr. Louis Ruprecht, before the summer meeting of the Society of Automobile Engineers, at Detroit, June 27-29, 1912, on the "Cost of Work with Gasoline Motor Trucks." It may be of interest to quote a few of the figures given, as the motor truck is now looked upon with considerable interest by many manufacturers. The depreciation may be figured at from 10 to 15 per cent per year, the tire value being deducted from the cost of the complete vehicle and the tires considered independently. The drivers' wages on a half-a-ton delivery wagon may be assumed to be about $2.75 per day, and on larger trucks from $3.00 to $4.00 per day. The garage charges, including only the washing and storing of the vehicle, are on an average from $240 to $300 per year, according to the size. The tire cost should be figured on the basis of a life of 8000 running miles, as guaranteed by the makers. The gasoline cost may be taken as about 11 cents per gallon, although at times it may be somewhat higher. Oil may be assumed to be 30 cents per gallon, and one gallon of oil will be sufficient for 50 to 125 running miles according to the size of the vehicle. The insurance will come from $100 to $250 per year according to the size. Repairs and replacements should be figured up to 3 cents per mile in the case of heavy trucks. This figure is based on extensive records.

Based on these figures a table has been compiled which gives, in the first place, the fixed charges per day for different sizes of vehicles, and in the second the additional running cost per mile. For example, the cost of operating a six-ton truck, all charges included, 45 miles per day, will be $\$6 + (0.1540 \times 45) = \$12.93$. The figures presented by the author also show conclusively that wherever a large tonnage is to be handled it is of the highest importance to use a few large units instead of many small ones.

Size of Vehicle	Fixed Charges	Increment Per Mile
1000-pound	$5.07	$0.0686
3-ton	5.33	0.0860
5-ton	5.60	0.1253
6-ton	6.00	0.1540
7-ton	6.15	0.1718
12½-ton train	7.40	0.2070

* * *

The data on the effect of vanadium in high-speed steel, given in the July number, was erroneously attributed to a publication issued by the American Vanadium Co., Pittsburg, Pa. The data should have been credited to the Vanadium-Alloys Steel Co., Latrobe, Pa.

THE STURTEVANT AERONAUTICAL MOTOR*

By CHESTER L. LUCAS†

Although the past few years have witnessed remarkable achievements in mechanical flight, it is evident, from the constantly recurring accidents, that, at best, aerial navigation is still extremely hazardous. Many of these accidents have been due to motor troubles of some form, and it is generally admitted that the majority of the present-day motors are inadequate, either through faulty design, poor workmanship or both. In the mad race for a light-weight motor, safety seems to have been almost entirely disregarded by introducing freaky designs and employing unsuitable light-weight materials; moreover, some of the workmanship displayed has been unmechanical, to say the least. The really reliable motors are few in number.

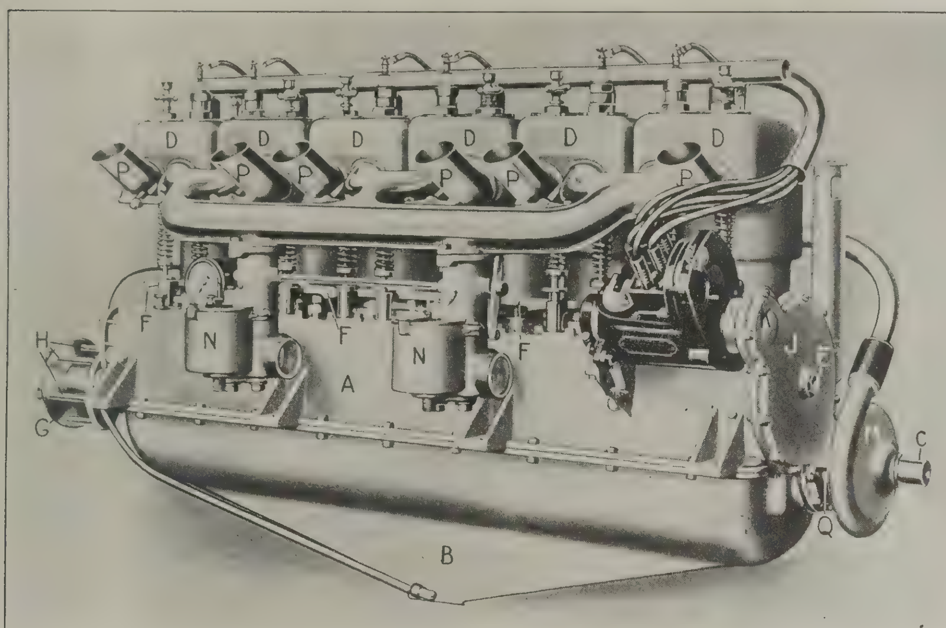


Fig. 1. The Sturtevant Aeronautical Motor, Six-cylinder

The ideal aeronautical motor should possess certain fundamental qualifications; these qualifications may be briefly summed up in the order of their importance: First it should be capable of continuous satisfactory performance at various angles over long periods; second, it should produce the maximum amount of power for a given weight, at the same time being economical in consumption of gasoline and lubricating oil; and third, it should be refined in appearance and operation, being hooded and muffled so as to be as small a source of distraction to the aviator as possible. This latter consideration is not, perhaps, as important at the present time as it will be in the future of aviation when the use of aeroplanes in war will necessitate that the motors employed be as nearly noiseless as possible, and when aeroplanes become more common it does not seem fanciful to state that there will be active legislation to silence aeronautical motors.

Distinctive Types of Aeronautical Motors

Generally speaking, aeronautical motors may be divided into two distinct classes: namely, those of the rotary type, in which the cylinders are arranged radially and constitute a revolving member about a stationary hollow shaft fitted with an inlet valve, and those of the stationary type in which the cylinders do not revolve. Under this latter head may be included those motors in which the cylinders are arranged vertically and in tandem; those in which the cylinders are placed in the form of a V, commonly known as the V-type; and those in which there are but two cylinders which are sometimes placed directly opposite each other as in the opposed type. Some motors operate on the four-cycle principle, while others are of the two-cycle type. Each of these different forms of motors has qualifications more or less important in its favor, but most of them have objectionable features to offset these qualifications.

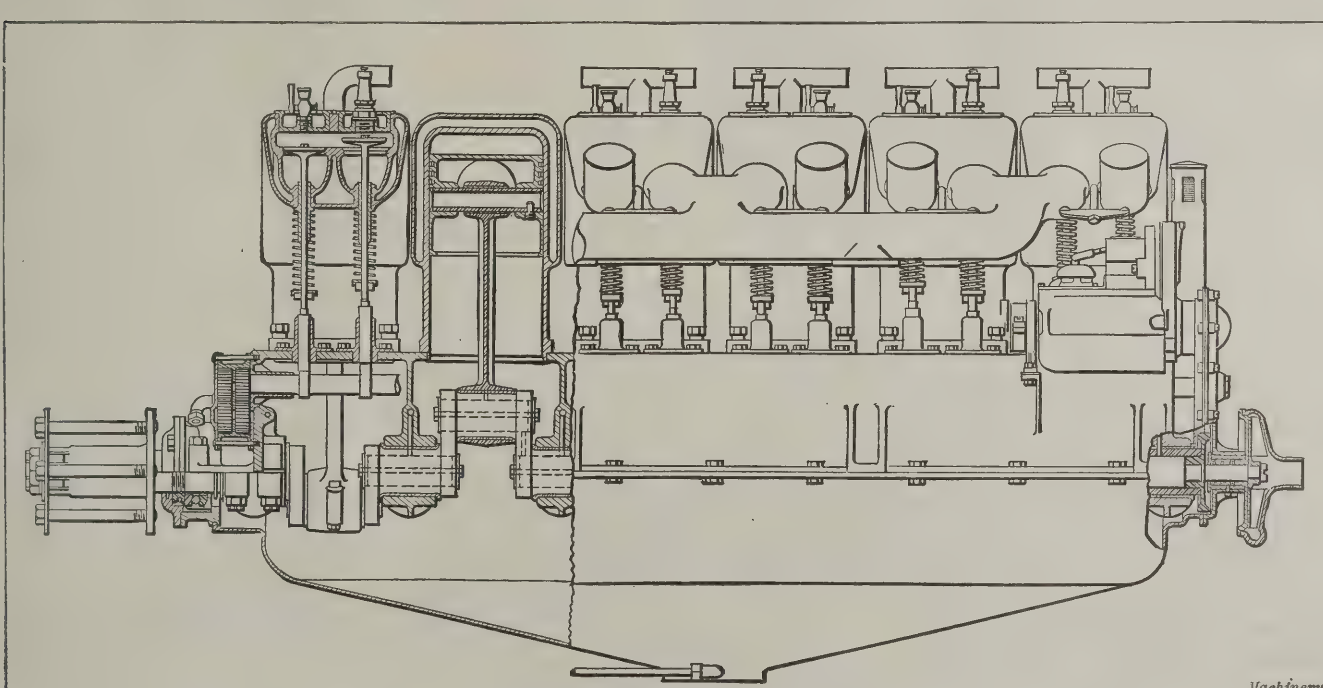


Fig. 2. Construction of Sturtevant Motor, Six-cylinder

The Rotary Type of Aeronautical Motor

Without doubt the rotary type of engine, of which the Gnome make is representative, is at present the most powerful type of motor in proportion to its weight. Its advantages, aside from being of light weight, are that up to certain powers it may be satisfactorily air-cooled; the torque

* For additional articles on this and kindred subjects, see MACHINERY, September, 1911, engineering edition, "Seventy-two Horsepower Adams-Farwell Aviation Motor; January, 1911, engineering edition, "Aeroplanes and Airship Engines" and articles there referred to.

† Associate Editor of MACHINERY.

is exceptionally uniform, due to the fact that while in operation, the group of cylinders acts as a flywheel, so of course no added weight is given to the motor. An additional advantage is present in this type of motor in that all the cylinders are in one plane, thus minimizing the effect of unbalanced forces.

On the other hand, however, the head resistance offered by a motor of this type is considerable; there is a large waste of lubricating oil due to the centrifugal force which tends to throw the oil away from the cylinders; the gyroscopic effect of the rotary motor is detrimental to the best working of the aeroplane, and moreover it requires about seven per cent of the total power developed by the motor to drive the revolving cylinders around the shaft. Of necessity, the compression of this type of motor is rather low, and an additional disadvantage manifests itself in the fact that there is as yet no satisfactory way of muffling the rotary type of motor.

Stationary Type of Motor

The advantages and disadvantages of the stationary type of motor may be summed up by considering the same points

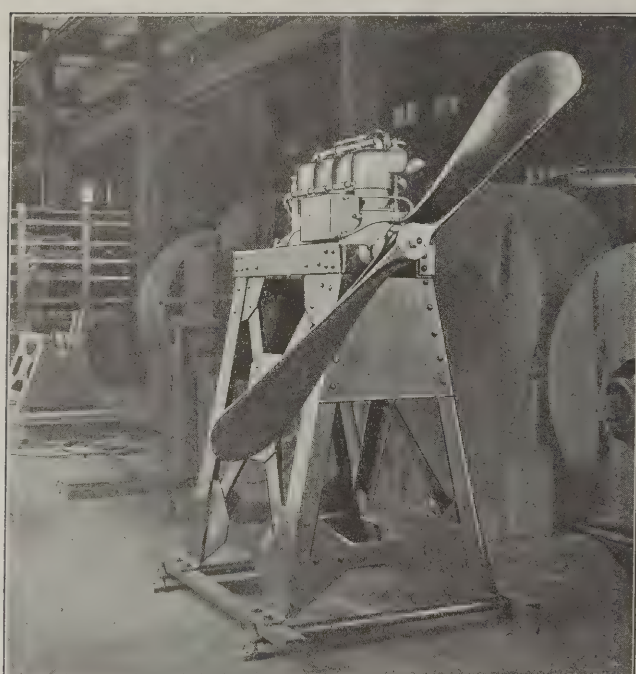


Fig. 3. Four-cylinder Motor mounted on Testing Stand

as set forth in connection with the rotary type. Of necessity, it is heavier in proportion to the power developed; it is not successfully air-cooled, nor is the torque as uniform. The reciprocating movements cause wear and loss of power and except for engines employing six or more cylinders, the balance is not nearly as good in this type of motor.

On the other hand, the head resistance of the stationary type of motor is much less than in the case of the rotary motor; it is very economical in its use of lubricating oil, and it has little gyroscopic effect upon the aeroplane. Less power is consumed in driving a revolving member about the shaft; when water-cooled, the compression may be kept high and it may be satisfactorily muffled, if desired.

While a much simpler motor may be designed by employing the two-cycle principle, its operation is not nearly as satisfactory as the four-cycle, and there are many sources from which trouble may arise. The V-type of motor is usually employed when the cylinders are above six in number, mostly on account of the compactness of this cylinder arrangement. The increased head resistance offered by this type of motor is, however, considerable. The opposed type of motor is seldom used except on two-cylinder engines.

Performances of Various Makes of Aeronautical Motors

The accompanying table has been compiled to show general characteristics and performances of several makes of aeronautical motors. The data used has been furnished by the respective makers of these motors and it is believed that this table should be of assistance to those interested in aeroplane power plants.

The Sturtevant Aeronautical Motor

The Sturtevant aeronautical motor was recently brought out by the B. F. Sturtevant Co., Hyde Park, Mass. Fig. 1 shows

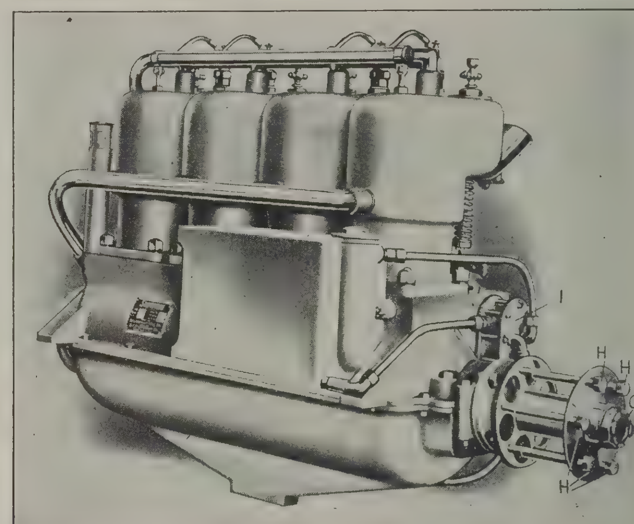


Fig. 4. Rear View of Four-cylinder Motor showing Method of Attaching Propeller

the general appearance of the six-cylinder motor, rated at 60 H. P., and Fig. 2 shows the same motor partly in section. The motor is also built as a four-cylinder type, rated at 40 H. P. This motor is shown in Figs. 3 and 4, and in Fig. 13, where it is set up ready for a propeller test. In designing this motor, the primary consideration was to build an absolutely reliable engine which could be depended upon when making long flights. While the weight has been reduced at every point possible, it has not been done at the expense of strength or reliability. The motor is of the stationary type, having either four or six cylinders. The company has endeavored to make this motor conform as nearly as practicable to the automobile type of motor, for the reason that this type of motor has been found the most practical for general use as evidenced by its employment in automobiles and, though a secondary consideration, it seems to be one which is generally appreciated by the average mechanic.

Crankshaft

The crankshaft which may be seen at *C* in Fig. 9 and in detail in Fig. 5, is machined from a bar of 3½ per cent nickel steel, containing 0.40 per cent carbon. After being machined, the crankshaft receives two heat treatments and has an ultimate tensile strength of 125,000 pounds per square inch of section. The bearings of the crankshaft are each 2⅜

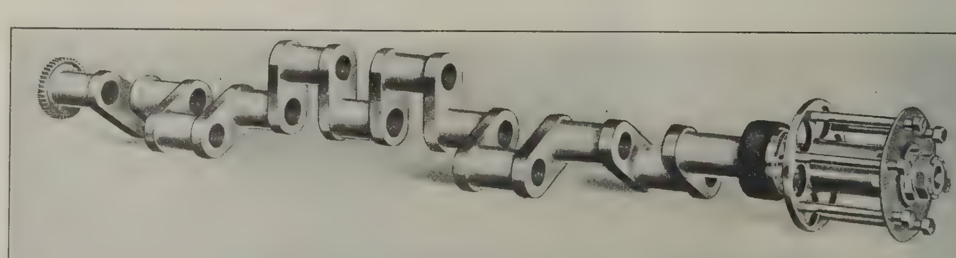


Fig. 5. Six-throw Crankshaft

inches long and are 1¾ inch diameter, the pins also being of the same dimensions. In order to lighten the crankshaft as much as possible, the pins and bearings are drilled and bored, the drilling operation being shown in Fig. 10, and the boring operation being illustrated in Fig. 11. The drilling of the pins and journals is accomplished by strapping the crankshaft to a suitable base located upon the Prentice Bros. drilling machine as shown. The boring to size is done in a

lathe by means of special boring-bars of the proper sizes. It is interesting to note that in finish-boring the crankshaft, the diameters of the holes in the successive journal bearings decrease regularly commencing with the first cylinder, which is bored to a diameter of 1⅜-inch and thence down to the sixth cylinder which is bored to a diameter of 1 inch. The reason for this is that at the driving end of the crankshaft, it is not necessary that there be as much strength as at the position of the sixth bearing where the power delivered by all six of the connecting rods is being transmitted. The pins are bored uniformly in order to preserve the balance of the crankshaft. These hollow pins and journal bearings are connected by drilled cross holes, and by closing the ends of the holes in the journals and pins by suitable caps *R*, shown in Fig. 9. The crankshaft is thus provided with a lubricating duct through which oil may be pumped. Fig. 12 shows the operation of grinding the pins and journals on a Norton grinding machine. The propeller end of the crankshaft is fitted with a ball thrust bearing shown at *T*, Fig. 9, which may be arranged to take the thrust in either direction as desired. The method of attaching the propeller is worthy of noting. The end of the crankshaft which receives the propeller is slightly tapered; a flange *G*, Fig. 1, is provided having six holes to correspond with the attaching bolts *H*, and the opening in the flange is castellated to slide over the end of the shaft which has, in turn, been castellated to receive this flange. Thus, by means of the flange the propeller is supported from both sides and the tendency of shearing the attaching bolts is distributed over both ends of the hub.

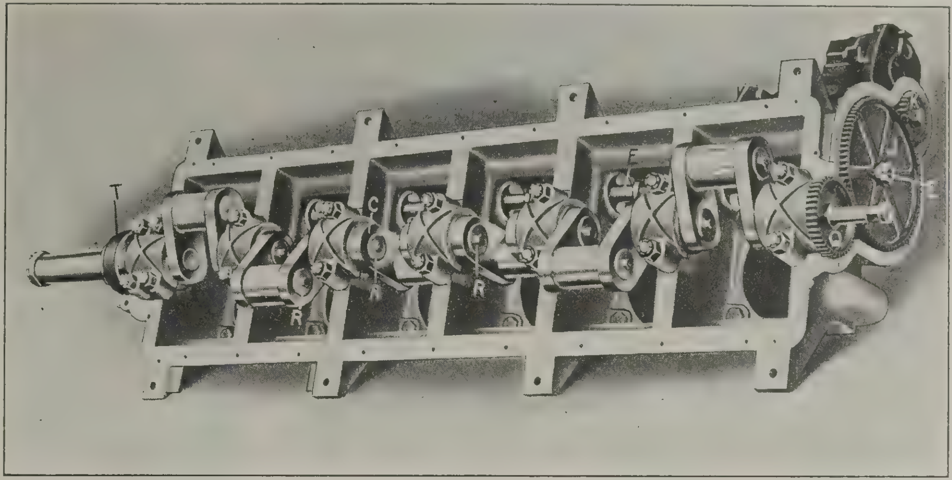


Fig. 9. Crankshaft and Base, showing Method of Mounting

Connecting-rods

The connecting-rods are made from drop-forgings of 3½ per cent nickel-steel and are of I-section. The bearings are die-cast bushings of Parsons white brass. When it is stated that some connecting-rods are made of non-ferrous metals it will be readily understood how inadequate they must be for use as aeronautical motor connecting-rods, and it is little wonder that they will not do the work required. Sturtevant connecting-rods are balanced with respect to the center of gravity, being placed on balances with opposite ends together; that is, the large end of one connecting-rod, together with the small end of another connecting-rod, is placed in the pans on one side of the balances, while the opposite ends are placed in the pans on the other side of the balances. Before being machined and balanced, the connecting-rods are heat-treated in accordance with the S. A. E. specifications. The connecting-rod caps are adjusted in position by the use of shims of laminated metal. Pieces of this metal are shown in Fig. 14 and, as will be seen, the metal is about 3/32-inch thick, and is composed of many thicknesses of thin sheet brass, each 0.002 inch thick and sweated together with soft solder. Successive layers of the metal may be easily pulled off as required in adjusting the boxes.

Pistons

The pistons, one of which is shown in Fig. 6, are cast from semi-steel having a tensile strength of 40,000 pounds. The exterior of the piston is ground and balanced to within two drams of standard weight. This balancing is done by removing metal from a boss which is left projecting within the interior of the piston, enough metal being removed to bring the pistons to standard weight. The piston rings are cast iron, of the ordinary type and are three in number. The piston pins are of 3½ per cent nickel steel and are bored hollow to reduce weight.

Cylinders

The cylinders, as shown in Fig. 7, are of the L-type, having the exhaust and intake valves located on the same side. An important reason for selecting this type of cylinder lies in the fact that with the straight cylinder which has been used to a large extent on aeronautical motors, there is always danger from broken valve parts being caught in the cylinder and causing damage to the motor. Of necessity, on cylinders of this type, the water jackets are cast integral. Experiments have been conducted in electro-depositing copper jackets, but so far, at least, the integral jacket seems to be the most satisfactory. The metal from which the cylinders are cast is the same semi-steel mixture from which the pistons are cast, and, of course, the jackets are made as thin as it is possible to cast the metal. After being machined, the cylinders are

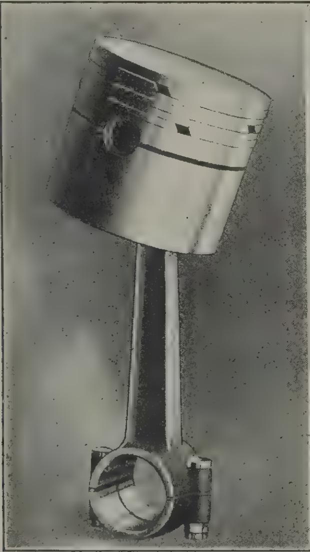


Fig. 6. Piston and Connecting-rod

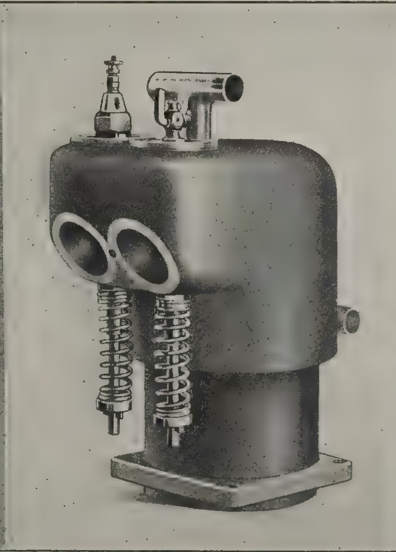


Fig. 7. Cylinder

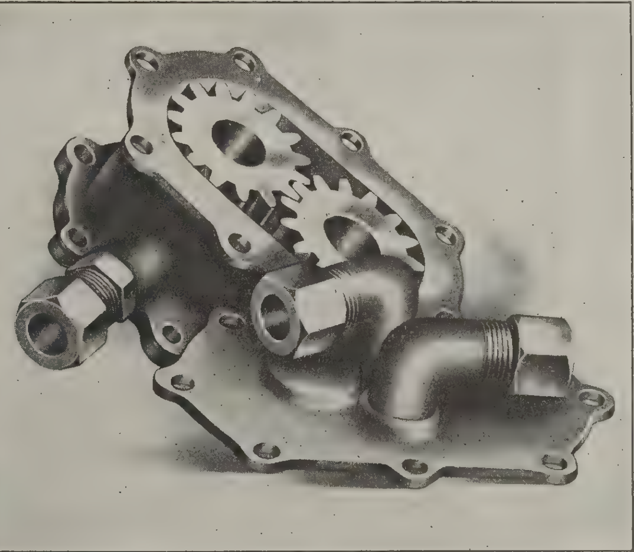


Fig. 8. Lubricating System Pump

hydraulically tested to 600 pounds per square inch. They are then heat-treated and accurately ground. The ratio between the stroke and the bore of these cylinders is 1 to 1, the stroke and bore each being 4½ inches. Upon this point of cylinder design there seems to be a difference of opinion, some designers being in favor of long stroke motors, while others consider the short stroke to be the better.

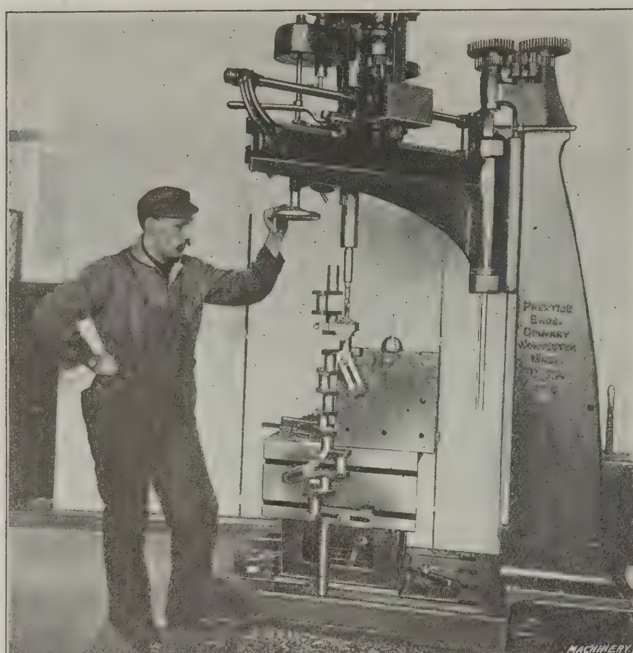


Fig. 10. Drilling out the Pins of the Hollow Crankshaft

Camshaft, Valve Mechanism and Other Parts

The camshaft, a portion of which may be seen at E, Fig. 9, is turned and ground from nickel steel, being ground with the Norton cam-grinding attachment. Previous to being finish-ground the camshaft is pack-hardened. Upon the forward end a gear J is mounted which transmits motion from the gear Q on the crankshaft to give rotation to the camshaft. This gear J also acts as an intermediate gear in the driving train which operates the magneto L, Fig. 1. These parts are also shown in Fig. 9. The camshaft is supported throughout its length in phosphor-bronze bearings. The inlet and exhaust valves for each cylinder, made of 30 per cent nickel steel, are located in the pockets cast integral with the cylinders. The exhaust pipes are shown at P in Fig. 1. The water pump, M, Fig. 1, is attached directly to the end of the crankshaft, the inlet C being coupled to it.

Means are provided for starting the motor in mid-air; this is an advantage in that it will enable an aviator to shut off his motor while "volplaning," and yet be able to start it again at will without landing. Referring to Fig. 1, at F may be seen a valve-lifting rod whose function it is to lift the exhaust valves, should the motor stop while in flight. By thus lifting the exhaust valves, the action of the air on the propeller will cause the motor to start automatically. The base of the motor, indicated at A, is a strong aluminum casting reinforced throughout and the cylinders are held to this base by means of four bolts, each of which passes through flanges on the cylinder bases. The construction of this base is illustrated in Fig. 9, and as will be seen, the bearings for the crankshaft are bolted to the under side. These bearings are die-cast bushings of Parsons white brass. The oil pan or sump B shown in Fig. 1, is of slightly different design than that ordinarily used. As the deepest point is at the center, the oil will gravitate toward the center of the sump, even though the motor be operating in an inclined position.

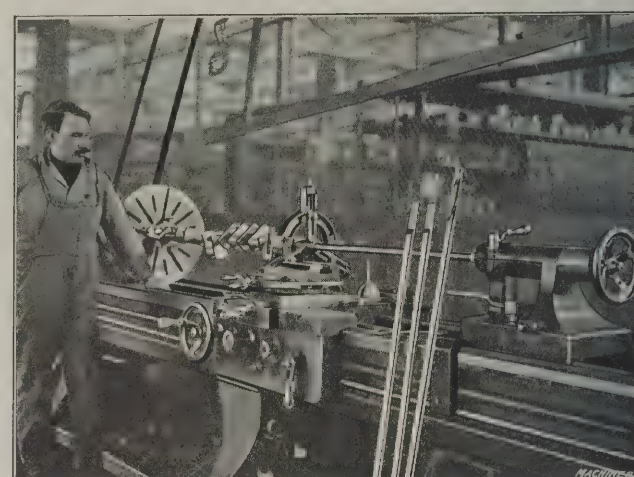


Fig. 11. Boring the Journal Bearings

Lubricating System

The lubrication system employed in the Sturtevant aeronautical motor is of more than ordinary interest. The fundamental idea in designing this system was to provide a method of lubrication that would be absolutely dependable. By means of a pressure pump shown in Fig. 8, driven directly from the end of the camshaft, the oil is forced through cored holes in the base and into the hollow crankshaft already described. It is thus distributed to the bearings in which the crankshaft runs, and also to the connecting-rod bearings. From these points the oil flies in a fine spray to all parts

COMPARATIVE DATA ON LEADING AERONAUTICAL MOTORS

Name	Rated H.P.	Speed*	Dev. H.P.	Weight	Wt. per H. P.	Type	No. Cylin.	Cycle	How Cooled	Gaso-line†	Lub. Oil†	Prop. Diam.	Prop. Pitch	Prop. Thrust	List Price
Sturtevant	40	1200	46	200	4.34	Vert.	4	4	Water	4.87	0.303	7′ 6″	4′ 6″	375	1500
Sturtevant	60	1200	69	300	4.34	Vert.	6	4	Water	7.31	0.455	8′ 0″	5′ 0′	450	2000
Hall-Scott	40	1250	35	160	4.57	Vert.	4	4	Water	3.50	1.000	7′ 0″	5′ 0″	300	1500
Hall-Scott	60	1250	70	265	3.78	V	8	4	Water	7.00	1.500	7′ 6″	5′ 0″	400	2250
Hall-Scott	80	1250	70	290	4.14	V	8	4	Water	7.00	1.500	7′ 6″	6′ 0″	500	2750
Gnome	50	1200	42	167	4.00	Rot.	7	4	Air	4.00	0.375	7′ 6″	7′ 0″	420	3000
Gnome	70	1200	63	212	3.35	Rot.	7	4	Air	6.00	1.000	8′ 0″	8′ 0″	500	4000
Renault	50	1800§	59.4	420	7.07	V	8	4	Air	......	......	......	......	......	3200
Renault	70	1800§	79.8	453	5.66	V	8	4	Air	......	......	......	......	......	3700
Gyro	50	1200	48	165	3.30	Rot.	7	4	Air	4.25	1.500	7′ 9″	5′ 2½″	420	2000
Roberts	50	1200	51	170	3.33	Vert.	4	2	Water	6.00	0.133	7′ 6″	5′ 3″	320	1500
Roberts	75	1200	70	270	3.43	Vert.	6	2	Water	9.00	0.200	8′ 6″	5′ 6″	480	2200
Curtiss	40	1100	45	175	3.90	Vert.	4	4	Water	4.20	0.750	7′ 0′	6′ 0″	310	1200
Curtiss	75	1000	78	285	3.65	V	8	4	Water	7.2	1.2	7′ 6″	8′ 0″	500	2200
Kirkham	50	1300	54.5	235	4.31	Vert.	6	4	Water	5.00	0.33	7′ 2″	5′ 0″	410	1400
Kirkham	35	1300	38.3	180	4.83	Vert.	4	4	Water	3.68	0.21	6′ 10″	4′ 6″	300	975
Kirkham	70	1680	76.3	285	3.40	Vert.	6	4	Water	7.71	0.42	8′ 0″	8′ 0″	500	1650
Adams-Farwell	72	1000	80	285	3.56	Rot.	5	4	Air	......	0.5	9′ 6″	6′ 6″	460	2500
Adams-Farwell	125	‡	......	......	2.25	Rot.	6	4	Air	......	0.75	9′ 6″	6′ 6″	......	3000
Trebert	100	1000	90	350	3.70	V	8	4	Water	8.75	0.25	8′ 0″	8′ 0″	450	1500
Trebert	50	900	50	250	5.00	Rot.	6	4	Water	5.25	0.15	7′ 6″	7′ 6″	250	2000
Maximotor	50	1050	50	210	4.20	Vert.	4	4	Water	......	0.50	7′ 6″	4′ 6″	360	1200
Maximotor	75	1350	75	320	4.25	Vert.	6	4	Water	......	0.68	......	......	400	1600
Maximotor	70	1350	70	270	3.86	Vert.	4	4	Water	......	......	......	......	......	1500
Maximotor	105	1350	105	390	3.83	Vert.	6	4	Water	......	......	......	......	......	2000

* Recommended by manufacturer. † Consumption in gallons per hour at developed H.P. ‡ Cylinders revolve 800 R.P.M. in one direction and crankshaft 1000 R.P.M. in opposite direction. Both are direct-connected to two propellers. § Propeller revolves at one-half engine speed or 900 R.P.M.

of the mechanism enclosed within the crank case, finally gravitating to the sump. Mounted in tandem with the first pump is a second pump. This pump is of slightly greater capacity and its function is to remove the oil from the sump, force it through the oil filter and into the tank ready to be used again. As this second pump is of slightly greater capacity than the pressure pump, the sump is always kept drained, and, moreover, as the filter is in advance of this pump, the oil is *forced* through the filter. In the event of the filter becoming clogged, the pump would exert sufficient force to burst the filter and prevent the lubrication system from failing. These pumps are shown detached from the motor in Fig. 8.

The lubricating oil storage tank holds sufficient oil for three

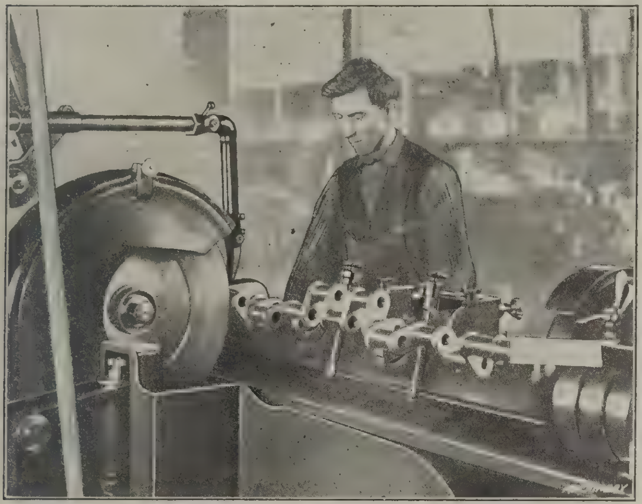


Fig. 12. Grinding the Crankshaft

hour's use and by virtue of the form of sump employed, there is no danger of overlubrication of the end cylinders when the motor is being operated continuously at an angle, since the sump is kept drained of its oil by means of the pump. The 40 H. P. motor requires 0.3 gallon of lubricating oil per hour's run.

Muffling

The subject of muffling aeronautical motors seems to have been an after-consideration with most manufacturers. The

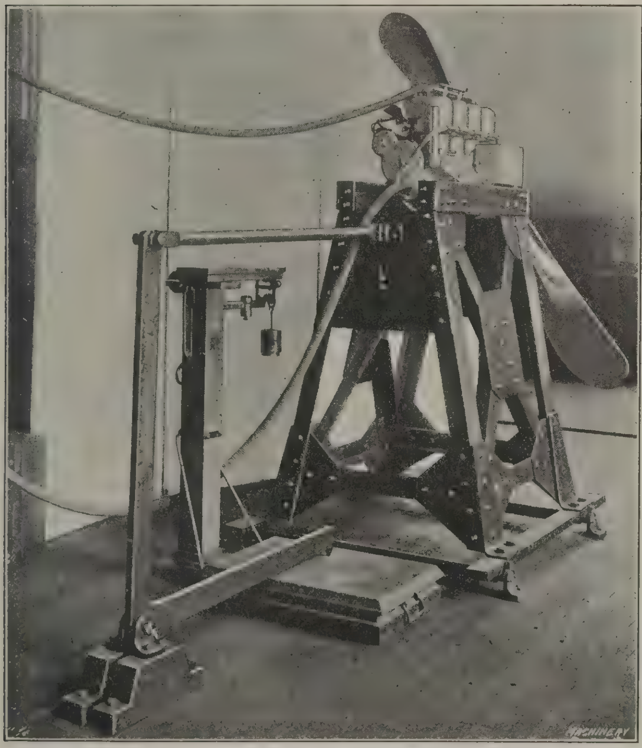


Fig. 13. Sturtevant Engine set up for a Propeller Test

Sturtevant muffler is a part of the power plant and can be shipped with the motor, or if ordered at any future time can be easily applied. It is very probable that in the near future no aeronautical motor which cannot be efficiently muffled will have commercial standing. As a forerunner of this view, the design of the Wright engine has recently been changed in order that it may be muffled. The Sturtevant muffler can be instantly detached from the motor when not required, and as its total weight is but eighteen pounds, it does not seri-

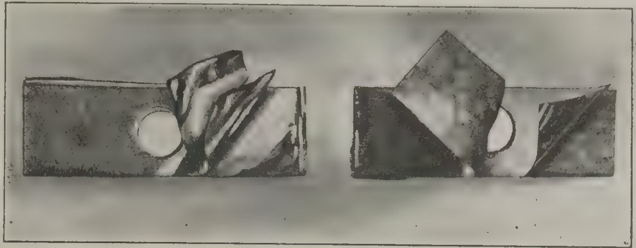


Fig. 14. Laminated Metal

ously handicap the aviation equipment. The loss of power due to the muffler is about five per cent.

Carbureter

The carbureters employed on this motor are of the Zenith make. An advantage claimed for the Zenith carbureter over other makes lies in the fact that after once being set no adjustment is required. Provision is also present for furnishing the carbureter with hot air from the exhaust, so that there will be no danger from freezing of the mixture in high altitudes. The carbureters may be seen at *N* in Fig. 1.

Tests

In addition to flying tests which have been conducted with the Sturtevant motors, interesting shop tests are being made from time to time. One of these tests was conducted over a period of 100 hours, the motor being operated for twelve consecutive days, 8 hours per day for 11 days, and 12 hours on

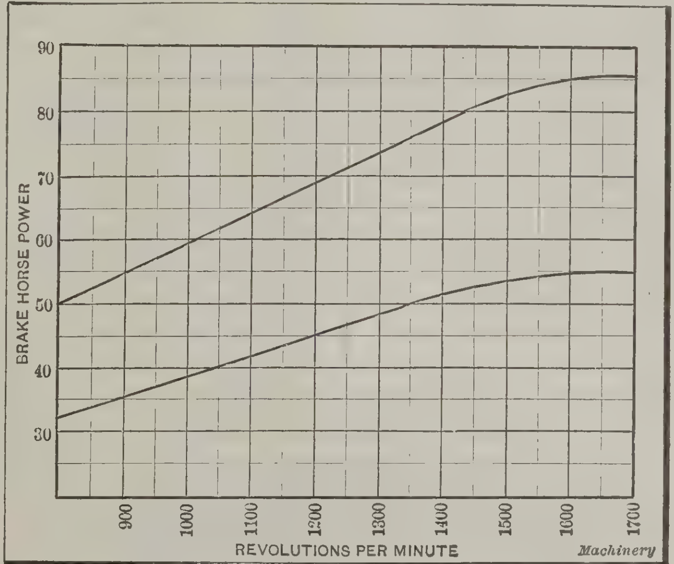


Fig. 15. Power Curves of Six-cylinder (Upper) and Four-cylinder (Lower) Motors

the last day. The motor used was four cylinder, 40 H. P., equipped with a 7½ foot diameter 4½-foot Sturtevant propeller. It developed brake horsepower as indicated upon the power curve chart shown in Fig. 15. During this test an average thrust of 360 pounds was recorded, the speed on the propeller being 1200 revolutions per minute. The only attention which the motor received was the cleaning of the spark plugs and the supplying of oil and gasoline to the tanks at the end of each day's run.

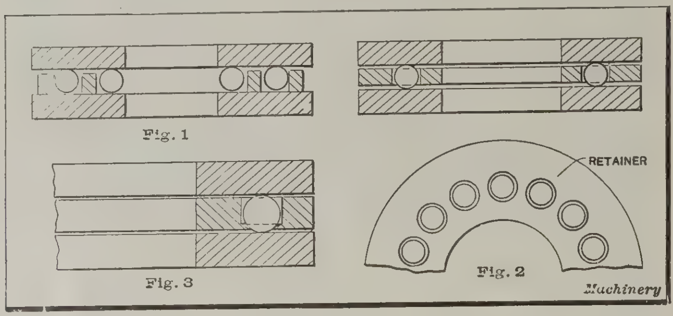
Referring to the power chart, Fig. 15, the comparison of A. L. A. M. ratings with the actual performances of these motors is very interesting and shows exceptionally high efficiency. The A. L. A. M. rating assumes a piston speed of 1000 feet per minute, with which speed the 4½-inch motor necessitates 1332 R. P. M. At this speed the four-cylinder motor is rated at 32 H. P., while its actual performance at 1332 R. P. M. is 50 H. P. The A. L. A. M. rating of a six-cylinder motor is 48 H. P., while the motor actually develops 76 H. P., at 1332 R. P. M. In both cases the peak of these power curves is reached at 1700 R. P. M., at which speed they develop 55 and 86 H. P. respectively.

BALL AND ROLLER THRUST BEARINGS*

By ROBERT H. GRANT†

In the early development of so-called "anti-friction" thrust bearings, there was no data with which the engineer could begin to work, and the great difference between the point bearing of a ball and the surface bearing of a collar or washer was not generally appreciated. In a great many cases, therefore, the early bearings were poorly designed and were made of materials which were not adapted for the purpose. Hence, they were often condemned by the user, and a general opinion was created that they were almost worthless; in fact, if the bicycle, which became so popular simply on account of the introduction of ball bearings, had not been a great factor in counteracting the hostile feeling, the adoption of ball and roller bearings in many fields would undoubtedly have been much slower. The automobile, the development of which followed immediately upon the bicycle, added to the favor with which ball bearings were received.

When ball bearings were first introduced, grinding machines were used to a very small extent, except as tool-room appliances. Hence, the bearing surfaces of the first ball bearings



Figs. 1 to 3. Evolution of the Ball Thrust Collar

were simply polished, and the balls touched only on the "high spots," producing a bearing which did not work smoothly and which soon wore out of true. This also accounts for the unfavorable results obtained with early ball bearings.

Early Development of Ball Thrust Collars

The first and simplest ball bearing made was that known as the "thrust collar." In 1888, Simonds Rolling Machine Co. made a worm-driven machine and experienced considerable trouble with the end thrust of the worm. This company manufactured balls at that time and decided to try a ball thrust bearing for the worm. The thrust collar, as it was first made, consisted of two washers, with two rows of balls

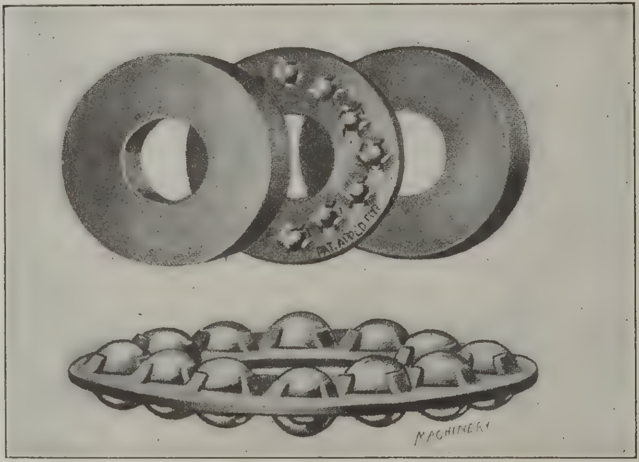


Fig. 4. Pressed Steel Ball Retainer of the Type made by the Pressed Steel Mfg. Co., Philadelphia, Pa.

and two rings, as shown in Fig. 1. In assembling this bearing, the washer was first placed upon the shaft against the bearing collar or shoulder and then the small ring was placed on the washer, after which a row of balls was placed between the shaft and the ring. The second ring and row of balls were then placed upon the washer, after which the second washer was put on the top. The washers and balls had to be held together by one man while another man put the shaft in place. However, the bearings often came to grief by the balls falling out, and it was therefore suggested that a soft steel washer of the same diameter as the hardened bearing washers be drilled with holes slightly larger than the balls. This washer would then act as a retainer and keep the balls in place. Experiments were made and it was found that this

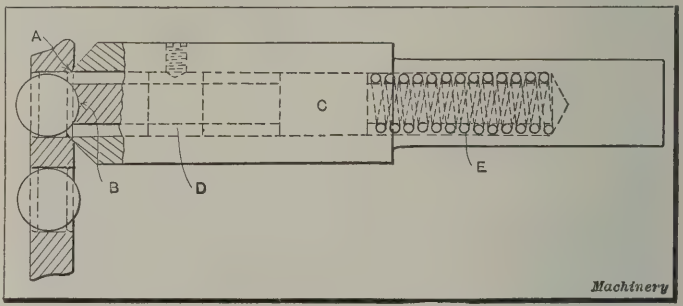
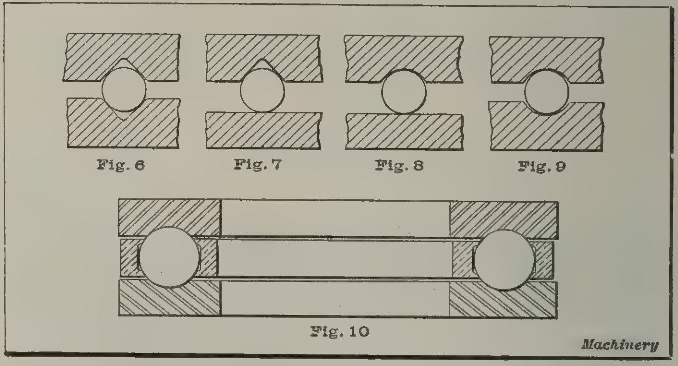


Fig. 5. Spinning Tool used in the Manufacture of Ball Cages

method worked satisfactorily. This type of bearing is shown in Fig. 2.

After this style of cage had been used for some time, a further improvement was made in that the holes in the cage were not drilled quite through, but as shown in Fig. 3, so that the balls could not fall through the retainer. This aided the assemblers in handling the balls in the cage without losing them. A groove would soon wear in the washers, however, and in order to cover as much of the surface of the washer as possible with the balls, the balls were later staggered in the cage so as to distribute the load and wear over a greater part of the washer surface.



Figs. 6 to 10. Different Types of Grooves for Balls

The Standard Roller Bearing Co. of Philadelphia made its first retainers by drilling holes in the periphery of the washer, and after the balls had been inserted in each hole, the edges of the holes were peened over at the outside. The drill, of course, was somewhat larger in diameter than the thickness of the washer, so that the balls could project on the sides of the retainer. The balls were thus arranged in a radial line from the center of the washer, but were not staggered, so that each row of balls took the same circular path. The generally adopted cage is now pressed out of sheet steel and the openings made of such a size that the balls can be sprung into them by a slight pressure. Such a cage is shown in Fig. 4. In special bearings the cage is made of brass and the holes are drilled the size of the balls. They are not drilled quite through, however, and after the balls have been inserted the holes are spun over with a tool of the type indicated in Fig. 5. The spinning edge *A* of this tool is hardened. The end of the plunger at *B* is concave so as to center the tool with the ball. At *C* is a shoulder on the plunger which is a sliding fit in the hole, thus keeping it straight; *D* is a collar held in place by a headless set-screw, which retains the plunger; *E* is a spring which presses the plunger forward and allows it to recede while in operation.

Thrust collar washers can be made either from bar stock in an automatic screw machine with a multiple cutting-off tool, or from punchings. The latter method is the preferable one, as the sheet steel is rolled lengthwise and the grain or fiber

* For information on ball and roller bearings, see the following articles previously published in MACHINERY: "Some Notes on Ball Bearings," May, 1909, engineering edition, and also other articles there referred to. See also MACHINERY'S Reference Book No. 56, "Ball Bearings."

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is so arranged that the point bearing of the ball does not come in contact with the ends of the fibers, as it does when the washers are cut in the automatic screw machine. The punched washers, therefore, have from 35 to 40 per cent better wearing qualities than the other type. The thrust collar is not used for heavy loads except in special cases, and the washers are, therefore, seldom made of tool steel, but of casehardened machine steel. As the washers are perfectly plain, a number of them can be put at a time on a magnetic chuck and can easily be ground parallel so that all the balls will have a bearing and take their share of the load. Table I gives the loads and speeds recommended by the ball bearing manufacturers.

Grooved Ball Thrust Bearings

The grooved ball thrust bearing can be made with grooves of different shapes, but the round groove is the only one to be recommended. In Fig. 6 is shown a thrust bearing with V-grooves. It is difficult to get the grooves in the two washers directly opposite each other so that there will be a perfect four-point bearing. Of course a sample bearing in the tool-room can be easily made to meet all requirements, but when the bearings are made in quantities, difficulties are met with. This, however, is not the greatest objection to this bearing. The main objection is that when the load is applied, the ball is squeezed into the V and prevented from turning freely. While the bearing is hardened, it is not glass hard, and it will allow the ball to seat itself so as to wear the bearing out of true in a short time.

TABLE I. GENERAL DIMENSIONS AND APPROXIMATE LOAD PER BEARING FOR REGULAR BALL THRUST BEARINGS

Diameter of Bearing, Inches		Diam. of Balls, Inches	Load in Pounds at					
Inside	Outside		1500 R.P.M.	1000 R.P.M.	500 R.P.M.	300 R.P.M.	150 R.P.M.	10 R.P.M.
$1\frac{1}{4}$	$2\frac{11}{32}$	$\frac{1}{4}$	350	500	600	750	800	2750
$1\frac{7}{16}$	$2\frac{15}{32}$	$\frac{1}{4}$	500	600	750	1000	1100	3750
$1\frac{5}{8}$	$2\frac{31}{32}$	$\frac{5}{16}$	600	750	850	1100	1350	4000
$1\frac{3}{4}$	$3\frac{3}{32}$	$\frac{5}{16}$	750	850	1000	1350	1750	5000
2	$3\frac{11}{32}$	$\frac{5}{16}$	850	1000	1250	1600	2000	5500
$2\frac{1}{8}$	$3\frac{19}{32}$	$\frac{5}{16}$	1000	1250	1500	1850	2500	7000
$2\frac{1}{4}$	$3\frac{23}{32}$	$\frac{5}{16}$	1100	1350	1750	2100	2750	7500
$2\frac{1}{2}$	$3\frac{31}{32}$	$\frac{5}{16}$	1250	1600	2000	2500	3000	9500
$2\frac{5}{8}$	$4\frac{11}{32}$	$\frac{3}{8}$	1500	1750	2250	2750	3500	10000
$2\frac{3}{4}$	$4\frac{15}{32}$	$\frac{3}{8}$	1750	2000	2750	3000	4200	12500
$3\frac{1}{4}$	$4\frac{31}{32}$	$\frac{3}{8}$	2100	2350	3200	3750	5000	15000
$3\frac{1}{2}$	$5\frac{7}{32}$	$\frac{3}{8}$	2500	2850	4000	4750	6000	17500

In the three-point bearing, Fig. 7, where there is one V and one flat surface, the objections to the V groove are the same as already mentioned, and the flat surface does not allow a greater load to be carried than that which can be carried by a plain thrust collar. Hence, this bearing is not superior to a regular thrust collar ball bearing, but is more difficult to make; nor is a bearing having one plain and one grooved washer as shown in Fig. 8 superior to a thrust collar. In Fig. 9 is shown the regular grooved ball thrust bearing in its simplest form. The radius of the groove is made from five to ten per cent greater than that of the ball used in the bearing. This allows some latitude for the washers so that they can line up properly. It can be readily seen that when the load increases on the ball, the surface bearing between the ball and the washer will become slightly greater on account of the fact that the radius of the groove is slightly larger than that of the ball. Theoretically, there is only a point contact when there is no load, but as the load gradually increases this point contact will become a surface contact over a gradually increasing length of the ball circumference.

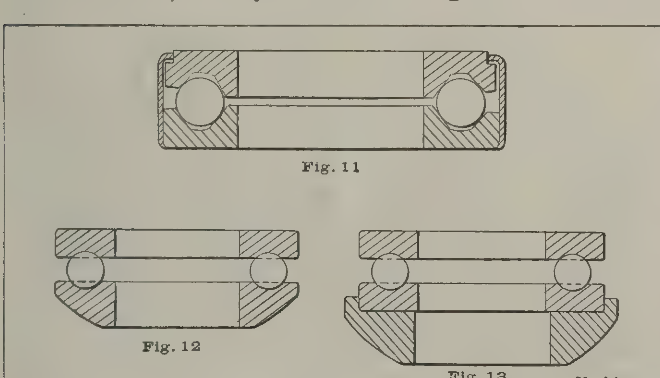

Fig 11. Ball Grooves with Different Angles on the Sides. Figs. 12 and 13. Thrust Bearings with Leveling Washers

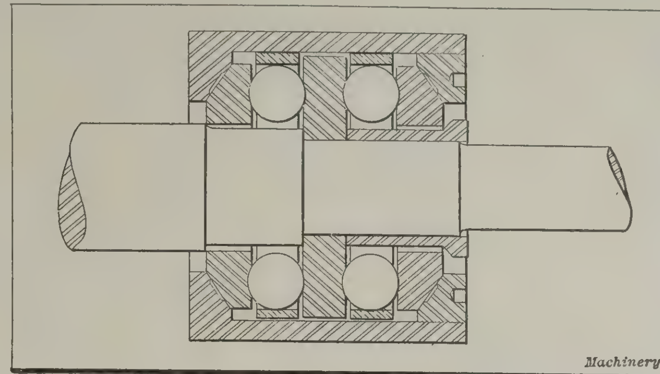

Fig. 14. A Ball Bearing taking Thrust in Both Directions

This makes it possible for the bearing to stand up under heavy loads. But it is difficult to make both grooves bear equally upon the balls unless the bearings are made in a very careful way.

Grooved thrust bearings require the use of a separator the same as the thrust collar. In Fig. 10 is shown the simplest form of retainer for this purpose. When the grooves in the washers are made very deep, the retainers must be made rather thin.

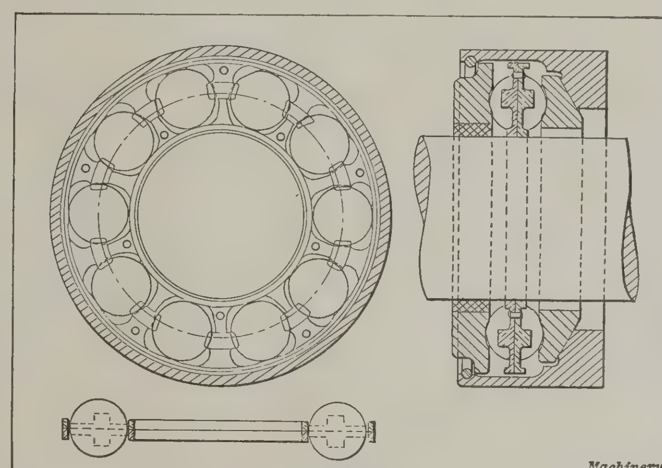

Fig. 15. Skeleton Cage for Ball Bearings

In order to overcome the slippage caused in the V-grooves on account of the inside bearing of the ball running slower than the outside, the Auburn Ball Bearing Co. makes a bearing in which the angle of the V is greater on one side than on the other, as shown in Fig. 11. This prevents slippage of the ball, but it does not overcome the squeezing effects of heavy loads. Nevertheless, this bearing has given satisfaction in light and mediumly heavy service.

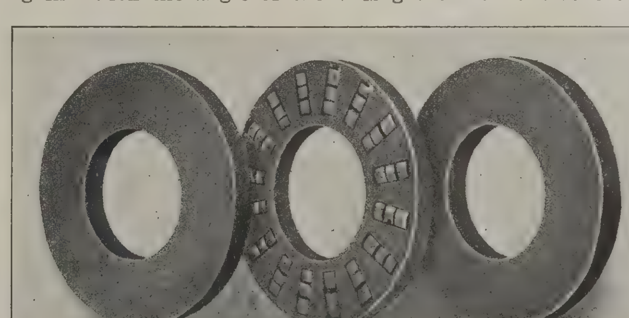

Fig. 16. Simple Form of Roller Bearing

Applications of Ball Thrust Bearings

For convenience in assembling and handling ball bearings, the self-contained thrust bearing is the most satisfactory. It

is necessary to have the surfaces against which the bearing rests perfectly parallel with each other. Many bearings do not give satisfaction on account of the poor methods employed in their application to the machinery on which they are to be used. In order to overcome the results of neglect on the part of the user, leveling washers are often provided on one side of the bearing to take care of any lack in alignment and insure that the entire surface of the thrust washers will take its proportion of the load. This method prevents breakage and should be universally adopted. It adds but little to the cost of the bearing and saves the user much trouble.

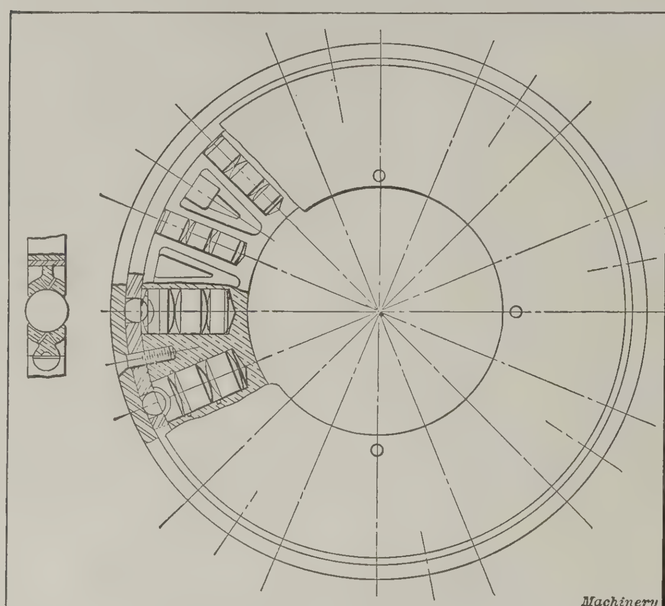

Fig. 17. Means for Taking Care of End Thrust of Rollers in Roller Thrust Bearings

The leveling washer, sometimes termed "radius washer," is made in two ways. In Fig. 12 it is made integral with the lower thrust bearing washer. This is done when the space for the bearing is limited. A corresponding concave surface must, of course, be provided in the housing or part which holds the thrust bearing. If there is plenty of space for the bearing, it is cheaper to use a standard grooved thrust bearing and a leveling washer with a slight recess beneath the lower bearing washer, as shown in Fig. 13.

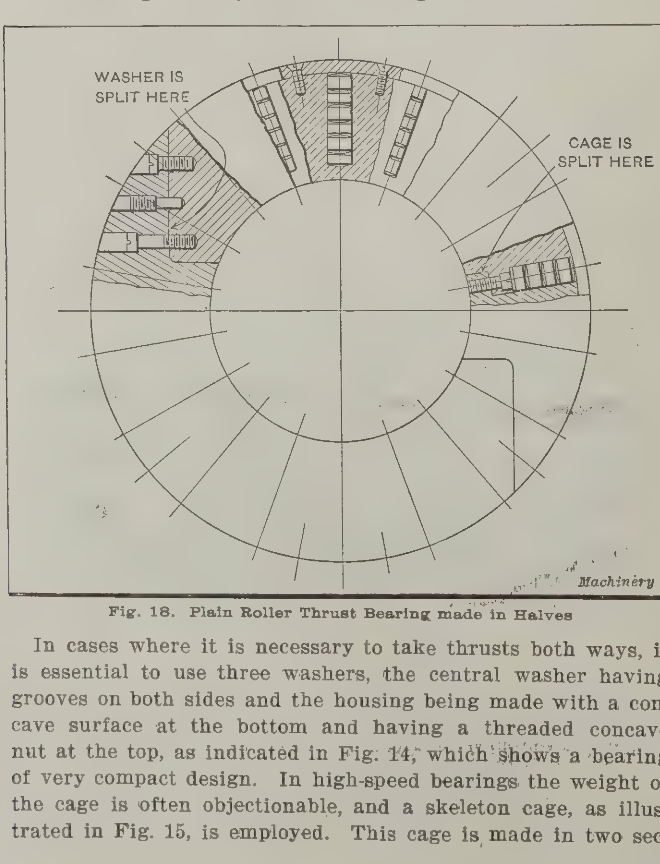

Fig. 18. Plain Roller Thrust Bearing made in Halves

In cases where it is necessary to take thrusts both ways, it is essential to use three washers, the central washer having grooves on both sides and the housing being made with a concave surface at the bottom and having a threaded concave nut at the top, as indicated in Fig. 14, which shows a bearing of very compact design. In high-speed bearings the weight of the cage is often objectionable, and a skeleton cage, as illustrated in Fig. 15, is employed. This cage is made in two sections, riveted together, and the only surfaces that are finished are those on which the balls and the shaft bear.

Roller Thrust Bearings

The principle of the roller thrust bearing, as shown in Fig. 16, is not theoretically correct, as apparently the rollers must slip to a certain extent. The outer and inner ends of the cylindrical roller roll along paths of different circumferences, and, hence, there cannot be a perfect rolling action. In fact, the rollers follow the path of a polygon with a great number of sides and a slight slippage takes place each time the roller changes its course. From a practical point of view, however, this bearing has proved a great success. Fig. 16 shows the simplest form of plain roller thrust bearing. The rollers are straight and cut into short sections so that they will turn readily. A bearing of this type will sustain loads from four to eight times greater than that carried by a ball thrust bearing of the same dimensions. The slippage that takes place as the rollers change their course in short, jerky movements around the circular path, has proved an advantage in that it partly takes care of the outward thrust caused by the centrifugal force. In large thrust bearings this outward thrust is very great and must be taken care of in other ways besides this.

One of the greatest advantages of this bearing is its simplicity, and the ease with which it can be manufactured. The washers and rollers can be readily ground. A high degree of

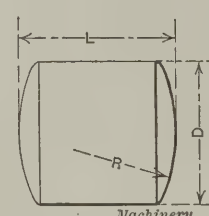

TABLE II. DIMENSIONS OF ROLLERS FOR ROLLER THRUST BEARINGS

Long Type			Short Type		
Diam. D	Length L	Radius R	Diam. D	Length L	Radius R
1/8	3/32	3/16	1/8	1/16	1/2
5/32	7/64	3/16	5/32	5/64	1/2
3/16	9/64	3/16	3/16	3/32	1/2
1/4	3/16	3/8	1/4	1/8	1
5/16	15/64	3/8	5/16	5/32	1
3/8	9/32	3/8	3/8	3/16	1
7/16	21/64	5/8	7/16	7/32	2
1/2	3/8	5/8	1/2	1/4	2
5/8	15/32	5/8	5/8	5/16	2
3/4	9/16	1	3/4	3/8	3
7/8	21/32	1	7/8	7/16	3
1	3/4	1	1	1/2	3
1 1/8	13/16	2	1 1/8	9/16	4
1 1/4	7/8	2	1 1/4	5/8	4
1 1/2	1	2	1 1/2	3/4	4
1 3/4	1 1/8	3	1 3/4	7/8	5
2	1 1/4	3	2	1	5

accuracy is also possible as all parts can be easily measured. The type of bearing shown in Fig. 16 is made by drilling holes into the periphery of the washer at equal distances around the circumference. The rollers are then inserted, allowing them to project a trifle beyond the sides of the washer; an annular ring or band is then forced onto the washer and is drilled and riveted in place.

The cages, of course, can be made in a great number of different ways. One company makes the slots the full size of the roller and then peens over the sides to retain the rollers. Another company used to make their cages by broaching rectangular holes through the washers and then staking them over to prevent the falling out of the rollers. In all the early types of ball bearings the rollers were all the same length, thereby allowing the roller to cut a path into the washer. To overcome this difficulty two widths of rollers were made, as shown in Table II. It will be noticed that the rollers are rounded on the ends so as to reduce the friction between them. The corners are also slightly rounded so as to prevent crumbling or chipping, which is apt to occur on account of

the slippage of the rollers. With these two different lengths of rollers put into the cage alternately, the whole surface of the washer can be covered.

In fast running roller thrust bearings, it is necessary to take care of the outward thrust of the rollers by placing a ball at the end of the rollers to take the thrust, as shown in Fig. 17. Two bands are placed on the outside of the cage instead of only one; the first band is a soft steel ring and the second is hardened to take the thrusts. The outside roller in each pocket is countersunk to receive the ball. In Fig. 17 is also shown a small section of the cage indicating its skeleton form in order to provide for a light construction. In high-speed horizontal bearings of this class a small thrust bearing

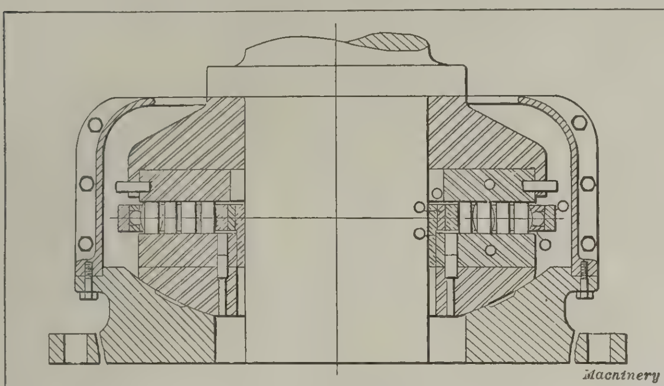

Fig. 19. A Complete Design of Roller Thrust Bearing

is often used to carry the cage. In slower running bearings there is usually a small shoulder on the cage upon which it revolves. Large roller thrust bearings of this class can seldom be used without leveling washers, as already described in connection with ball thrust bearings.

The ordinary form of bearing is made solid, but some are made in halves with all the joints accurately ground, and if properly designed will give as good service as those made from solid plates. The splitting, as shown in Fig. 18, is done in such a way that the rollers pass over the joint at an angle. Bearings made in this way are somewhat more expensive than solid bearings, but are especially desirable in cases where it may become necessary to remove them from the shaft without removing other parts.

Fig. 19 shows a roller thrust bearing with a leveling washer. The bearing washers are made reversible in case of wear. A

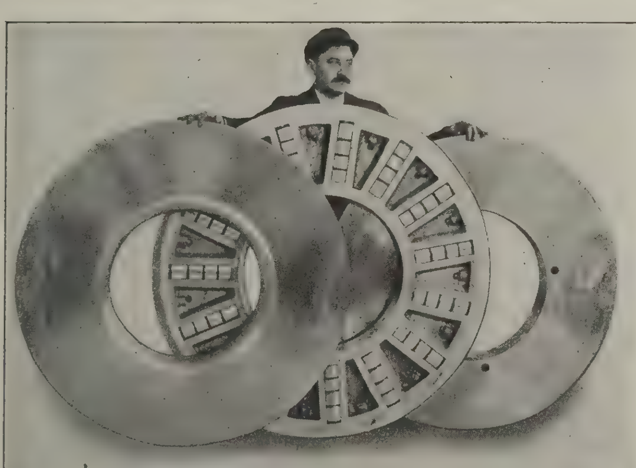

Fig. 20. Example of Unusually Large Roller Thrust Bearing

complete housing is used so that the whole bearing can be run in oil; at the same time the bearing can be easily taken apart, if necessary. The upper washer is held from the outside so as to prevent wear on the shaft. The housing, which is concaved to receive the bottom or leveling washer, is recessed at this joint so as to reduce the bearing surface. This is an example of a compact roller thrust bearing.

As an example of what has been done in large roller thrust bearings, that in Fig. 20 is shown. This is probably the largest bearing of this type ever made and it is installed at the Carnegie Steel Works. This bearing is capable of carrying a load of 1,500,000 pounds running at a speed of 100 R. P. M. The machine upon which this thrust bearing is used is designed for making steel car wheels by hydraulic pressure. The diameter of the washer of this bearing is 46 inches and the cage diameter, 50 inches. The washers, made from chrome-nickel steel, are $3\frac{1}{2}$ inches thick and weigh nearly 1700 pounds. The cage is made in skeleton form from manganese bronze and is provided with 4-inch chrome-nickel steel rollers. At the end of each set of rollers a large ball is placed to take the outward thrusts, as shown in Fig. 17. These rollers were made from a bar, four at a time, and were not cut entirely apart but simply "necked" so that they would hold together during the hardening process. They were then ground to the same diameter and broken apart and oil grooves ground in the face so as to prevent their cutting the washers. Oil holes were also drilled at the bottom of the recess in the cage from the bore to the pockets which hold the rollers. The pockets in the cage were carefully bored so that the rollers would have a running fit.

For hardening these thrust washers, a track was provided in the furnace, the door of which was made level with the floor, and a truck was made with a table on ball bearings; then a hole was cut in the side of the furnace so that the table could be revolved from the outside. The washers were allowed to heat for ten hours and the table was revolved at certain intervals to insure that they would be uniformly heated. In order to avoid confusion, the men in the hardening room had been previously drilled in removing the washer from the furnace to the hardening tank which was twenty-five feet long, four feet wide and ten feet deep. There was a

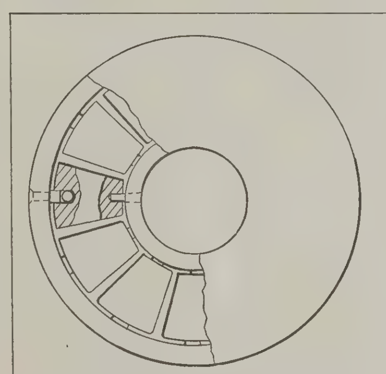

Fig. 21. Tapered Roller Thrust Bearing

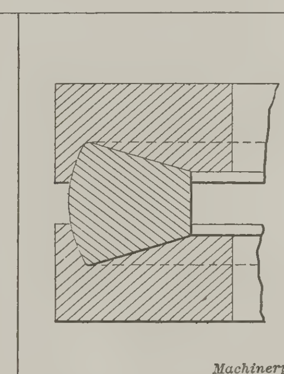

Fig. 22. Method of taking the End Thrust in a Tapered Roller Thrust Bearing

track overhead with a pneumatic hoist and two ropes were attached to the hook so that the washer could be pulled back and forth in the water. Seventeen seconds was required for the first washer hardened, from the time it left the furnace until the time it was submerged in the water. It was then raised and lowered by one man while two other men pulled it back and forth in the tank. After the washer was perfectly cold, it was placed in an oil tank over night and upon inspection was found to be perfectly hard. It had warped only about 0.020 inch.

Tapered Rollers in Thrust Bearings

It would seem upon first consideration as if it would be better to use a tapered roller rather than a cylindrical one in a thrust bearing of the type described, in order that a perfect rolling action might be insured. Bearings provided with tapered rollers, however, have not, as far as the writer knows, proved successful, except in very rare cases where the load has been light, or, if the load has been heavy, where the speed has been very slow. The difficulty to be overcome with the tapered roller is the great outward thrust. Several methods have been used to overcome this difficulty. In Fig. 21 is shown a tapered roller thrust bearing with a hardened pin driven into the cage ring and a hole drilled into the end of the roller in which a ball is inserted. This would prove quite successful if every roller were of exactly the same diameter and could be drilled to the same depth, and if all the balls and pins were exactly alike, but, if they are not, the rollers nearest to the center will bear all of the load until some of the parts wear so as to bring the other rollers into action. The rollers must also all be of exactly the same angle, and,

hence, a bearing of this type presents many practical difficulties in its manufacture.

Fig. 22 shows another method by means of which the end thrust of the rollers can be taken care of—that is, by having the washers extend over the ends of the rollers. This, however, is not a practical method for high-speed bearings, as it does not give the roller freedom of action. In cheap bearings, however, this method has proved quite successful. A great many different schemes have been evolved for this class of bearing, such as placing set-screws in the cage ring so that each roller could be adjusted to take its share of the load, etc. Methods of this kind may have worked well for a short time, but as the readjustment has to be done by an expert, the bearings have been considered impracticable for regular use.

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BRITISH ENGINEERING STANDARDS COMMITTEE

In a report by Consul General John L. Griffiths of London, England, a brief history of the British Engineering-Standards committee is given.

The committee was originally appointed in January, 1901, by the council of the Institution of Civil Engineers, to consider the advisability of standardizing various kinds of iron and steel sections. It was then composed of seven members, and the first meeting was held in February, 1901, when it was decided to approach the councils of the Institutions of Mechanical Engineers, Naval Architects, and of the Iron and Steel Institute in order to secure, if possible, their cooperation. These invitations were accepted, and the reorganized committee began work in April, 1901. In November of the same year it was suggested that the standardization of electrical plants should be undertaken, with the result that the Institution of Electrical Engineers was also invited to nominate members of the committee, and in June, 1902, the committee was enlarged.

The work as originally undertaken has thus from time to time been expanded, and numerous subjects have been considered. Some idea of their diversity may be suggested by an enumeration of the several sectional committees. They are: Main; finance; publication and calculations; sections and tests for materials used in the construction of ships and their machinery; steel castings and forgings for marine work; iron for shipbuilding and ships' cables; bridges and building construction; railway rolling-stock under frames and locomotives, with subcommittees on component parts and types, tires, axles, and springs, steel plates, copper and its alloys, iron for railway rolling stock, railway rails, tramway rails, tire profiles, screw threads and limit gages, automobile threads, and also on small screws and screw heads, rolled and drawn sections, keys and keyways, pipe flanges, cement, vitrified-ware pipe, cast-iron pipes for hydraulic power, water, gas, and sewage, heating, ventilating, and house drainage, and for electrical purposes; electrical plant with subcommittees on generators, motors, and transformers, prime movers, physical standards, telegraphs and telephones, cables, electric tramways, and electrical plant accessories. The main committee, with the sectional and subcommittees, now has a membership of 321.

The various original standard specifications are carefully revised from time to time in order to keep abreast with new inventions and improvements. It is pointed out, on behalf of the committee, that perhaps its most salient feature is the advantage which accrues to Great Britain in that it possesses a central organization from which information may readily be obtained, both as to standards and as to the causes that led to their adoption.

Some fifty-seven reports on various subjects have been published and may be secured at prices ranging from 60 cents to \$5.10 each. A minimum subscription of \$51.10 entitles the subscriber to a copy of each report as published and of each revised report and to information two or three times a year concerning the various subjects dealt with by the committee and early information of any revisions in hand.

Steps have been taken for holding at an early date—probably in London—a conference on international electrical standardization.

NATURAL ALLOY STEEL*

By E. F. LAKE†

Natural alloy steel is rapidly becoming prominent in the manufacturing field. It derives its name from the fact that the steel is manufactured from an ore in which nickel and chromium are alloyed by nature. While such ores have been known to exist for some time, it is only within the last decade that ores were discovered that had a uniform composition and existed in quantities sufficiently large to warrant their manufacture into steel.

Shortly after the Spanish-American War, such ore was discovered at Mayari and Moa in the Province of Oriente, in the eastern part of Cuba. These ores showed a remarkable uniformity of composition and covered some 25,000 acres on a plateau on the northern slope of a mountain range. In this place there is something like 1,000,000,000 tons of ore in sight, low in phosphorus and sulphur. The Pennsylvania Steel Co., Steelton, Pa., obtained the control of these ore beds and is, besides the Maryland Steel Co. of Sparrows Point, Md., the only company manufacturing steel billets, blooms, bars, and miscellaneous forgings from the ore. The steel made by the Pennsylvania Steel Co. is known by the trade name "Mayari steel." Other companies purchase the billets, bars, etc., and roll and forge them into commercial shapes. The Philadelphia Steel & Forge Co., Philadelphia, Pa., is one of these firms and it has given the product the trade name "natural alloy steel," while the Carpenter Steel Co., Reading, Pa., calls it "Samson steel." Both of these latter firms make a specialty of rolling and forging shapes suitable for automobile parts, but they also manufacture the steel into bars and shapes that can be used for die-blocks, spindles, tools, and numerous other purposes.

Composition

The various grades of steel into which this ore is manufactured contain from 1.00 to 1.50 per cent of nickel; from 0.20 to 0.70 per cent of chromium; and from 0.30 to 1.50 per cent of carbon; the manganese runs from 0.50 to 0.80 per cent; while the silicon is kept below 0.20 per cent and the phosphorus and sulphur below 0.04 per cent. These two latter elements, however, seldom reach 0.035 per cent, and a phosphorus content that is below 0.02 per cent is often obtained. The commercial stock is manufactured into two types, one of which contains between 0.20 and 0.40 per cent of chromium, and the other between 0.40 and 0.70 per cent. Both of these can be obtained in any of the following carbon percentages: 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45 and 0.50 per cent. Another brand that is used to a large extent for leaf springs, and also for other purposes, contains from 0.90 to 1.50 per cent of carbon and between 0.20 and 0.40 per cent of manganese, which is in accordance with the spring steel specifications of the Pennsylvania Railroad Co. Titanium, vanadium and other purifying materials can be added to the steel if it is so desired, and thus further enhance the physical properties.

These natural alloy steels are carefully made by the open-hearth process and are, in the heat-treated condition, in every way the equal to 3½ per cent nickel steel. In some ways they are superior to this steel and especially is this so of the type that contains the higher percentages of chromium, or when they are manufactured into parts that have a comparatively large sectional area. They are also cheaper than the nickel steels made by the same process, and in the billet form they are but little higher than the ordinary carbon steels. The high-grade and high-priced nickel-chrome steels are the only ones that are superior to the natural alloy steels in static strength, and this is largely due to the fact that they are usually made by the crucible process and contain a higher percentage of chromium, this being approximately 1.00 and 1.50 per cent in the two best brands.

* The following articles on alloy steels and kindred subjects have previously been published in MACHINERY: September, 1911, engineering edition, "Titanium Steel," and "Composition and Heat Treatment of Carbon and Alloy Steels"; May, 1911, engineering edition, "The Properties of Vanadium Steel;" April, 1911, engineering edition, "Manganese Steel"; October, 1909, "Heat Treatment of Alloy Steel"; June, 1909, "Remarkable Physical Characteristics of Rolled Manganese Steel Rails"; May, 1909, "The Machining of Manganese Steel"; October, 1907, engineering edition, "Vanadium Steel"; September, 1907, "Nickel Steel." See also the note referring to other articles, published in connection with that last mentioned.

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Properties of Natural Alloy Steels

For comparing the static strength, a large number of tests were made with natural alloy, nickel and carbon steels that contained 0.40 per cent of carbon and were hardened at the critical point and then drawn at various temperatures between 500 and 1500 degrees F. The average results obtained from these three kinds of steels are shown in Fig. 1. The steels compared all contain 0.40 per cent carbon. The natural alloy steel was quenched at 1520 degrees F.; the 3½ per cent nickel steel at 1500 degrees F.; and the carbon steel at 1530 degrees F. The average strength of each steel at a given drawing temperature can be obtained by following the line indicated by the desired number of degrees downward, until it meets the curve of the tensile strength, elastic limit, elongation or contraction, according to which is to be found, and from this point following the horizontal line to the left, where the number of pounds per square inch, or the percentage, is recorded. In Table I are shown the average elastic limit and ultimate strength of the fiber stress as ascertained in some torsional tests made at the Pennsylvania State College. All heat-treated specimens were hardened and drawn to develop the best properties for driving shafts, axles, etc.

Much care has to be used in manufacturing the ordinary nickel or nickel-chrome steels to prevent either of these elements from segregating in the bath or when teeming it into ingots. This is largely due to the fact that the nickel and

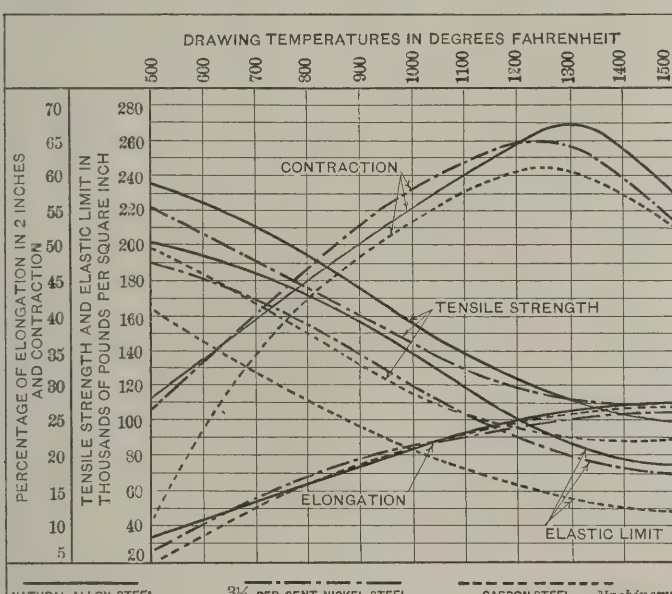


Fig. 1. Comparison of Characteristics of Natural Alloy, Nickel and Carbon Steels

chromium are additions and the bath must be heated to a comparatively high temperature just before teeming. In the natural alloy steel, however, the nickel and chromium are alloyed in the ore and are present in the bath from the time the melting operation starts until the finished steel is poured into ingots. Hence the bath does not have to be heated to any higher temperature at the time of tapping than do ordinary steels, and any tendency towards segregation is largely overcome. Thus, the elements are more uniformly distributed throughout the mass, and a homogeneous metal is obtained. When such elements segregate and the steel is rolled, they produce laminations in the metal which have a very injurious effect upon its strength, especially at right angles to the direction in which they are rolled.

The chromium gives the steel a mineral hardness and refines the grain remarkably, owing to its tendency to prevent the development of a crystalline structure. In the annealed state, every increase of chromium up to a content of 6.50 per cent raises the tensile strength, while the elastic limit is gradually raised until a chromium content of 3.00 per cent is reached. This latter remains constant until the chromium content has passed 9 per cent, but after this a rapid reduction takes place. In the hardened steels, both the tensile strength and the elastic limit increase until a chromium percentage of 5.00 per cent has been reached, and beyond this point both gradually decline.

When 2.00 per cent of chromium has been added to a steel that has a carbon content between 0.75 and 1.50 per cent, it combines great hardness with ability to resist shock. It is one of the best materials for piercing armor plate, and is also used in making projectiles. A chromium content of 3.50 per cent in a tool steel that contains 8.25 per cent of tungsten, gives the steel the well-known property of red hardness; that is, the hardness is not drawn and the cutting edge is maintained when using the tool at a red heat. A high percentage of chromium is also added to a steel that is forged between layers of wrought iron or soft steel and hardened in water. This is used in safes, vaults, etc., to make them burglar proof, and is also used for ploughshares and similar work.

TABLE I. AVERAGE FIBER STRESS IN POUNDS PER SQUARE INCH OF TORSIONAL TESTS MADE AT PENNSYLVANIA STATE COLLEGE

Kind of Steel		Natural Alloy Steel	3½ % Nickel Steel	Carbon Steel
Annealed	Elastic Limit	41,500	40,800	32,500
	Ultimate	93,400	78,200	75,100
Heat-treated	Elastic Limit	93,600	76,400	60,500
	Ultimate	130,200	108,000	102,400

Extreme hardness may be obtained in chromium steels, as the chromium intensifies the sensitiveness of the metal to quenching and greatly reduces the liability to fracture that is found in carbon steels. This is due to the fact that in chromium steels the critical changes that take place when heating all steels to the hardening temperature take place more slowly. Chromium is also one of the best elements in a steel that is to be carbonized or casehardened, as it greatly increases the susceptibility of steel to heat-treatment and acts as a carrier of the carbon. Thus, in steels containing chromium, the carbon will penetrate to a much greater depth, and a higher percentage will be absorbed by the outer layer in a given time, than with any other kind of steel, especially carbon steel. The increase in depth of penetration of carbon is about 30 per cent of the penetration in ordinary carbon steels.

The extreme hardness produced by chromium makes it necessary to use comparatively small percentages in steels that are to be machined. When the chromium content reaches 2.00 per

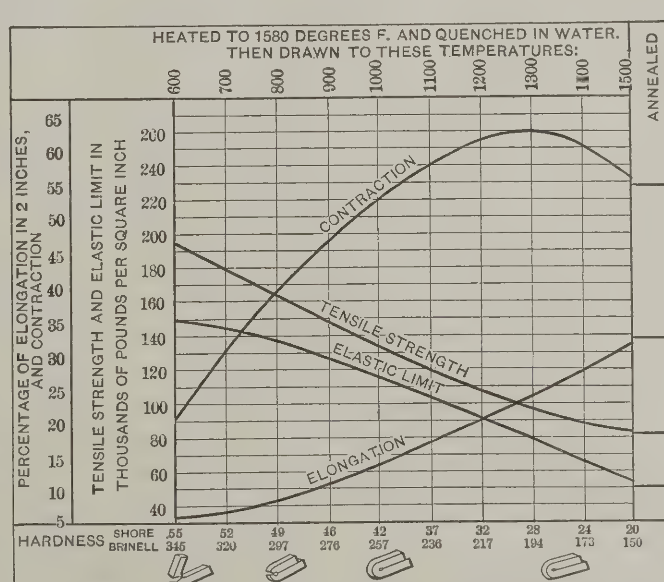


Fig. 2. Physical Properties of 0.20 Per Cent Carbon Natural Alloy Steel

cent, the steel is very difficult to cut when cold, and when higher percentages are used, the steel cannot be cut with any kind of cutting tools and must be ground to shape, this latter being an expensive method to pursue. Thus, in the high-grade nickel-chrome steels that are to be manufactured into parts of machines or instruments, the chromium is usually at or below 1.50 per cent. Owing to the difficulty of working even this steel, however, many grades of steel have been made with a chromium content of 0.25, 0.50 and 0.75 per cent, and it is for these grades that the natural alloy steel can be used.

In steel, the chromium gives the metal a hardness simi-

lar to that given by carbon, but to a lesser degree for the same percentage. It is a hardness, however, that makes the cohesion of the molecules much greater and thus greatly increases the static and dynamic properties. Chromium also greatly retards the formation of any grain or fiber, and thus makes the steel practically grainless. All of these effects of chromium upon steel cause it to increase its tensile strength, elastic limit, hardness, resistance to torsion, shocks, vibrations, or other stresses, and also increase its wearing qualities and prolong its life.

Influence of Nickel

Nickel increases the ductility, toughness and resiliency of steel, and also increases its susceptibility to heat-treatment. It reduces the size of the crystalline structure and microscopic cracks that are liable to develop into large cracks and produce ruptures. It was first added to steel to overcome the property of "sudden rupture" which is inherent in all carbon steels. It reduces the tendency of steels to become damaged by overheating in hardening, and shows its effect in the hardening operations by making the tensile strength and elastic limit two and three times that of the un-treated, or annealed steel. Nickel raises the elastic ratio in steels, *i. e.*, the elastic limit is raised to a higher percentage of the tensile strength. This condition is always sought for in the better grades of steel.

The tensile strength is rapidly increased with each increase in the percentage of nickel until a content of about 8 per cent has been reached. From that point to 15 per cent it makes the steel so brittle that it can be powdered under a hand-hammer, but after 15 per cent has been passed, the tensile strength returns, but not to quite as high a figure as is reached with an 8 per cent content. The elastic limit also continues to rise until 8 per cent has been reached and after the zone of brittleness has been passed, it again returns, but in a much smaller ratio than the tensile strength. From 20 per cent of nickel, upwards, the elastic limit cannot be made much greater than that of steels that do not contain nickel.

The elongation shows a slight rise until about 3 per cent of nickel is added to the steel, and after that it shows a rapid decrease, until the zone of brittleness is reached, when it becomes nil. With from 20 to 25 per cent nickel, the elongation again rapidly rises and from that point to 100 per cent it shows a slight increase. The best results, therefore, in steels that are used for machine parts, are obtained with a nickel content of 3½ per cent, although for some purposes 5 per cent nickel steel is used at a sacrifice of the elongation.

The two above elements in natural alloy steel, therefore, greatly enhances the value of this material for the various parts of machinery that are submitted to severe stresses. These steels also resist corrosion much better than other steels, the sulphuric acid test showing that they corrode from 10 to 20 per cent less than the low carbon and manganese, basic and open-hearth metals with nearly all of the impurities removed, and which have been given such names as "pure ingot iron," "old-fashioned iron," "toncan metal," etc. While there are some that doubt whether this test agrees with the actual weather conditions, it is generally conceded that steels containing nickel, corrode less rapidly than carbon steels and wrought iron.

Working Alloy Steels

Natural alloy steel can be hammered, rolled, drop-forged, pressed, stamped, or machined with the same ease and at the same temperatures as carbon steel; no special precautions are necessary. The high-grade nickel-chrome steel, however, must be heated to a white heat before being hammered, rolled, or drop-forged. The high temperature must also be maintained during this mechanical working, and if it falls very much, the steel must be reheated. Nickel steels must also be carefully handled when thus working them, and hence it will be seen that natural alloy steel is more cheaply worked into shape than other alloy steels. Natural alloy steel is similar to other alloy steels, however, in that it is very difficult to weld by ordinary methods; parts that are to be submitted to great strains should not be welded together. Like other alloy steels it can be welded with more or less success by the various electric welding processes and machines that are on the market. The electric machines that squeeze the parts together are preferable, as these prevent the grain from becoming coarse, as it does when other methods are used. If the steel is hammered after welding, this will aid in refining the grain that has become coarse at the weld. By careful workmanship with the electric process it is often possible to obtain from 70 to 80 per cent efficiency at the weld, whereas an efficiency of between 30 and 40 per cent is all that can be obtained by ordinary welding methods.

Natural alloy steels, like all other steels, will attain the highest strength only when properly heat-treated. In the untreated or annealed state, they show a tensile strength and elastic limit that is from 8000 to 10,000 pounds per square inch higher than carbon steels of the same carbon content, but when properly heat-treated they compare favorably with other alloy steels. Some figures that were obtained from annealed and heat-treated forgings are given in Table II.

TABLE II. EFFECT OF HEAT-TREATMENT ON FORGINGS OF NATURAL ALLOY STEELS

Per Cent of Carbon	Annealed				Heated to 1550° F. and Quenched in Water											
					Tempered at 1050° F.				Tempered at 1000° F.				Tempered at 600° F.			
	Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent	
	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction
0.30	89,500	57,500	28.0	51.9	106,500	76,000	21.0	51.9	131,000	114,000	17.5	51.9	193,000	177,000	8.5	30.7
0.40	88,500	56,000	29.0	51.9	112,500	83,000	23.0	59.8	130,500	118,500	18.5	51.9	209,000	188,000	10.5	37.1
0.50	119,500	68,000	18.0	37.1	135,000	107,000	16.5	46.2	155,000	138,500	14.0	43.0	252,000	232,000	7.0	24.0

Heat-treatment

The heat-treatment is practically the same as that given other steels. The hardening temperature may vary somewhat, but not to any great extent. The brands containing from 0.15 to 0.20 per cent carbon should be heated to 1500 degrees F. and quenched in brine to obtain the best results. Those with a carbon content between 0.30 and 0.50 per cent should be heated to 1550 degrees F. They can then be quenched in water as readily as carbon steels, although oil and special liquid compositions can be used for the quenching bath with equally good results. The temperature at which they are afterwards drawn, of course, varies with the kind of work that the finished piece would be called upon to perform.

When hardening steel, a cold piece should never be put in a highly heated furnace, as it is liable to crack. It should either be preheated to above 600 degrees F., or it should be put in a cold furnace and heated up slowly. It should soak in the heat at the hardening temperature long enough for the piece to heat clear to its center. The work should never lie directly on the hearth of the furnace, but should be raised sufficiently to allow the heat to attack it from all sides, and it should be supported in a way that will not allow it to sag, as hot steel is soft and pliable and likely to bend. The axis of the piece should be vertical when plunging it into the quenching bath to prevent unequal contraction in cooling. The work should never have sharp grooves, corners, or other features, that easily develop cracks when the steel is heated and quenched.

In drawing steel, a furnace should never be used that is hotter than the drawing temperature. It is difficult to judge the temperature that the work has attained in such a furnace

and get within 50 degrees of the desired results. If the piece attains too high a temperature, it will be softer than that required, and if the drawing is too low, it will not be soft enough. With a tempering furnace held at the correct temperature, the work can be allowed to remain in it until it has absorbed the heat of the furnace and then accurate results can be obtained. A difference of 50 degrees in the drawing temperature is of much more importance than 50 degrees in the hardening temperature, and it is more difficult to estimate.

Casehardening

Carbonizing or casehardening can be performed in any of the various ways that are now used for other steels. Pieces can be heated to a red heat and quenched in cyanide to give them a depth of casehardened surface of a few hundredths of

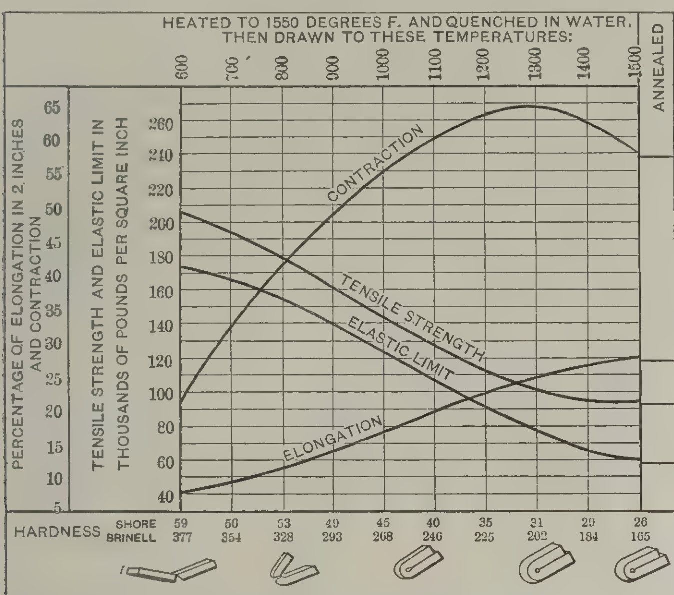


Fig. 3. Physical Properties of 0.30 Per Cent Carbon Natural Alloy Steel

an inch; or they can be packed in iron boxes with bone and charcoal, or other carbonizing materials, and then heated in furnaces for a time that is sufficient to give them a greater depth of penetration. Where the output would warrant it, however, the special furnaces that have been designed for carbonizing with gas would probably give the most uniform results, if the work is properly done. This is also the cheaper method when large quantities are worked or handled.

In any case, however, the carbonizing mixtures should not contain over 15 per cent of moisture or 0.50 per cent sulphur. Moisture might cause a pitting of the steel which is liable to cause it to chip on the surface, while the sulphur soaks into the casehardened shell to a considerable extent. A carbonizing temperature of from 1750 to 1800 degrees F. can be used, and this will probably give the most rapid absorption and most uniform composition of the case. The time the steel is submitted to this temperature depends upon the depth of carbonized case desired.

After carbonizing, the work should be allowed to cool slowly until it becomes black in daylight. It should then be reheated to 1500 degrees F. and quenched in either oil or water. After this it should again be reheated to 1350 degrees F. and again quenched in either oil or water. This double quenching gives much better results on all steels than does the ordinary practice of quenching directly from the carbonizing furnace and reheating but once to about 1375 degrees F. and quenching in oil.

In casehardened work, the core of the piece has a carbon content of about 0.20 per cent while the carbonized shell contains about 1.00 per cent. Thus, there are two steels of a different nature and these should be given different heat-treatments. In the double quenching, the first heating and quenching hardens the core but overheats the case and makes it brittle. The second re-heating restores the case to its finest grain structure and also toughens the core, and the final quenching hardens the case.

Uses of Natural Alloy Steels

Natural alloy steels are largely used in the manufacture of automobile parts. A grade containing 0.15 per cent of carbon is often used for carbonized parts where the toughness of the core is of more importance than the strength or ability to resist shocks. When parts are required to withstand severe shocks or strains and have a good wearing surface, steel containing 0.20 per cent of carbon is used. This grade responds more readily to heat-treatment. Thus the change-speed gears, differential gears, drive gears, etc., are made from this steel. It is used without carbonizing where considerable toughness is required rather than strength, as in various structural parts. It is also used for cold rolling or cold pressing, and for such work as seamless tubes, small drop forgings, etc.

Tensile Strength, Elastic Limit, etc.

The tensile strength, elastic limit, elongation and contraction of this steel, as affected by various heat-treatment temperatures are shown in Fig. 2. The vertical lines show the drawing temperatures which are marked in degrees at the top, while the horizontal lines represent the tensile strength and elastic limit and the percentage of elongation and contraction. Below the chart are given the hardness scales of the steels, at these temperatures, taken from both the Shore and Brinell instruments. The cold-bend testing properties at the various temperatures are illustrated by the sketches below the chart.

From this diagram the heat-treatment that should be given this steel to obtain any of the properties that are within its range, can readily be ascertained. Thus if an elastic limit of 144,000 pounds per square inch, with a contraction of 31 per cent, is desired, the vertical line will show that the drawing temperature should be 700 degrees F. This would also give a tensile strength of about 177,000 pounds per square inch, and an elongation of about 6.5 per cent. The diagrams are based on 7/8-inch round stock; if larger pieces are used, the drawing temperature should be lowered.

The grade containing 0.25 per cent carbon is usually used for such parts as can be cold pressed, for instance, such parts as brake drums, frame members, axle housings, etc. These parts require all the strength that can be obtained in combination with enough toughness to withstand the operation of bending

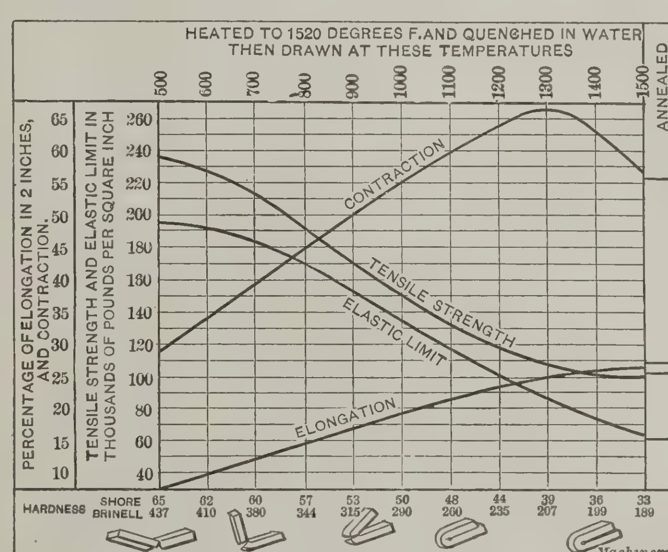


Fig. 4. Physical Properties of 0.40 Per Cent Carbon Natural Alloy Steel

into shape without developing cracks or checks. Steel 1¼ inch round, of this grade, when made into bolts, has a tensile strength of 106,000 pounds per square inch, an elastic limit of 87,500 pounds, an elongation of 26 per cent, and a contraction of 69.5 per cent.

The grade containing 0.30 per cent carbon is still harder and more applicable to heat-treated parts. Hence it is made into axles, connecting-rods, jack-shafts, drive shafts, and other parts that require considerable strength and at the same time a high degree of toughness. It is also used for drop-forgings, heavy forgings and numerous other things. The strength, hardness and cold bending properties of the 0.30 per cent natural alloy steels are shown in Fig. 3. That still greater strength can be obtained than shown in this chart was proved by a test made by one of the automobile manufacturers. The test bar was

properly hardened and drawn at 600 degrees F.; the tensile strength was found to be 236,000 pounds per square inch, the elastic limit, 215,000 pounds, the elongation in two inches, 10.8 per cent, and the contraction, 36 per cent.

The grades containing 0.35 and 0.40 per cent carbon are usually used for spindles, rear axles, crankshafts, etc. From the 0.40 per cent grade are also made locomotive driving axles and heavy automobile truck axles, connecting-rods, piston-rods, steering knuckles, etc. The properties of the 0.40 per cent carbon grades are shown in Fig. 4. Some finished cranksnafts, 2½ inches in diameter of the 0.35 per cent grade, had a tensile strength of 148,400 pounds per square inch, an elastic limit of 127,300 pounds, an elongation in two inches of 15.3 per cent, and a contraction of 53.8 per cent.

The 0.45 and 0.50 per cent carbon grades are used where extreme strength is needed in combination with considerable ductility. Thus, transmission gears that are to be heat-treated without carbonizing are usually made from this brand. The strength when heat-treated will, of course, be greater than shown in Fig. 4, but the ductility will be reduced.

At the present time there seems to be a tendency to "load" steels with alloying materials, and thus make them difficult to forge, weld, machine, or heat-treat; the results obtained do not always warrant the high prices of the finished parts. This natural alloy steel, however, is not overloaded with such alloying materials, but at the same time has properties that are well within the specifications for which many manufacturers are using much more expensive steels.

* * *

LIMITS FOR VARIOUS KINDS OF FITS*

The accompanying table gives the limits of accuracy used by the firm of Ludwig Loewe & Co., Berlin, Germany. The tabulated values are directly "translated" from the metric system, which accounts for the use of four decimal places in practically all instances. The table on which the one here published is based was published by *Verkstäderna* (Stockholm, Sweden). Only a few words are necessary to explain the use of the table.

It will be noted that three kinds of loose fits are specified. Loose fit *A* is for shafts resting in a single bearing; loose fit *B* for shafts resting in two or more bearings; and loose fit *C* for shafts with large clearance, lubricated with heavy lubricants, such as grease, etc. The sliding fit indicates a fit where the parts can be moved by hand, but without shake or play. The drive fit indicates a fit where it is necessary to assemble the parts with simple means, such as light blows or easy pressure. The press and shrinkage fits have their ordinary significance. By using this table, it is not necessary to put the limits on every dimension on the drawing, but simply to specify the kind of fit required.

* See MACHINERY, engineering edition, April, 1912: "Table of Allowances and Limits." See also MACHINERY'S Data Sheet Book No. 7, pages 26 to 31, inclusive: "Allowances and Tolerances for Various Kinds of Fits."

ALLOWANCES FOR VARIOUS KINDS OF FITS

Diameter			1/4–7/16	15/32–3/4	25/32–1 1/4	1 9/32–2	2 1/32–3	3 1/32–4 1/2	4 17/32–7	7 1/32–10
	Hole	Min.	−0.0004	−0.0006	−0.0006	−0.0008	−0.0008	−0.001	−0.0012	−0.0015
		Max.	+0.0004	+0.0004	+0.0006	+0.0006	+0.0008	+0.0008	+0.001	+0.0012
Shaft	Loose Fit A	Max.	−0.0004	−0.0006	−0.0008	−0.001	−0.0012	−0.0014	−0.0017	−0.0021
		Min.	−0.001	−0.0012	−0.0014	−0.0018	−0.002	−0.0024	−0.003	−0.0036
	Loose Fit B	Max	−0.0008	−0.0012	−0.0016	−0.002	−0.0024	−0.0028	−0.0034	−0.0042
		Min.	−0.0014	−0.002	−0.0024	−0.0028	−0.0032	−0.0038	−0.0044	−0.0052
	Loose Fit C	Max.	−0.0012	−0.0014	−0.0016	−0.002	−0.0024	−0.0028	−0.0034	−0.0042
		Min.	−0.002	−0.0028	−0.0032	−0.0037	−0.0044	−0.0052	−0.0064	−0.008
	Sliding Fit	Max.	−0.0002	−0.0002	−0.0003	−0.0003	−0.0004	−0.0004	−0.0006	−0.0007
		Min.	−0.0004	−0.0006	−0.0008	−0.001	−0.0012	−0.0014	−0.0017	−0.0021
	Drive Fit	Max.	+0.0004	+0.0004	+0.0004	+0.0004	+0.0003	+0.0002	+0.0002	+0.0002
		Min.	−0.0002	−0.0002	−0.0002	−0.0003	−0.0003	−0.0004	−0.0004	−0.0005
	Press Fit	Max.	+0.0016	+0.0021	+0.0028	+0.0034	+0.0044	+0.0054	+0.0072	+0.010
		Min.	+0.0008	+0.0011	+0.0014	+0.0018	+0.0022	+0.0026	+0.0034	+0.0044
	Shrinkage Fit	Max.	+0.001	+0.0014	+0.0018	+0.0024	+0.0032	+0.0044	+0.0058	+0.008
		Min.	+0.0006	+0.0008	+0.0008	+0.0012	+0.0014	+0.0018	+0.0036	+0.0052

FOUNDRY AND MACHINE SHOP STATISTICS

The thirteenth census statistics of factories engaged in the manufacture of foundry and machine shop products are summarized in an advance bulletin issued by the director of the Bureau of the Census, Department of Commerce and Labor. These statistics show the number of establishments, the number of persons engaged, capitalization and value of the manufactured products. In the statistics are included all industries in the machinery field except those which manufacture distinctive products individually classified in the statistics, such as cash registers, calculating machines, sewing machines, and electrical machinery. The statistics are for the year 1909.

In this year there were 13,253 establishments, employing 615,485 persons, of which number 9851 were proprietors and firm members, 21,754 were salaried officers, superintendents, and managers, 42,242 were male, and 10,627 female, clerks; the average number of wage-earners was 521,011; the number of wage earners in the maximum month, December, being 597,234, and in the minimum month, January, 482,080. The total number of wage earners on December 15, 1909, or the nearest representative day, was 604,167, of which 587,636 were males and 11,895 were females, all 16 years of age and over; while 4093 were males and 543 females, under 16 years of age. The capital invested was $1,514,332,273. The total expenses were $1,077,736,456, of which $47,817,236 were paid officials, $45,977,781 clerks, $321,520,917 wage-earners, $23,750,838 fuel and rent of power, $516,260,301 other materials, $5,970,800 rent of factory or works, $6,269,172 taxes, including internal revenue, $6,653,816 contract work, and $103,515,297 other miscellaneous expenses. The value of products was $1,228,475,148. The value added by manufacture, which is the difference between value of products and cost of materials, was $688,464,009.

The states which lead in this industry are, in the order of their importance: Pennsylvania, New York, Ohio, Illinois, Massachusetts, Connecticut, New Jersey, Wisconsin, Michigan, Indiana, Rhode Island, California, and Missouri. The average number of wage-earners employed in 1909, the total number of products, and the value added by manufacture (value of products less cost of materials) for these states, is tabulated in the accompanying table.

State	Average No. of Wage Earners	Value of Products	Value added by Manufacture
California	8,377	$26,730,891	$13,830,000
Connecticut	37,736	65,535,155	40,715,099
Illinois	52,266	138,578,993	74,768,805
Indiana	15,809	39,883,774	21,265,086
Massachusetts	44,179	86,925,671	55,743,781
Michigan	21,649	45,399,023	26,688,471
Missouri	7,443	19,975,149	10,819,432
New Jersey	27,815	65,398,437	35,458,387
New York	64,066	154,570,346	92,749,146
Ohio	64,817	145,836,648	81,276,753
Pennsylvania	86,821	210,746,257	109,735,517
Rhode Island	10,937	20,611,693	12,598,192
Wisconsin	24,219	54,124,000	31,590,264

ANALYSIS AND HEAT TREATMENT OF LOW-CARBON AND ALLOY STEELS*

PRACTICE FOLLOWED BY THE FROST GEAR AND MACHINE CO., JACKSON, MICH.

By DOUGLAS T. HAMILTON†

The heat treatment of low-carbon steel differs considerably from that used for hardening ordinary tool or high-carbon steel. To begin with, low-carbon steel must be carburized, so that its outer surface will harden when the steel is again heated and dipped in oil. With tool steel it is only necessary to heat the steel to the desired temperature and plunge it in oil or water, after which the temper is usually drawn.

To obtain the best results when heat treating the modern alloy steels, the percentage of the constituent elements must

Fig. 1. Samples of Bar Steel and Milling Chips used in obtaining Chemical Analyses

be definitely known, and, therefore, a sample of each bar of steel should be analyzed before any parts are made from it. The greatest difficulty encountered in heat treating alloy steel is that if the carbon content varies but a few points, unsatisfactory results will be obtained unless this variation is taken into account. This is particularly true in heat treating drop forgings for automobile gears, which are subjected to heavy duty. The very best steel obtainable is of little value unless properly heat treated. The annealing, harden-

Fig. 2. Electric Furnace and Combustion Train used in determining Carbon Content of Milling Chips from Sample of Bar Steel

ing and tempering must be attended to with great care and thoroughness. Drop forgings are more difficult to heat treat properly than parts made from bar stock.

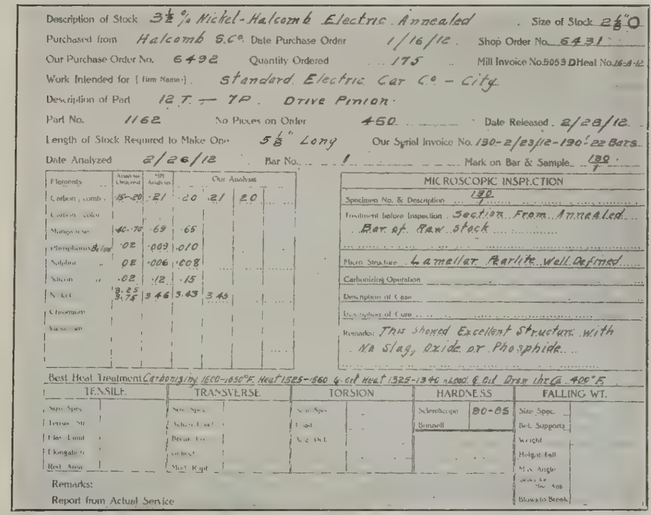
In no branch of the metal working industry is greater care given to the heat treatment of steel than in automobile manufacture. This industry has practically revolutionized former methods of making and heat treating alloy steel. In the following article a description is given of the heat treating methods employed by the Frost Gear & Machine Co., Jackson, Mich., which firm makes a large number of gears for the automobile trade. After having had considerable difficulty in heat treating automobile parts, owing to the variations in the carbon contents, and often to variations in the entire chemical composition, this firm installed a chemical laboratory in connection with its hardening department. Now, before any material is made up into gears or other parts, it is analyzed and its chemical composition ascertained.

In order that a manufacturer may be able to guarantee that all parts turned out by him are up to a certain standard, it is absolutely necessary that he follow some definite plan of analyzing and heat treating the different grades of steel. It is not wise to rely solely upon the steel mills for the correct analysis, for the simple reason that it is difficult to keep defective material from getting mixed up with the good stock. This is not always due to negligence on the part of the steel mill, but sometimes happens during transportation, unloading, etc.

Grading and Analyzing Steel

In ordering steel, the Frost Gear & Machine Co. gives the steel mill a complete analysis of the steel required. When the steel is received the bars are painted according to a certain standard. For gear stock the following colors are used to designate the different grades of steel:

Grade of Steel	Color
3.5 per cent nickel..................	Lemon yellow
0.15-0.20 per cent carbon, open-hearth machine steel	Pale green
0.30-0.40 per cent carbon, open-hearth	Medium green
0.40-0.50 per cent carbon, open-hearth	Dark green
Chrome-nickel steel	Deep red
Vanadium steel	Black



Description of Stock 3½% Nickel-Halcomb Electric Annealed. Size of Stock 2⅛" O

Purchased from Halcomb S.Co. Date Purchase Order 1/16/12. Shop Order No. 6431

Our Purchase Order No. 6492 Quantity Ordered 175 Mill Invoice No. 5059 D Heat No. 16-A-12

Work Intended for (Firm Name) Standard Electric Car Co. – City

Description of Part 12 T. — 7 P. Drive Pinion

Part No. 1162 No. Pieces on Order 450 Date Released 2/28/12

Length of Stock Required to Make One 5⅛" Long Our Serial Invoice No. 130-2/23/12-130-22 Bars

Date Analyzed 2/26/12 Bar No. 1 Mark on Bar & Sample 130/1

Elements	Analysis Ordered	Mill Analysis	Our Analysis		
Carbon, comb.	.15-.20	.21	.20	.21	.20
Carbon, color					
Manganese	.40-.70	.69	.65		
Phosphorus Below	.02	.009	.010		
Sulphur "	.02	.006	.008		
Silicon "	.02	.12	.15		
Nickel	3.25 3.75	3.46	3.43	3.45	
Chromium					
Vanadium					

MICROSCOPIC INSPECTION

Specimen No. & Description 130/1

Treatment before Inspection Section From Annealed Bar of Raw Stock

Micro Structure Lamellar Pearlite Well Defined

Carbonizing Operation

Description of Case

Description of Core

Remarks: This Showed Excellent Structure with No Slag, Oxide or Phosphide

Best Heat Treatment Carbonizing 1600-1650°F. Heat 1525-1560 & Oil Heat 1325-1340 Lead & Oil Draw thr. @ 400°F.

TENSILE	TRANSVERSE	TORSION	HARDNESS		FALLING WT.
Size Spec.	Size Spec.	Size Spec.	Scleroscope	80-85	Size Spec.
Tensile Str.	Yield Load	Load	Brinell		Bet. Supports
Elas. Limit	Break Load	Angle Def.			Weight
Elongation	Deflect.				Height Fall
Red. Area	Mod. Rupt.				Max. Angle
					Blows for Max. Ang.
					Blows to Break

Remarks:

Report from Actual Service

Fig. 3. Record of Analysis of a 3 1-2 per cent Nickel Halcomb Electric Annealed Alloy Steel—Actual Size of Record Sheet, 9 by 7 3-4 inches

A wide stripe denoting the character of the steel is painted longitudinally on the bar, and a narrow diagonal stripe, of a different color, is used to designate the steel maker's name.

There are at the present time three common methods for determining the carbon contents of steel. The first and possibly the most common method is the use of the electric furnace and combustion train; the second is microscopic analysis; and the third, color comparison.

To obtain the carbon contents by means of the electric furnace and combustion train, a sample must be cut from each bar and chips obtained from these samples by milling or drilling. Milling chips are to be preferred, as these can be obtained quickly and can be taken from the entire cross-section. In milling off the chips, no oil should be used on the cutter, because a drop of oil in the chips would raise the carbon content far above its true percentage, due to the fact that oil is composed largely of carbon.

These chips are placed in small bottles labeled as shown in Fig. 1, the labels carrying the serial invoice number and the number of the bar. For example, suppose twenty-two bars of a certain brand of steel have been ordered, and that the serial invoice number is 130; then the first bottle, containing the chips from bar No. 1, would be labeled $\frac{130}{1}$, and the following bars and bottles would be marked consecutively

*See MACHINERY, June 1912, engineering edition: "Society of Automobile Engineers Specifications for Steel," and the articles there referred to.

† Associate Editor of MACHINERY.

$\frac{130}{2}$, up to and including $\frac{130}{22}$. The sample from which the chips are taken is also marked, and kept on the shelf with the bottles, as shown in Fig. 1. A sheet, as shown in Fig. 3, is made out for each bar of which an analysis is made, and this is filed away for future reference.

Obtaining the Carbon Contents by Means of the Electric Furnace and Combustion Train

The distinctive features of the different grades of steel are due more to variations in the carbon contents than to variations of any of the other elements, so that the carbon analysis is really the most important point to consider. A very small percentage of carbon makes a considerable difference in the quality of the steel after hardening.

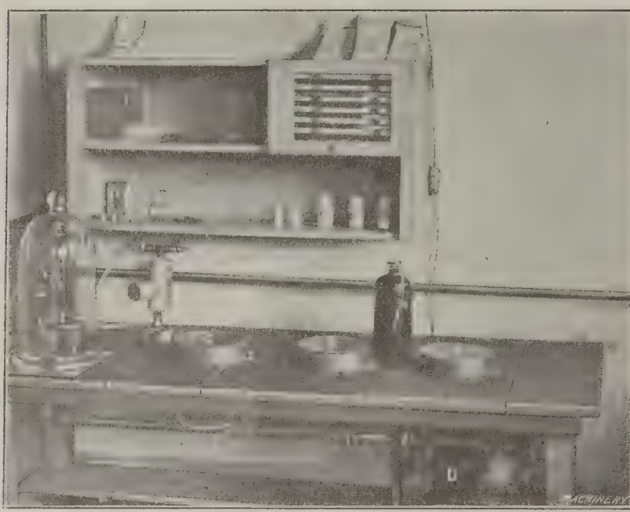


Fig. 4. Polishing Disks for Polishing the Specimen of Steel and Microscope used for Determining Structure of Steel

To obtain the carbon analysis by the electric furnace and combustion train, the milling chips are put in a small alundum boat *A*, containing aluminum oxide, as shown in Fig. 2. The latter is placed in the electric furnace *B*, where the chips are heated to about 1800 degrees F. A stream of oxygen from tank *C* is passed over the chips until the carbon has been burned out, the resulting gas—carbon dioxide (CO_2)—being collected in a liquid, potassium hydrate, in the potash bulb *D*. Now, after all of the carbon has been burned out of the milling chips, the weight of bulb *D* is compared with that of counterpoise bulb *E*, and its gain in weight noted; before burning out the carbon of the chips the difference in weight between bulbs *E* and *D* was ascertained. By a simple calculation, taking into account the weight of the milling chips, which have also been weighed before being put into the furnace, the percentage of carbon in the steel is obtained.

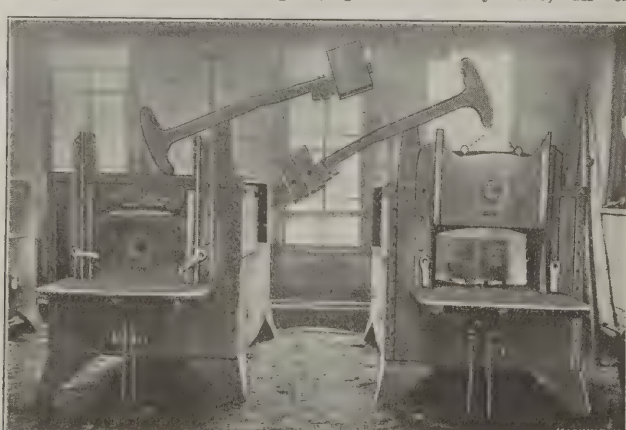


Fig. 5. Two of the Casehardening Furnaces

The names of the various tubes and devices used in connection with the electric furnace and combustion train shown in Fig. 2, starting at the left, are as follows: *F*, extra oxygen tank; *C*, oxygen tank; *G*, concentrated potassium hydrate bulb; *H*, concentrated sulphuric acid bulb (these two bulbs are called gas washers and act as the purifying train for the oxygen); *I*, granulated calcium chloride tower; *J*, cooling wick for the terminal of the quartz combustion tube; *N*, quartz combustion tube; *B*, electric furnace; *K*, another cooling wick; *L*, a U-tube containing granulated zinc; and *M* a U-tube containing calcium chloride. U-tubes *L* and *M* comprise the purifying train for the carbon dioxide collected from the milling chips being heated in the electric furnace. Finally, *D* is the weighed potash bulb and *E* the counterpoise bulb.

Analyzing Steel by Microscopic Inspection and Chemical Analysis

The microscopic examination of steel is of the utmost importance, as it reveals the nature of the metal to such an extent that the knowledge obtained thereby can be used to good advantage for practical purposes. Some of the problems which previously were beyond the scope of chemical analysis have been elucidated by means of the microscope. Of course, to use a microscope to the best advantage, it is necessary that the characteristics of steel and their relation to the appearance of a section when greatly enlarged, be understood.

To prepare the steel for microscopic examination, a small piece of the required size is cut from the bar and then ground as smooth as possible. After this, it is polished by means of different abrasive materials on the small polishing stands shown in Fig. 4. The first stand *A* consists of a disk covered with canvas and charged with fine alundum. The disk on stand *B* is covered with ordinary pocket lining, and is charged with lenigated alumina, while the disk on stand *C* is covered with broadcloth and charged with rouge. These polishing stands are driven from a shaft located beneath the bench, which, in turn, is operated by a small electric motor *D*. The disks are used in the order in which they are placed, starting at *A*. Covers are placed over these disks to prevent dust and dirt from collecting on the abrading surface.

Fig. 6. The Lead Baths used for Heat-treating the Parts

After the piece to be examined under the microscope *E* has been polished to a high degree, it is etched with a five per cent solution of picric acid, in alcohol for annealed steels. This brings the structure of the steel into prominence, the less readily attacked constituents being left standing in slight relief, and the structure thus rendered visible. One of the most striking objects which appears under the microscopic treatment, sometimes causing a beautiful play of colors, is pearlite, which has a pearly lustre, from which it derives its name. Pearlite is an intimate mixture of ferrite and cementite and consists of 87 per cent of ferrite and 13 per cent of cementite. Lamellar pearlite, which was clearly defined in the analysis recorded in Fig. 3, is a formation which consists of alternate plates of ferrite (pure iron) and cementite (carbon of iron Fe_3C). The ferrite is readily attacked by the etching acid, leaving the cementite standing out in relief.

The other constituents in the steel, such as nickel, manganese, sulphur, etc., are generally obtained by chemical analysis. This method can only be carried on successfully by an experienced metallurgist, as the determination of the percentage of any one constituent usually is obtained by volumetric titration with standard solutions of reagents.

Carburizing

When the material has passed analysis and is found to be "O. K.," the blueprint number of the piece for which this grade of steel is to be used is painted on the end of each bar.

This gives the foreman authority to use it. Any bars found to be of wrong chemical composition or difficult to machine, or that do not show up properly under microscopic inspection—showing slag and defects—are picked out and returned to the mill. After the part is made that is to be carburized, it is painted with fire clay where a hardened surface is not required, and then put in a carburizing compound, composed

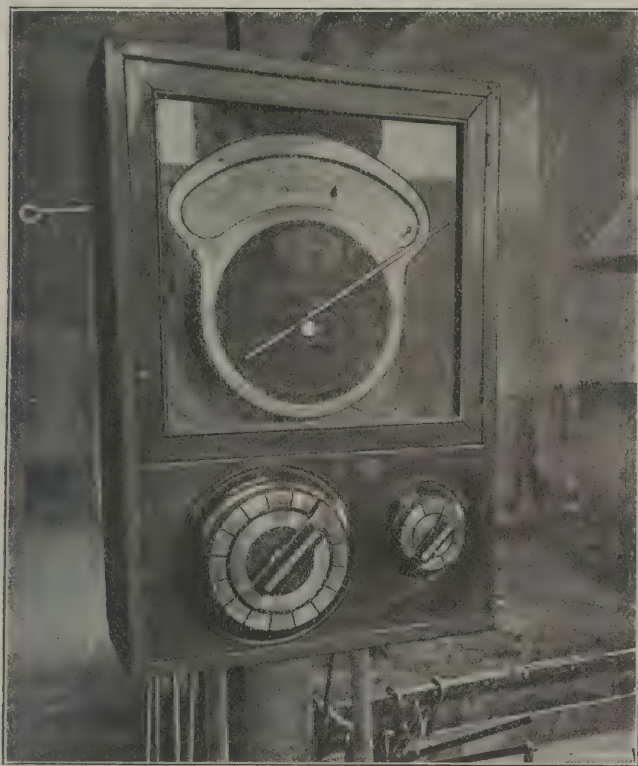


Fig. 7. Hoskins Electric Pyrometer used for Regulating the Temperature of Casehardening, Heat-treating and Tempering Furnaces

of charred leather, crushed charcoal and ammonium carbonate.

The work is packed in pots in this mixture, the lids put on and sealed with fire clay, and then the pots are put in the carburizing furnaces, two of which are shown in Fig. 5. The temperature in these furnaces is raised to the desired point and maintained for a sufficient length of time to let the carbon penetrate into the steel about 0.02-0.04 inch. This generally requires from three to five hours after the correct temperature has been reached. Of course, the length of time depends entirely upon the depth of casehardening desired and the size of the piece to be treated. The temperature in the pot is slightly greater than that near the walls of the furnace, and is consequently greater than that registered on the pyrometer.

The carburizing furnaces are heated by high-pressure fuel oil burners having a pressure of 18 pounds on the oil and 40 pounds on the air for atomizing, and about 12 ounces for supplying air for combustion through a two-inch pipe. The temperature is recorded on a Hoskins electric pyrometer, Fig. 7, which is provided with "reading contact points" for all the furnaces in the room. After the parts have been left in the furnace for a sufficient length of time, the pots are taken out of the furnaces and allowed to cool down gradually, the covers not being removed until the pots are perfectly cold; then the covers are taken off and the parts unpacked and heated to treat the core, and plunged in oil; they are then again heated to from about 1350 to 1425 degrees F., to harden the case, dipped in oil, and tempered.

Heat-treating Automobile Drive Gears

Automobile drive gears which contain 3½ per cent nickel, are put in a lead bath after carburizing (see Fig. 6), and are heated from 1550 to 1600 degrees F. After the gear is brought to this temperature it is taken out and quenched in the bath of running oil shown at *A*, Fig. 6. Charcoal is put on top of the lead to prevent it from oxidizing. This also helps to keep the temperature even and prevents the lead from sticking to the gear. After quenching, the gear is again heated to a temperature of from 1325 to 1350 degrees F., so as to harden the case. After the gear is brought to the proper temperature, it is quenched in the running oil bath.

Tempering

Most automobile gears and other parts require to be tempered after being heat treated. The tempering is accomplished in an oil bath shown in Fig. 8. The work is placed in the basket shown and the latter lowered into the oil, which is a grade of fish oil, called "No. 14 tempering oil." This is heated to from 325 to 400 degrees F. for nickel steel, and from 550 to 600 degrees F. for oil-hardening chrome-nickel steel. After the work has been brought to the same temperature as the bath, it is allowed to remain for a certain specified time, and is then removed and allowed to cool off gradually. It is then washed in a lye solution and sand blasted.

All of the oil tempering, casehardening and heat treating furnaces are supplied with the same type of oil pressure burners. The cold ends of the thermo couples are surrounded by water jackets in which cool water is circulated as indicated at *B* in Fig. 6. This water jacket keeps the couples at an exact temperature and thus makes possible correct reading on the pyrometer. The pyrometer is tested from time to time and is automatically regulated according to the temperature of the room.

Examining the Fracture of a Broken Gear

After a sample is carried through in the manner previously described, it is broken with a sledge hammer to determine if the core has been heat treated properly, or whether crystallization has taken place. This process of breaking and examining is carried on until a piece is obtained which shows that it has been properly heat treated. The operations are slightly varied until a satisfactory final result is obtained.

Fig. 9 shows a drive pinion for an automobile, which has been broken to show the fracture. This pinion was made from a drop forging as is clearly indicated in the illustration, where the grain of the steel is seen to follow closely

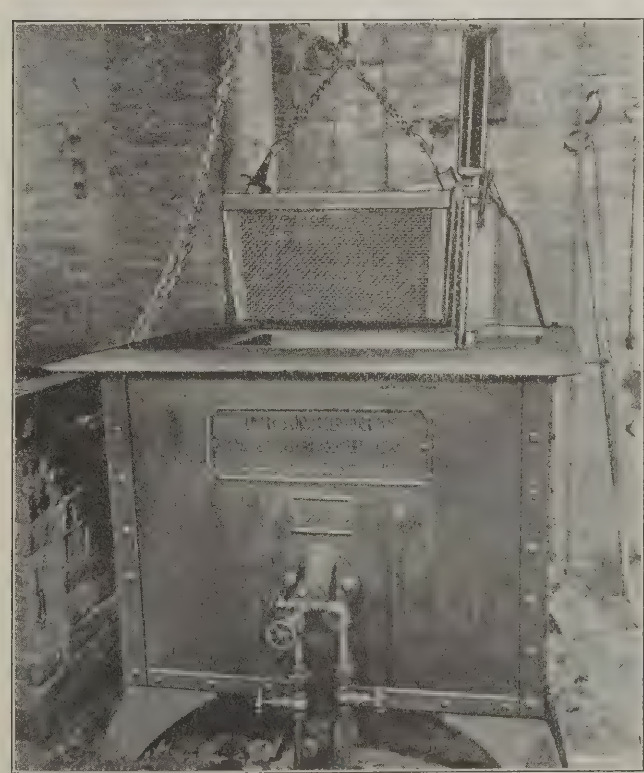


Fig. 8. Oil Bath for Drawing the Temper after Hardening

the shape of the gear. The depth of the case also stands out very prominently. At *B* are shown cracks which illustrate that the case, which is extremely hard, cracked when breaking the gear, but the core still remained intact. A tooth broken off by the sledge is shown at *C*.

The scleroscope is used to determine the hardness of a gear after being heat treated, but it is not relied upon altogether. Sometimes a gear can be "touched" with a file after a high reading has been obtained by the scleroscope. The

main point in heat treating steel is to get a close-grained and "velvety" structure. If the structure is coarse, the part will not be strong and will be easily broken. After a piece has been carried through the process previously outlined, broken and found to be all that is desired, all parts made from the bars containing the same percentages of the various ingredients are given the same treatment. The data thus collected, are tabulated, and filed away for future reference, as shown on the chart in Fig. 3.

Heat-treating a Main Drive or Ring Gear for an Automobile

The main drive or ring gear used on an automobile is considered by most automobile manufacturers as one of the

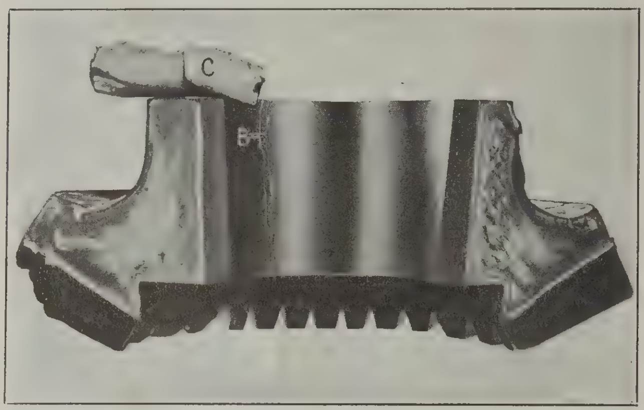


Fig. 9. An Automobile Drive Pinion broken to show Structure of Steel after Heat-treating

most difficult parts to make, and more money is being spent on perfecting this one gear than on any other part. It is very difficult to turn out a gear which has not been slightly distorted during the heat treating operations; such gears will produce considerable noise when running at a high speed. This is a very objectionable feature, and every possible means is devised and employed to obviate it.

The gear shown in Fig. 10 is made from 3½ per cent nickel steel, containing 0.18 per cent carbon. The blank is cut from flat stock of oblong section, split in the center and then expanded to form a ring. This ring is then heated and finished to the desired shape by drop forging. It is evident

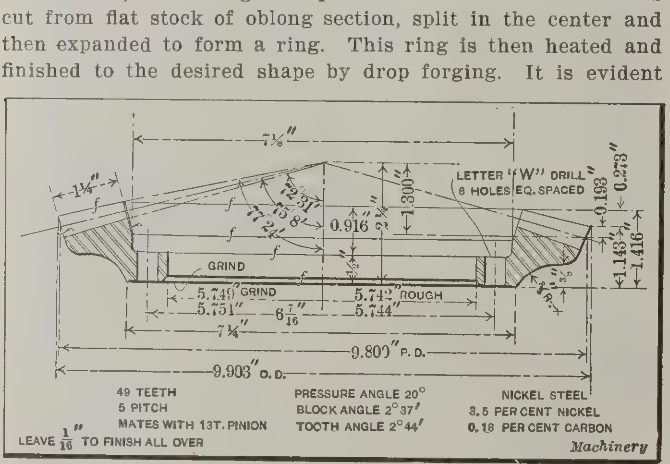


Fig. 10. Automobile Main Drive or Ring Gear to be heat-treated

that the grain of the steel will practically form a complete circle when worked in this way, and this tends to prevent the finished piece from distorting much during the heat treatment. After being drop-forged, the gear is annealed and allowed to cool off gradually; then it is sent to the machining department where it is machined to the correct shape, the teeth cut and all the operations, except grinding, performed. It is then painted on the back with fire clay, put in the carburizing furnaces, and passed through the operations previously outlined.

The heat treatment for this particular gear was as follows: Heated in carburizing compound for four hours at a temperature of 1650 degrees F. and allowed to cool off in the pots; then heated in lead pot to a temperature of 1580 degrees F. and quenched in oil; heated in lead to 1325 degrees F. and quenched in oil; after this, allowed to remain in the oil tempering furnace for one hour at a temperature of 375 degrees F., taken out, allowed to cool off gradually, washed and sand blasted.

It has been found from actual experience that the best way to determine the proper heat treatment for any particular grade of steel or parts made from it is to put a sample through the regular heat treating process, break it and examine the structure. By following this method and using the tabulated data obtained when making the analysis as a guide, very satisfactory results are secured without recourse to any "rule of thumb" methods.

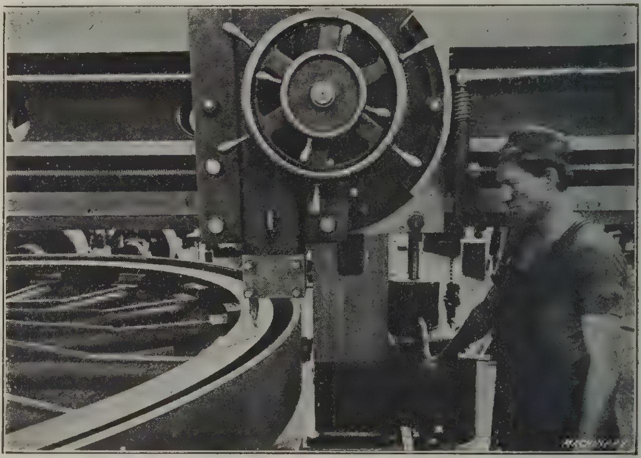
In closing, the writer wishes to express his appreciation of the assistance given him in the preparation of this article by Mr. E. J. Frost, president of the Frost Gear & Machine Co.

* * *

CUTTING AN OIL GROOVE IN A BORING MILL

A simple but rapid method of producing a zig-zag oil groove in a circular piece of work is shown in the accompanying illustration. The work is a 10-foot table for a Cincinnati boring mill, and the machine in which this unusual feat is being accomplished is a Cincinnati 10–16-foot boring mill. The oil groove is 1/4 inch wide and about 3/32 inch deep, and is completed in one minute—the time required for the table to make one revolution. The zig-zag path of the groove is the result of the combined movements of the work and tool-head.

In action, the operator after setting the tool and feeding it down to the proper depth, grasps the shifting lever for operat-



Set-up and Method of Cutting an Oil Groove 1-4 inch wide by 3-32 inch deep, and over 32 feet long in One Minute on a Cincinnati 10-16-foot Boring Mill

ing the rapid power traverse of the tool-head (as shown in the illustration), and then starts up the machine. He watches the cutting tool closely, and as it approaches the edge of the circular bearing, shifts the lever to traverse the tool-head in the opposite direction. This procedure is followed until the table has made one complete revolution, when the oil groove is completed. Formerly this oil groove was laid out, and then chipped with a chisel and hammer, the time required being about six hours.

The cutting of this oil groove in the manner described, illustrates the ease of control of the boring mills manufactured by the Cincinnati Planer Co., Cincinnati, Ohio. D. T. H.

* * *

THE BEGINNINGS OF MONEL METAL

About seven years ago one of the large smelting companies began investigating the chemical and physical properties of an alloy that had been reduced directly from a nickel-copper matte without the previous separation of the two metals. This alloy was found to possess not only the valuable properties of nickel, but also other desirable properties in addition, that would insure a wide usefulness, and owing to the simple method of production, was obtainable at about one-third the cost of nickel. In 1905-6 the International Nickel Co. considering, no doubt, that for many purposes there was no need to separate the amicable metals nickel and copper, took up the problem of reducing them together and obtaining an alloy of the two metals in the proportions in which they occur in the ore. The alloy thus obtained was named Monel metal, after Mr. Ambrose Monel, the president of the International Nickel Co.

BOSTON GEAR WORKS NEW FACTORY

LAY-OUT AND MACHINE EQUIPMENT

Of the few large plants in the United States devoted exclusively to the manufacture of gears the Boston Gear Works probably is the largest manufacturing such a great variety of gears. This firm started business in Boston in May, 1891, with twelve men, under the management of Mr. Frank Burgess. The business gradually grew so that during the spring of 1906 an enlargement became necessary, and a modern one-story factory of saw-tooth construction, with the exception of the office department, was built at Norfolk Downs, about six miles from Boston. This plant was completely destroyed by fire November 27, 1909.* In less than one week after this fire, gears were cut in a nearby building on machinery taken from the ruins.

By February 10, 1910, a new and better factory was completed on the site of the old structure, and running on full time. This record was due to the great energy of Mr. Burgess, and the cooperation of his 125 employes.

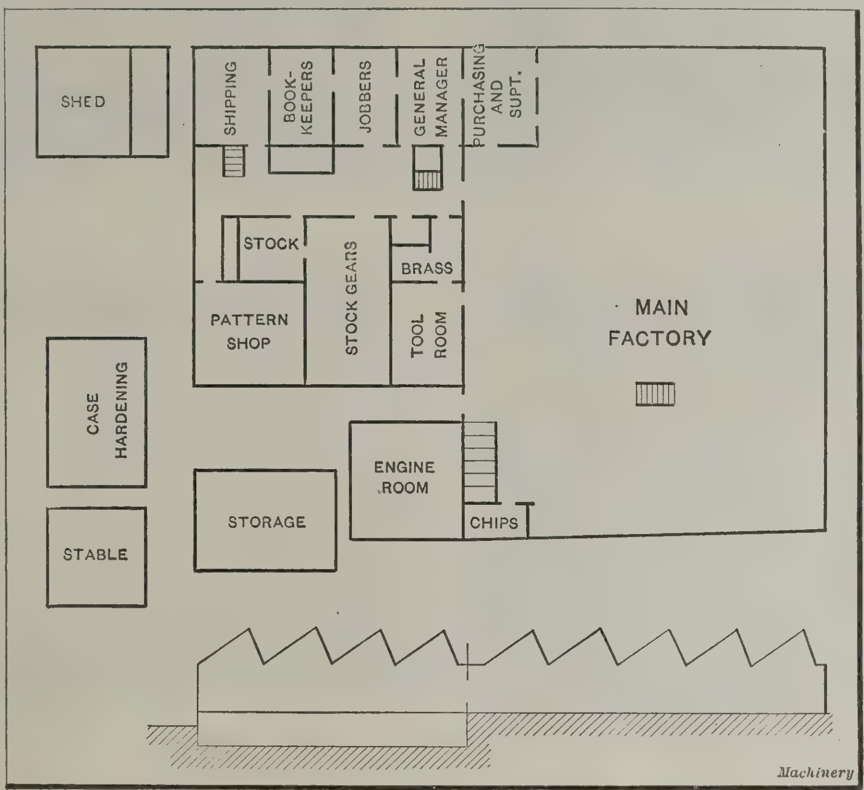


Fig. 1. Plan of Boston Gear Works

The new factory, like the old, is of saw-tooth roof construction, which had proved very satisfactory. The office is placed on the first floor in order to give more uniform light and direct communication with the factory. There is 29,000 square feet of floor space in the main building, and a total floor space, including other buildings, of 37,000 square feet.

The main building is divided into two parts by a fire wall, the factory section being 90 feet by 131 feet, and the office section 90 feet by 71 feet. In the office section are located the pattern shop, two gear stockrooms, toolroom, shipping room, and three offices, on the ground floor. The three offices, being those of the general manager, bookkeepers and jobbers, are so arranged that quick communication can be had with each other, as well as with the main factory section.

In the basement under the office section are storage, millwright and experimental rooms, a steam heating plant, and one 50 H. P. De LaVergne oil engine, and in the basement under part of the main factory building are located a 50 H. P. De LaVergne oil engine generator, pumps, etc., several cutting-off machines, and steel racks. In 1910 a power plant was erected in a new building 31 feet by 32 feet, adjacent to the fire wall of the main factory building, and an 85 H. P. Hornsby-Akroyd-De LaVergne oil engine installed.

The main factory is divided into about fourteen separate departments, each under a working foreman, scientifically arranged so that the work may progress in the most systematic manner. The entire equipment consists of about 225 machines, seventy-five of which are automatics, most of them being of the latest design. The equipment by departments is as follows:

The model, or small gear department, consists of over forty turning and gear cutting machines, ten of which are automatics. Most of these machines were designed and built by the Boston Gear Works. The Cleveland automatic section consists of seven Cleveland automatic turning machines, handling bar stock up to six inches diameter. This department also includes four Acme and two Hartford automatic screw machines. The Potter & Johnston section contains three Potter & Johnston automatic chucking machines, one plain chucking machine, one Jones & Lamson, one Prentice, one Bullard and two Fay lathes. The Gleason gear planing section consists of six bevel gear generators and three single tool planers, taking in work up to forty-eight inches diameter. The Whiton section comprises nine automatic milling machines for cutting sprockets, spur and bevel gears of small diameters. The spiral section contains ten machines for cutting spiral and worm gears up to thirty-six inches diameter. The hobbing department includes seven machines for cutting spur, helical and worm gears, up to ten feet in diameter. The Fellows and Gould & Eberhardt department consists of six Fellows gear shapers, including one rack cutter; seven Gould & Eberhardt automatic spur and sprocket gear cutters, and

Fig. 2. General View of Boston Gear Works

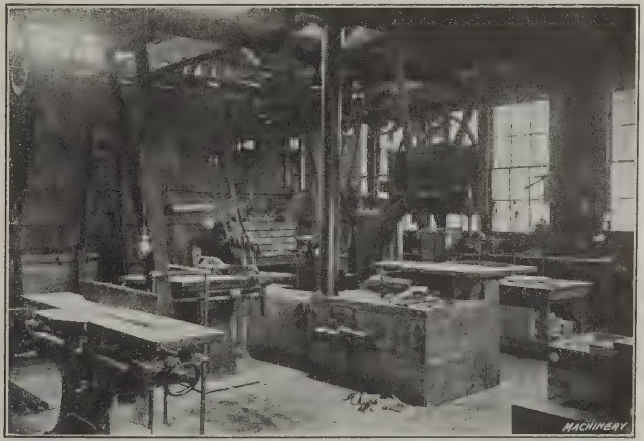


Fig. 3. The Pattern Shop

* See "New Plant of the Boston Gear Works," November, 1906, for description of the plant destroyed by fire.

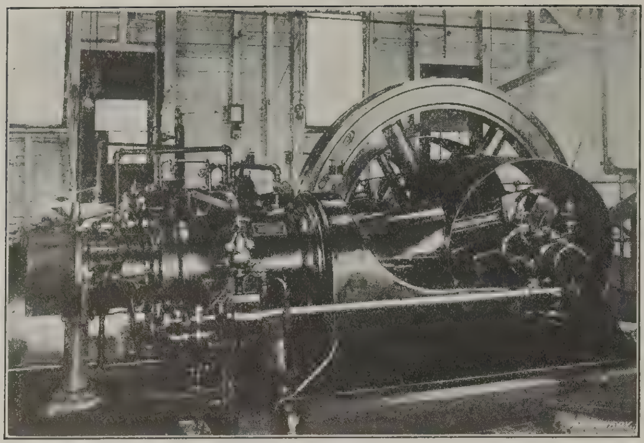


Fig. 4. Eighty-five H.P. Hornsby-Akroyd Oil Engine Power Plant

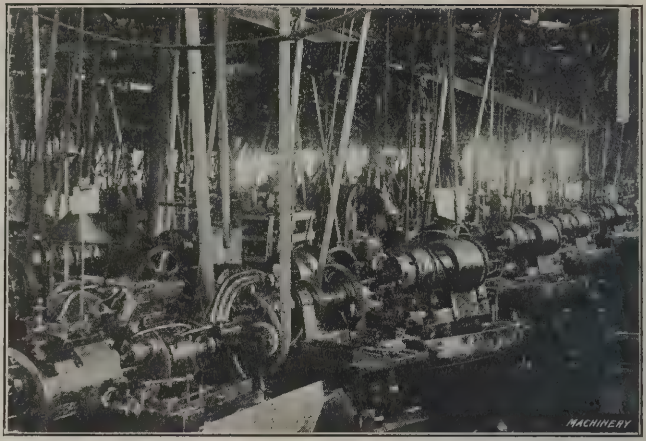


Fig. 5. Cleveland Automatic Department

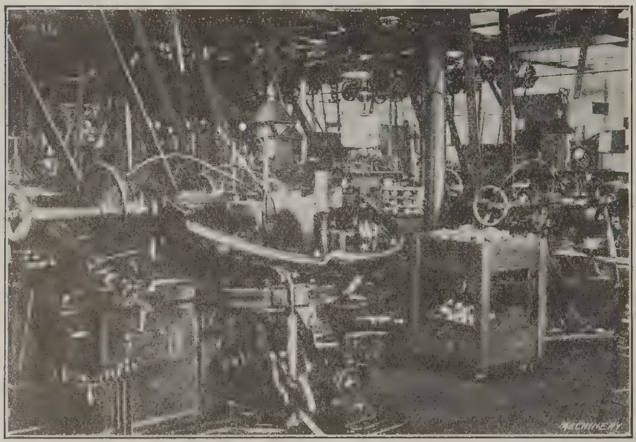


Fig. 6. Gleason Gear Planing Department

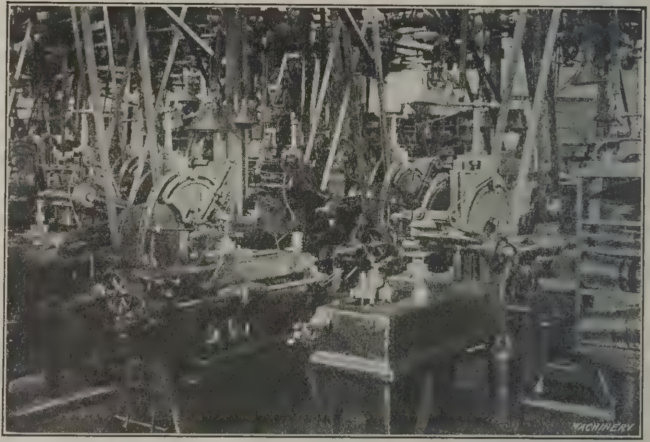


Fig. 7. Whiton Gear Cutting Machine Department

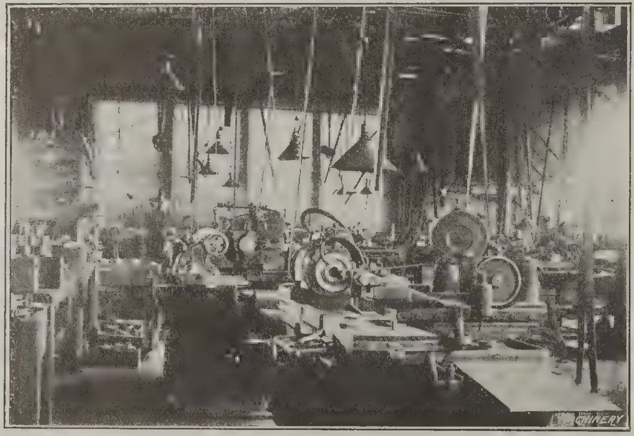


Fig. 8. Grinding Department

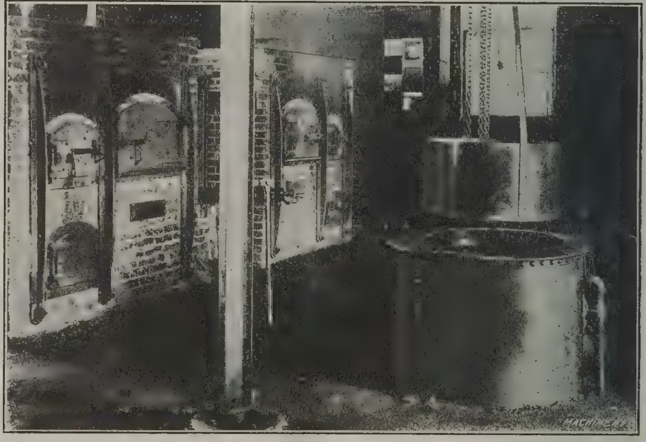


Fig. 9. Coal Carbonizing Furnaces

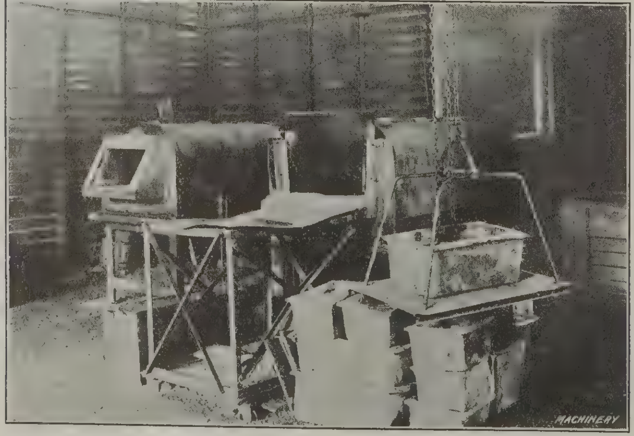


Fig. 10. American Gas Furnaces equipped for burning Oil

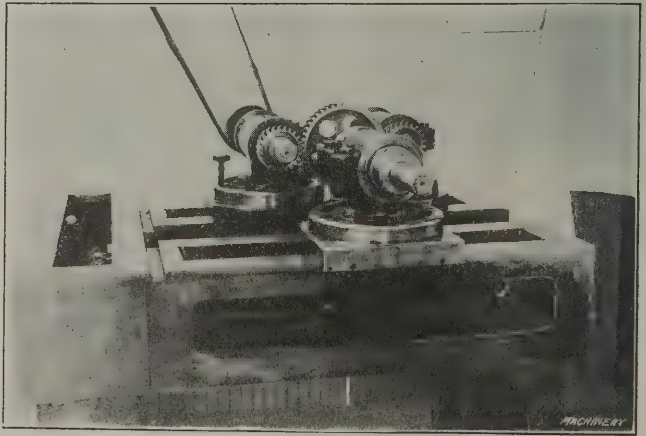


Fig. 11. Universal Gear Testing Machine

one Brainard machine. Gears up to seventy-four inches diameter can be cut in this section. The lathe, drill and miscellaneous department contains twenty-two machines. The tool section consists of twelve machines, among which are milling and special hobbing machines. The grinding department comprises nine universal, plain and internal grinding machines.

In 1911 a new casehardening plant, 26 by 45 feet, of fire-proof construction was built, consisting of a steel frame covered with asbestos protected metal. This plant is equipped with two modern brick coal carbonizing furnaces, two of the American Gas Co.'s furnaces equipped for burning fuel oil,

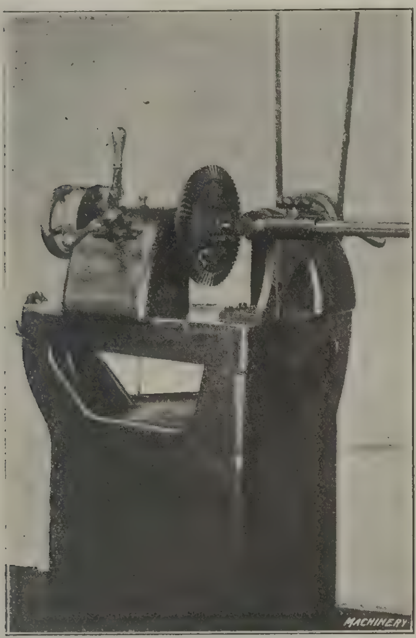


Fig. 12. Bevel Gear Testing Machine

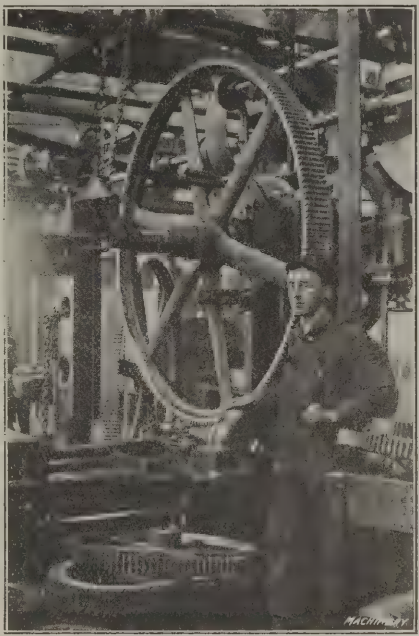


Fig. 13. Gould & Eberhardt Department

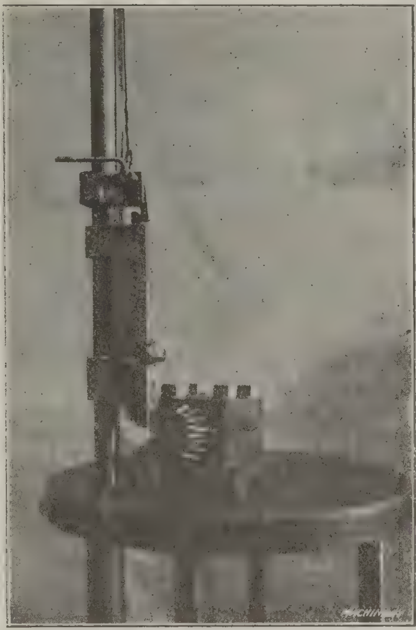


Fig. 14. Drop Hammer Testing Machine

and lead reheating and oil tempering furnaces, also using fuel oil. The temperatures are recorded by a Bristol pyrometer, and the very latest and best methods are used for treating all kinds of steel.

The inspection department is equipped with the latest and best machines for testing gears under actual running conditions; there are also all kinds of measuring tools, such as plugs, micrometers and tooth vernier calipers, drop hammer machine and scleroscope for testing heat-treated gears. Back of all this

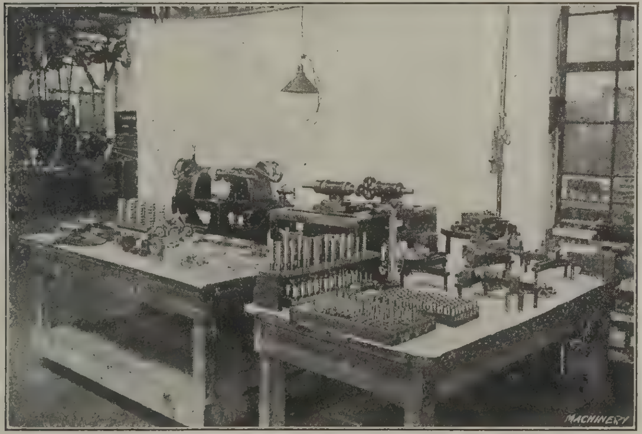


Fig. 15. Inspection Department

equipment is thirty-two years experience in the manufacture of all kinds of gears.

The works are prepared to handle large or small quantities of special gears from one-eighth inch to ten feet diameter. They make a specialty of all kinds of steel gears, including automatic differential and transmission gears, as well as fan, cam, timer, and pump gears for engines. Recently a number of worm and helical gear cutting machines were developed to manufacture special worm gear combinations both small and large to transmit light and heavy power. They will also soon be prepared to manufacture in large quantities worm gears for automobile rear axle drives, both of the straight and Hindley types.

IRON AND STEEL INDUSTRIES IN U. S.

The director of the Bureau of the Census, Department of Commerce and Labor, has issued an advance bulletin giving a summary of the thirteenth census statistics with relation to the number of establishments, persons engaged and capital invested in the steel works and rolling mill industry in the United States. This industry, considering the value of the products, ranked fourth among the industries of the country in 1909.

In that year there were 446 establishments with a total number of 260,762 persons engaged, of which 47 were proprietors and firm members, 4239 salaried officers, superintendents and managers, 14,613 male, and 1767 female, clerks. The average number of wage-earners was 240,076; the number in the maximum month, December, was 283,629, and in the minimum month, March, 215,076. The primary horsepower was 2,100,978. The capital invested was $1,004,735,111. The total expenses were $889,501,220. The value of products was $985,722,534. The value added by manufacture, which is the difference between cost of materials and value of products, was $328,221,678.

With regard to the number of wage-earners employed, the

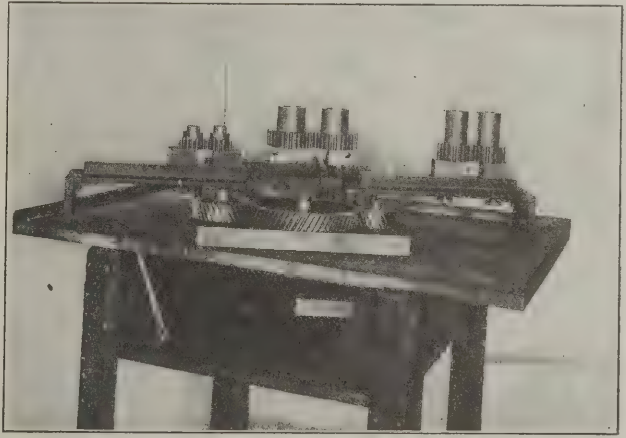


Fig. 16. Spur and Spiral Gear Testing Apparatus

leading states in the order of their importance were as follows: Pennsylvania, Ohio, Illinois, Indiana, New York, West Virginia, New Jersey, and Massachusetts. The accompanying table gives the average number of wage-earners, the value of the products, and the value added by manufacture in these states.

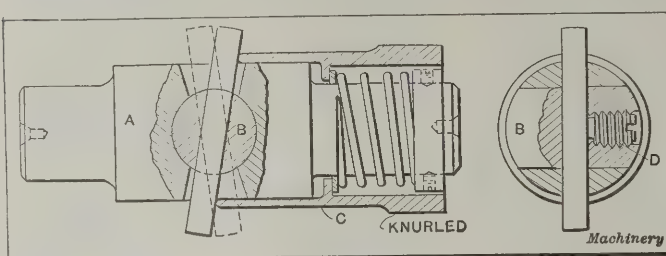
States	Average No. of Wage Earners	Value of Products	Value added by Manufacture
Illinois	17,584	$86,608,137	$30,363,674
Indiana	12,255	38,651,848	12,553,089
Massachusetts	3,115	13,567,628	3,535,355
New Jersey	4,671	12,013,719	5,378,679
New York	10,091	39,532,414	13,643,244
Ohio	38,586	197,780,043	58,536,888
Pennsylvania	126,911	500,343,995	171,330,574
West Virginia	5,060	22,435,411	6,539,111

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

GRINDING GAGES WITH SPHERICAL ENDS

A number of spherical end gages, from 2½ to 6 inches long, were to be made, and the device shown in the accompanying engraving was designed for grinding them so that they would be of the correct length when measured anywhere over the ends. This device can be used on any grinding machine having ordinary centers. The illustration practically explains itself. One end of bar *A* is turned down to suit the ordinary driving dog. The other end is turned down for a spring and provided with a stop-collar. The central portion is bored and ground to fit the swiveling plug *B*, and



Device for Grinding Gages with Spherical Ends

has a slot cut through it at right angles to the plug. This slot should be of the same width as the diameter of the gage to be ground. The swiveling plug is drilled and reamed to fit the gage and provided with a clamping screw *D*.

A piece of round steel of the same diameter as the gage to be ground and with a length equal to the diameter of the bar *A*, is inserted through the slot and clamped in the swiveling plug. The outside of the bar and the ends of the plug are now ground up together to suit the bore of sleeve *C*. This sleeve keeps the plug in position when the gage is removed, and, being provided with a cam surface on its end, gives the required motion to the gage being ground. The right-hand end of this sleeve is knurled so that the operator can grip it and hold it stationary while the remainder of the device rotates.

The gages to be made are rough-turned, cut off to the required length with proper allowances, and the diameter ground to suit the slot and the bore of the swivel. Then the centers are removed and the gage inserted in the fixture and clamped central by screw *D*, and finish-ground on the ends. Only a slight grip on the sleeve is required to hold it stationary, so that the gage to be ground will swivel to and fro against the cam surface on the end of the sleeve.

G. R.

SEASONING CAST IRON

In the June number of MACHINERY, R. L. S. asks for some method for quickly seasoning castings. The writer would advise him that the quickest way of removing the internal strains is to anneal the castings, provided facilities for this process are at hand. Mr. George M. Bond of Hartford, Conn., whose work in connection with accurate measuring machines is well known, first has the beds of the machines rough-planed and then anneals them in the Jones process furnace. In this furnace, which is the invention of Mr. H. K. Jones of Hartford, Conn., the work to be annealed is kept in a closed receptacle. This prevents oxidation and the work will come out as bright as it goes in.

The measuring machine beds mentioned are of box section about three feet long; 1/16 inch is allowed for the finishing cut after annealing. The planing is practically all on one side and none of the castings have warped in the annealing process to such an extent that they would not finish up properly in the subsequent replaning; *i. e.*, they have sprung much less than 1/16 inch.

The special skill in connection with annealing lies in choosing proper points for supporting the casting and heating it to a low red heat only. It has not been found necessary to run the heat higher in order to eliminate all the internal strains. At the higher heat the casting would undoubtedly sag out of shape by its own weight.

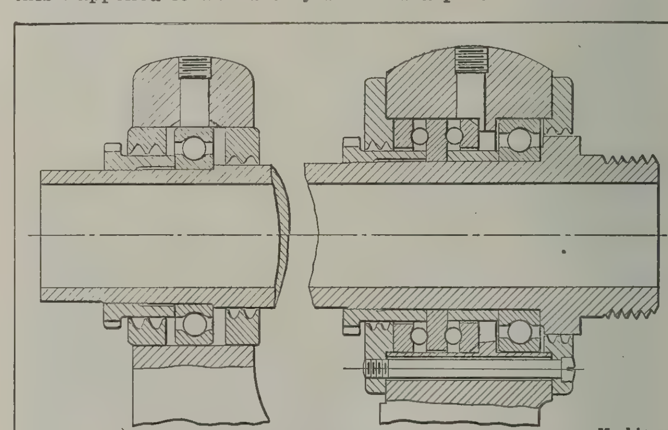
New Britain, Conn. R. S. BROWN

BALL-BEARING LATHE SPINDLE

Frequent references have been made of late in MACHINERY to the use of ball-bearings for the spindles of heavy machine tools. The accompanying drawing shows an example from actual practice of a spindle of a lathe of 16-inch center (32-inch swing) which has been in constant use for about two years. During the preliminary tests it was found that about 25 horsepower was needed for some of the cuts taken, although probably a 10-horsepower motor would have been ample for the ordinary duties of the machine.

The spindle runs at a speed varying from 22 to 505 revolutions per minute and has so far given no trouble whatever and has never required adjustment. The outside diameter of the front end of the spindle is 4¼ inches, and in addition to chucking work it can take bars up to 2½-inch diameter through the spindle. No vibration is felt under the heaviest cuts or during forming operations.

It will be seen that the thrust is taken at the front end by a double thrust bearing, the middle unit of which, together with the journal bearing, is clamped solidly to the front shoulder of the spindle by a notched nut, the bearings being retained at correct distances by sleeves or bushings. The retaining plates are clamped to the headstock by four fillister-head screws, as indicated. The one at the left-hand end of the bearing is adjusted once for all, it being considered advisable to make it impossible for the workmen to tamper with the adjustment. The argument for absence of facilities for adjustment is as follows: If adjustment should prove to be necessary after running, it would indicate that wear had taken place and if this happened it would only serve as a proof that the scheme



Mounting of Ball Bearings for Lathe Spindles

was a failure—at any rate, as regards the thrust bearings; and if the thrust bearings were subject to wear, the journal bearings would, in all probability, be subject to wear also. In fact, it may be said generally of ball bearings that wear proves that either they are unsuitable or the bearing is too small. In the particular arrangement shown it was thought that since the thrust bearings were very closely adjusted this had some influence in restraining vibration. S. PINDLE

LOCALLY CASEHARDENING GEAR AND CUTTER TEETH

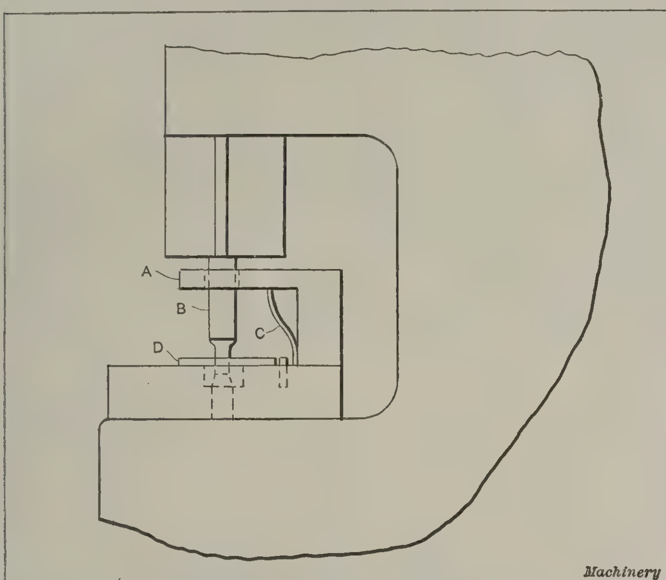
In the May number of MACHINERY I noticed an item on casehardening gears without distortion, stating that the Cadillac Motor Car Co., of Detroit, Mich., has solved the problem by copper plating the teeth after the roughing cut, and then taking a finishing cut which removes the copper plating from the faces of the teeth; then when the teeth are casehardened only the faces of the teeth harden, the remainder staying soft.

This process may be new to the Cadillac Motor Car Co., but not to me and many other skilled mechanics. As long ago as ten years I made long reamers that way and later I made broaches 4 feet long for broaching keyways in automobile gears, hardening them by this process. The only parts of the broach that were hardened were the teeth, and it worked very successfully in the shop of which I was then foreman.

J. A. L.

SPRING EJECTOR FOR PIERCING DIE

The accompanying illustration shows a device which in certain instances is useful in connection with piercing dies. With this device in use, flat blanks being pierced will be thrown out in front of the machine. The construction is simply as follows:



A Spring Ejector Arrangement for a Piercing Die

The piece *D* when punched sticks to the punch *B* on the upward stroke, until it strikes stripper *A*, when it is stripped off. On its upward way, however, it compresses spring *C*, and is, therefore, suddenly pushed outward by the spring as soon as it is released from the punch. This device, while not new, may be of interest to many who have not seen it employed.

W. ALTON

SUPERSTITION VS. COMMON SENSE

It is true that we no longer burn witches at the stake as did our Puritan forebears in Salem but superstitious beliefs are still too common to let us be very proud of our superiority. Common sense is a trait so uncommon that people endowed with it are regarded as uncommonly smart if not actual geniuses. In the past, MACHINERY has expressed a few ideas on the prevalence of superstition among engineers and others in charge of machinery. An engine or pump may have run satisfactorily for several years and then without apparent reason it goes wrong. After perfunctory tinkering and a half-hearted attempt to find the cause and correct it, the job is given up in despair by those immediately responsible for its operation. If it be a small, comparatively cheap apparatus it may be unceremoniously dragged out and replaced with a new one on the assumption that the old one is beyond hope, and a lurking belief is betrayed that no amount of repairs could have made the thing go. The men in charge may be able to learnedly discuss steam engine diagrams, heat units in steam, condenser capacity, etc., and would be righteously indignant if called superstitious.

To illustrate the attitude of workmen toward apparatus I will mention a case of an ordinary kitchen range in a rented house which gave trouble to the good housewife who essayed to use it. It would not bake or boil. The fire burned red and lifeless. Plumbers, experts and non-experts examined and agreed on a common verdict, "That range is no good; it must be replaced." Replaced it was, but the owner who is not a believer in witchcraft and who holds that the laws of nature operate without regard to location, set the stove up in his own house and quickly discovered the cause of the trouble—a wide gap between the water back and the casing that let the air pass which should have gone through the fire and supported combustion. A few handfuls of furnace cement stopped the air leak and converted a worthless range into a thing of joy and a household delight.

No, superstitious beliefs in the mechanical world are not dead. They will live as long as ignorance exists and men are not taught to seek diligently and intelligently for causes and effects.

F. E. R.

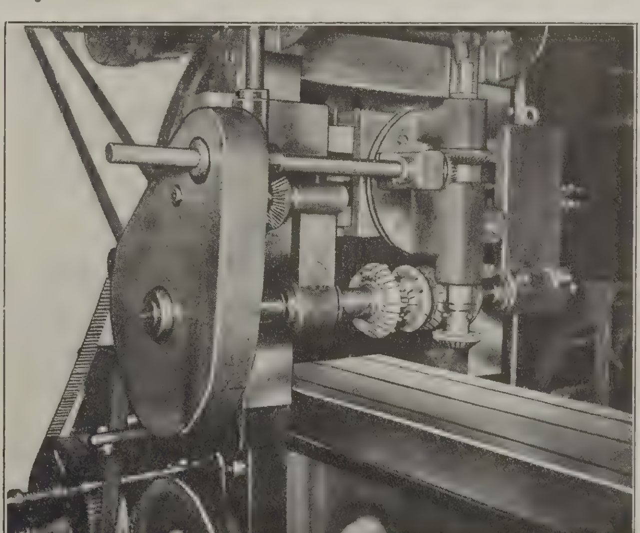
PREVENTION OF RUST ON TOOLS

No doubt a great many of the readers of MACHINERY have noticed the rust formation that takes place on tools within a few hours after they have been hardened in brine or in any of the numerous hardening solutions containing different salts used for this purpose. To counteract this rusting of tools, they should be boiled in a strong solution of soda water for fifteen or twenty minutes after having been hardened. Sal-soda (common washing soda) is the kind to use for the solution. A kettle holding about six or eight gallons of water may be used. About five pounds of soda are put in at the start, and after that about one to one and one-half pound is added every day. In this way the strength of the solution is kept about right. The addition of soda is necessary on account of the overflow which is required because of the method used for heating, the solution being brought to the boiling point by introducing steam. The work should always be boiled before being put into the tempering furnace and the latter should be at a temperature of about 212 degrees F. when the tools are changed from the soda kettle to the furnace. A basket arrangement with windlass may be used for raising and lowering the work to prevent scalding the hands. The directions given, if followed, will prove of advantage in hardening and tempering tools, in that the formation of rust will be prevented.

Decatur, Ill. GEORGE COLES

A MILLING ATTACHMENT FOR THE PLANER

The accompanying halftone illustrates a milling attachment designed for, and mounted on, a Putnam planer. This attachment is used for milling a great variety of work. It consists mainly of a horizontal head, a vertical head, a tailstock, and driving mechanism. The cutter heads are driven from the regular planer countershaft by means of a cone pulley mounted on the countershaft and belted to a cone



A Milling Attachment for the Planer

pulley on the main driving shaft of the attachment. A planetary gearing mechanism is provided to reduce the table travel to a rate suitable for milling. This mechanism is also driven from the regular countershaft on which is placed a small two-step cone pulley belted to a large two-step cone pulley on the planer, which carries the planetary pinion. The motion is then transmitted to the planer table by a Morse silent chain and sprockets, in addition to the regular gearing. The planetary gearing is of such a ratio that the

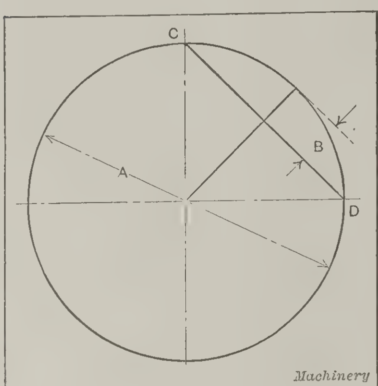
driven gear makes one revolution for every fifty revolutions of the cone pulley.

The attachment is very convenient and durable and has been in operation for eight years without any repairs. It is used on a planer with a 16-foot table. It is easily attached and detached. The planer is run back with the regular planer reverse belt, and, in general, is operated with the regular equipment for table travel, such as stops, etc.

Seneca Falls, N. Y. W. H. RUNGE

LAYING OUT THE CIRCUMFERENCE OF A CIRCLE ALONG A STRAIGHT LINE

The accompanying illustration indicates a simple method for laying out the circumference of a circle along a straight line. This is frequently required in laying out cylindrical grooved cams, and in finding, graphically, the angles of thread helixes or spirals. The method is, briefly, as follows: Divide the circle by two diameters into four equal parts; then draw a line *CD*, bisect this line, and measure the distance *B*. This distance, added to three times the diameter, is a close approximation of the total circumference.



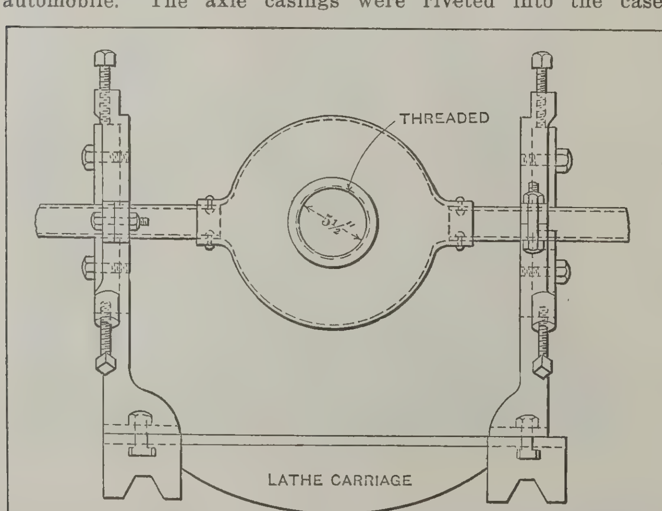
Laying Out Circumference of Circle

The accuracy of the method may be easily investigated. The distance *B* is the versed sine of 45 degrees, which equals 0.29289. This multiplied by the radius of the circle, plus three times the diameter, gives the approximate circumference obtained by this method. Assume, for example, that the circle is 4 inches in diameter; the actual circumference then equals $4 \times 3.1416 = 12.5664$. By the approximate method we obtain $3 \times 4 + 2 \times 0.29289 = 12.5858$. The difference between these two dimensions is negligible in ordinary drafting-room lay-out work. I believe this will be found helpful to readers who are looking for a simple graphical method which saves calculation or reference to tables.

Christchurch, New Zealand. PERCY W. FRAMPTON

THREADING A DIFFERENTIAL GEAR CASE IN THE LATHE

The writer was recently confronted with the task of cutting an internal thread in a differential gear case for an automobile. The axle casings were riveted into the case



Threading a Differential Gear Case in the Lathe

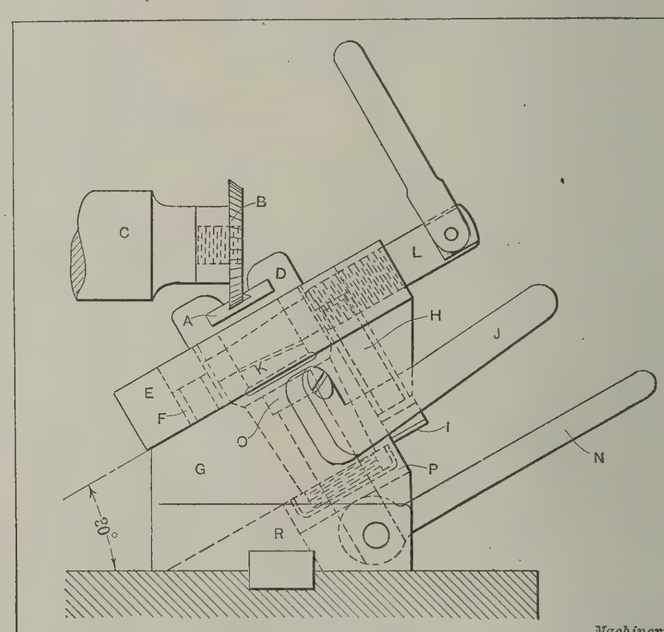
as shown in the accompanying engraving, which prevented swinging the case in the lathe; hence, it was necessary to clamp the work to the carriage and use a rotating tool fastened to one of the chuck jaws. The clamping of the case was done as shown, the work being performed in a 28-inch lathe. Steadyrests, which supported the work, were taken from two smaller lathes in the shop. These rests were bolted to the 28-inch lathe carriage. The jaws of the steadyrests clamped the work very securely, and furnished a simple method for setting the work central.

Denver, Colo. STANLEY EDWARDS

FIXTURE FOR MILLING DOVETAIL SLOTS

Previous to the design of the fixture, the principle of which is shown in the accompanying engraving, the dovetail slot in the steel block *A* was cut with a 60-degree angular cutter, 7/32 inch in diameter, having a neck about 5/32 inch in diameter, and a No. 4 Brown & Sharpe taper shank; or in other words, a cutter was used of the same size and shape as the slot. A roughing cut was first taken with an ordinary slitting saw. The finishing mill in that case, of course, had to be exactly to size, and to run true. High-speed steel was used for the mill, and a fine feed was required; the operator also had to exercise considerable care in starting the cut, as otherwise the cutter was likely to break.

By milling these pieces as indicated in the illustration, the cutter *B* can be made large in diameter; it is easily ground to the required angle and can be re-ground without materially affecting its efficiency; a coarse feed can also be taken. Another favorable feature of the fixture is that the slot is finished at one handling, although, of course, two cuts are taken. As will be seen, the cutter is mounted on a threaded arbor *C*.



A Fixture for Milling Dovetail Slots at a Rapid Rate

The work is held in block *D*, which is the end of the spindle of the fixture. The square indexing plate *E* is keyed to this spindle. In this plate there are two bushed indexing holes *F*, 180 degrees apart. Chips are prevented from getting into these holes by plugs at the top of the plate. The base casting *G* is provided with the usual tongue to locate it in alignment with the milling machine table. The upper surface of this casting is machined at an angle of 30 degrees as indicated. As the axis of the spindle is inclined at right angles to the 30-degree surface of the base, one edge of the dovetail slot is brought at right angles to the center line of the cutter arbor. A 60-degree cutter is used, and as its width is a little more than one-half the distance across the bottom of the dovetail, the two cuts, the second of which is taken after indexing the work around, finish the piece. The index pin *H* is held in bushing *F* by a flat spring *I*. Lever *J* is used for pulling the pin *H* out before indexing.

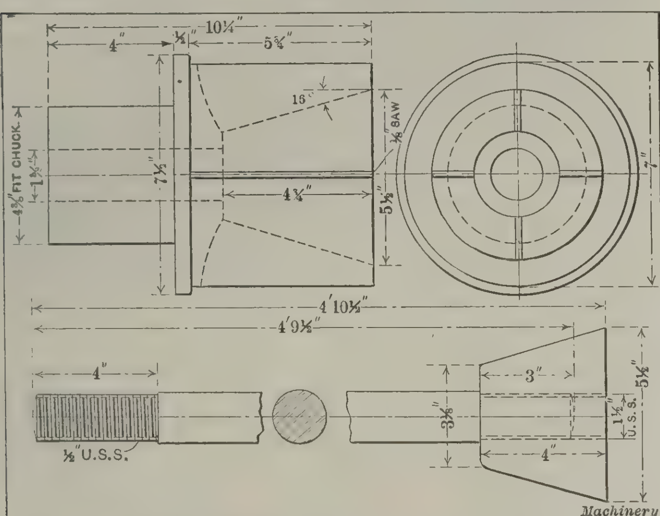
The work *A* is clamped against the upper side of the slot in *D* by means of the plunger *K*, which is actuated through screw *L*, the handle of which acts as a wrench. The clamping is done by means of the wedge action due to the taper of screw *L* on that part of it which is inside of *K*. The spindle and plate *E* are clamped in position before taking a cut by means of cam lever *N* acting through cam-shaft *O*,

which has on its upper end a head for pulling the spindle down. Some of the details are rather obscure in this view, but it is all that is necessary to explain the principle involved.

East Orange, N. J., J. W. WEED and
Tottenville, N. Y. S. J. PUTNAM

EXPANDING ARBOR FOR HEAVY TURRET LATHE WORK

The accompanying engraving shows an expanding arbor of heavy design which has proved satisfactory for rapid and accurate work on a heavy turret lathe. As will be seen, the arbor is intended to fit the chuck on the machine, and is provided with an expander having a bolt which extends through the entire spindle, this arrangement allowing for quick ex-

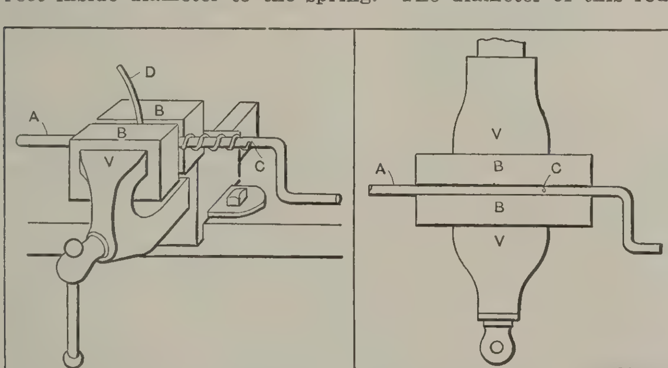


Expanding Arbor for Heavy Turret Lathe Work

pansion by means of a handwheel and washer on the end of the bolt. By means of this arbor the work is secured and held central for facing, turning or counterboring, independently of the chuck jaws, and the jaws are needed only to act as drivers. Whether the chuck is of the independent or universal type, it is possible to hold the casting true to the bore by means of this arbor, and a great deal of time is saved that is ordinarily spent in truing up work held by the chuck jaws only. At the same time, variations in the bore are taken care of by the expansion feature. M. W. W.

METHOD OF WINDING SPRINGS IN A VISE

The accompanying illustrations show a method of winding springs in a vise. The writer has used this method for a number of years, but has never seen it described in MACHINERY. In the device, *A* is a rod so selected that it will give the correct inside diameter to the spring. The diameter of this rod



Winding Springs in a Vise

must be determined experimentally, as there must be some compensation for the enlarging of the spring when released. This rod is bent at one end to form a crank. A hole *C* is drilled near the crank end. This hole should be large enough to allow the end of the spring wire to enter. At *B* are shown hard-wood blocks, *V* being the vise jaws.

The rod *A* is clamped between the wooden blocks with the crank as close to the blocks as possible, and with the hole *C* in a vertical position. The end of the spring wire is inserted into the hole. At the start the wire *D* must be guided so as to give the correct pitch. If held in a vertical position, the spring will be close-coiled. If inclined to the left, the coils will be open; the more the inclination, the wider the spacing. The first turn determines the pitch. After the first turn, a groove is formed in the wooden blocks and the wire will follow this groove. When the rod has passed through the blocks, or the wire has come to an end, release the blocks and cut the wire at hole *C*, thus allowing the spring to slide off the rod.

When springs are wound in this manner it seems that they do not enlarge as much in diameter when released as they do when wound in the lathe. The reason for using hard-wood blocks is that the wire "beds" into soft wood too easily.

Ft. Atkinson, Wis. E. L. WHITE

HANDY TOOL-HOLDERS

The three tool-holders shown in the accompanying engravings have proved a valuable part of a toolmaker's equipment. In Fig. 1 is shown a splining-tool holder used for work where an ordinary holder cannot be used to advantage. The tools

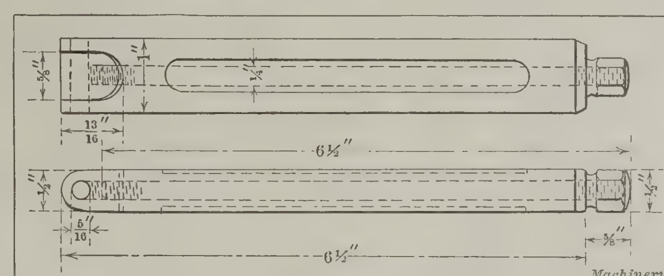


Fig. 1. Splining Tool Holder

are made of 5/16-inch drill rod, forged to the desired shape, and are firmly held in place by the clamping arrangement shown in the engraving. In Fig. 2 is shown a tool-holder for forming tools, when the cutters are made in quantities. This tool-holder is of considerable value; the forming tools may be

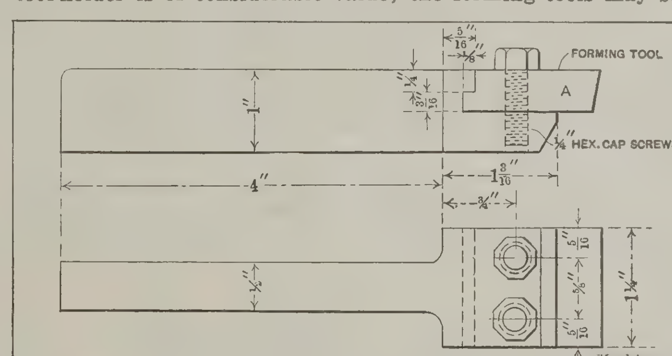


Fig. 2. Forming Tool Holder

made at low cost, and in case of breakage can be easily replaced.

In Fig. 3 is shown a tool intended primarily for threading operations, but it can also be used for light forming work. All parts of this tool are made of steel and casehardened.

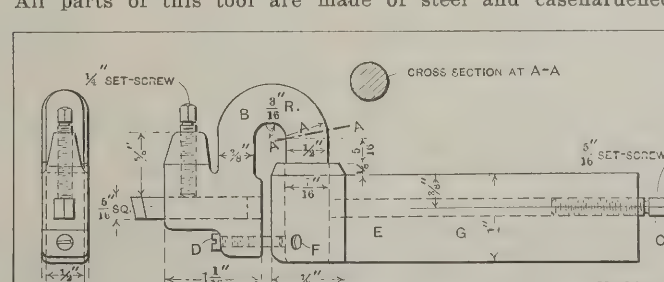


Fig. 3. Spring Threading and Forming Tool Holder

This tool is adjustable to three positions, right-hand, left-hand, and central. The head *B* is made a snug fit in body *E*, and is held in place by rod *G*, which is forced against it by set-screw *C*. Three flats are ground on head *B* so that it may be held rigidly in any of the three positions. Three holes *F* are drilled in the body *E*, one central, and the others at an angle of 30

degrees, on each side of the center, for the adjusting screw *D*. When the tool is used for threading, screw *D* does not reach fully down to part *B*, but a clearance of 1/32 inch is left. In this way the required elasticity of the threading-tool is provided for. When a rigid tool is wanted, it is only necessary to screw *D* tightly into place.

New Britain, Conn. J. M. HENRY

A DRILL JIG FOR A NUMBER OF LEVERS

Fig. 1 shows four levers, *M*, *N*, *O* and *P*. The length *l*, the width of the hub *h*, the hole *a*, and the position of the lever arm in relation to the hub, are different in all cases, while the hole *b* is the same for all. The levers are machined in sets of four (one of each kind), which go through all operations together until they are ready for the machine for which they are designated.

The hole *a* is simply bored in the center of its hub, while *b* must be drilled by means of a jig, since the distance *l* from center to center must be absolutely correct. It would mean

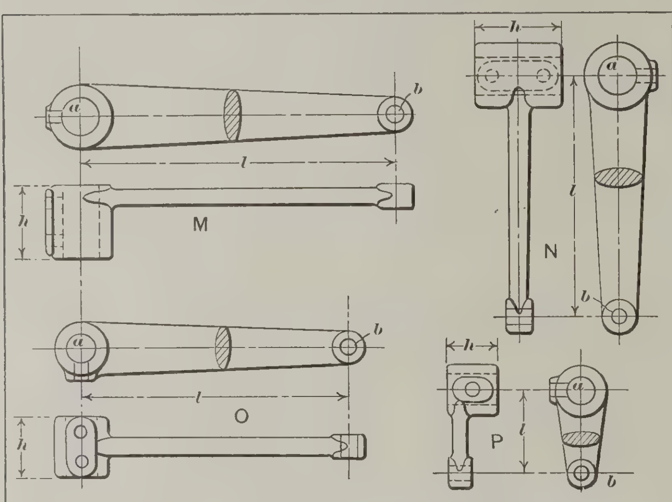


Fig. 1. The Four Levers to be drilled

a considerable loss of time, however, to change the jig for every lever, and the necessity arose, therefore, to design a jig which would allow the drilling of all the levers without taking the jig from the drill press table.

Figs. 2 and 3 show a jig constructed for that purpose. Fig. 2 shows a top view, a longitudinal section and a cross section, while Fig. 3 shows a general view of the jig with lever *M* in

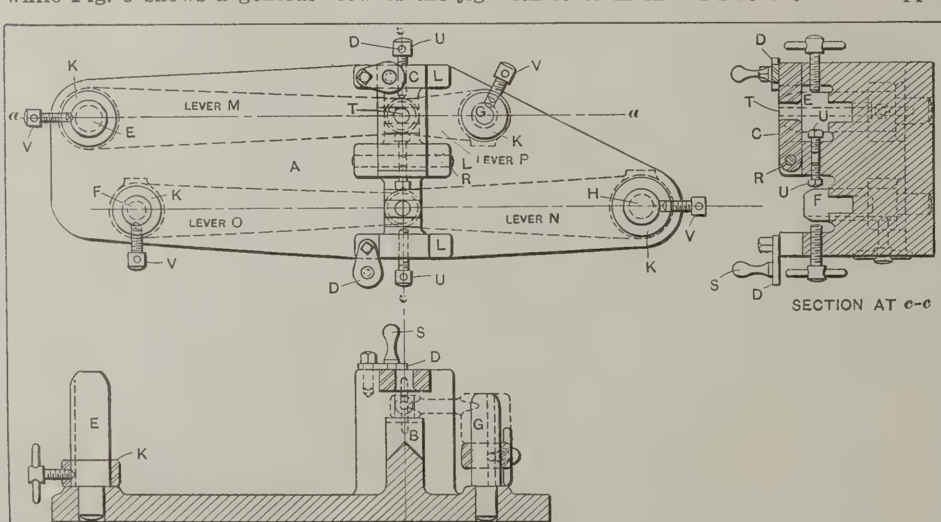


Fig. 2. Plan and Section of Drill Jig for Levers in Fig. 1

place. The jig consists of a cast-iron base-plate *A* which is cast with a projection *B*. This projection has three ribs *L*. The center rib is worked out to receive a hardened steel hinge *C* which swings about a pin *R*; *C* may be laid over to both sides, which are also worked out to suit the hinge. Each side is provided with a small steel lever *D*, with handle *S*, which serves to hold the hinge in its position while the jig is in operation. The guide hole *T* for the drill is used in both positions. The V-shaped part of *B*, directly underneath the guide hole (see section along *a-a*) aids the chips in falling off. Screws *U* are provided to adjust the levers sideways. The correct distances for the lengths of the various levers are laid off, as shown. At the points thus found, studs *E*, *F*, *G* and *H* are provided to suit the respective levers. A collar *K* is fitted to each of these studs. Every collar suits the hub of the lever

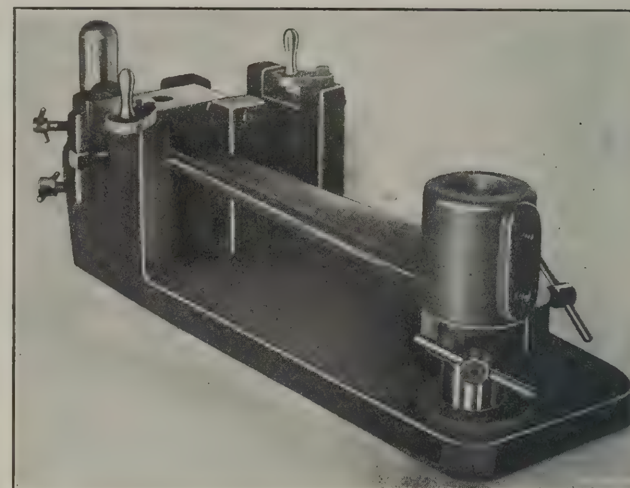


Fig. 3. General View of Drill Jig

which it is supposed to support, and may be fastened at any height by means of a screw *V*. The hardened center-point of the latter slides in a V-shaped groove provided for that purpose, thus preventing the collars from turning, and the handles of the screws from interfering with the body of the jig. Collars *K* hold the levers in the correct horizontal position.

Wyomissing, Pa. CHRISTIAN F. MEYER

SUB-PRESS DIE FOR MAKING A CLEAT

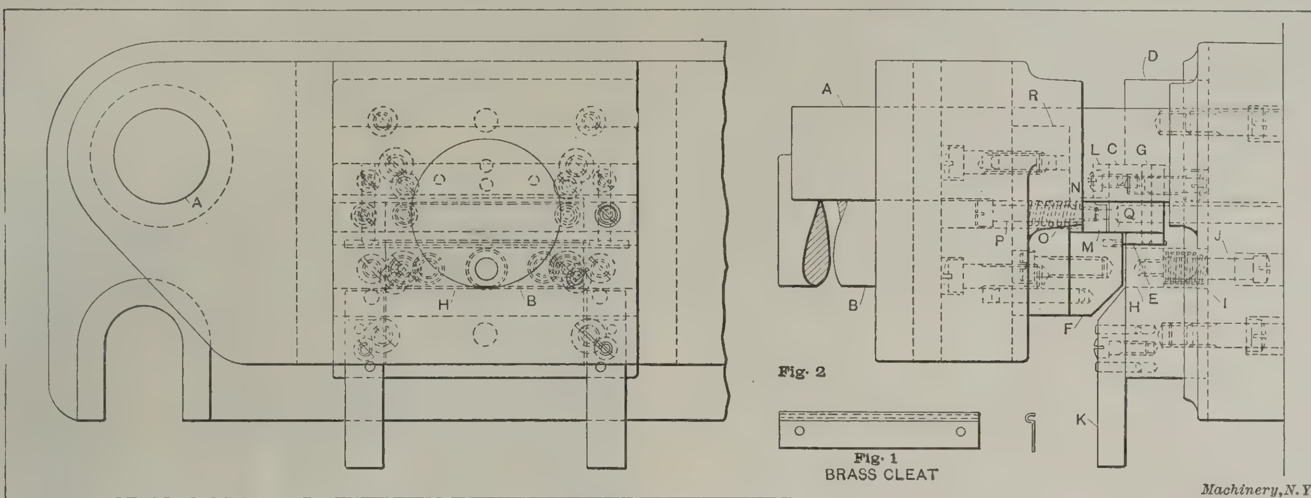
The sub-press die shown in Fig. 2 was designed for producing the brass cleat shown in Fig. 1, this die superseding a set of simple dies previously used for the purpose. With the dies previously made, it required three operations to produce a cleat, the rehandling necessary causing considerable loss of time.

The base and upper portions of the sub-press die are made of cast iron, in the usual form, and are equipped with hardened and ground pins *A* to preserve the alignment of the upper and lower members. A cast-iron shank *B*, fitted in a T-slot cut in the upper member, serves to connect the latter with the ram of the press. Attached to the lower member or base is a hardened tool-steel block *C* mounted by means of screws and dowels on a soft-steel shoe *D*, and entering into a slot cut in the latter as shown. To the block *C* is held a "ribbon bar" *E*, which, in conjunction with the slot in the block *F*, serves to fold the edge of the cleat. The ribbon bar is held to block *C* by two horizontal dowel pins *G*, so that in case of breakage a new strip may be quickly inserted.

The lower member of the die is cut out to receive a spring pad *H*, which acts as a stripper for removing the cleat from the ribbon bar *E*. This pad is actuated by three helical springs *I*, and is limited in its upward movement by the shouldered screws *J*. The two guide strips *K* make provision for the entrance of the strip into the dies. A feed stop-bar *L*, mounted on the block *C*, controls the width of the finished cleat, and a stripper-plate *M*, sliding on the piercing punches *N*, holds the stock while the holes are being pierced. On the ascent of the press, stripper-plate *M* strips the cleat from the piercing punches. The stripper *M* is pressed downward by coil springs *O*, and is retained from further movement by the

shouldered screws P. The block F which acts as a bending punch is mounted on a soft-steel block R which, in turn, is attached to the upper member of the sub-press die.

The operation of this sub-press die is as follows: Stock of the correct width is fed in until the front edge of the strip is slightly beyond the shearing edge Q of blocks F and C. The first stroke of the press shears off the front edge of the strip, thus straightening it, and at the same time forming the bend in the blank. When the ram of the press ascends, pad H forces the bent strip from the ribbon bar E, so that the strip can be fed forward against the stop L. When the ram again descends, the holes in the blank are pierced, the first blank cut off, and the part for the next blank bent to the required shape. The finished cleat is ejected by means of a wooden pencil or rod, and the stock is fed in continuously in the manner described.



Figs. 1 and 2. Cleat and Sub-press Die for Producing it

It will be noticed that the only scrap made is the small disks punched out of the strip by the piercing punches N. In practice, about 100,000 cleats may be punched without sharpening the die, for which, it will be noticed, due provision has been made.

ARON LAWRENCE

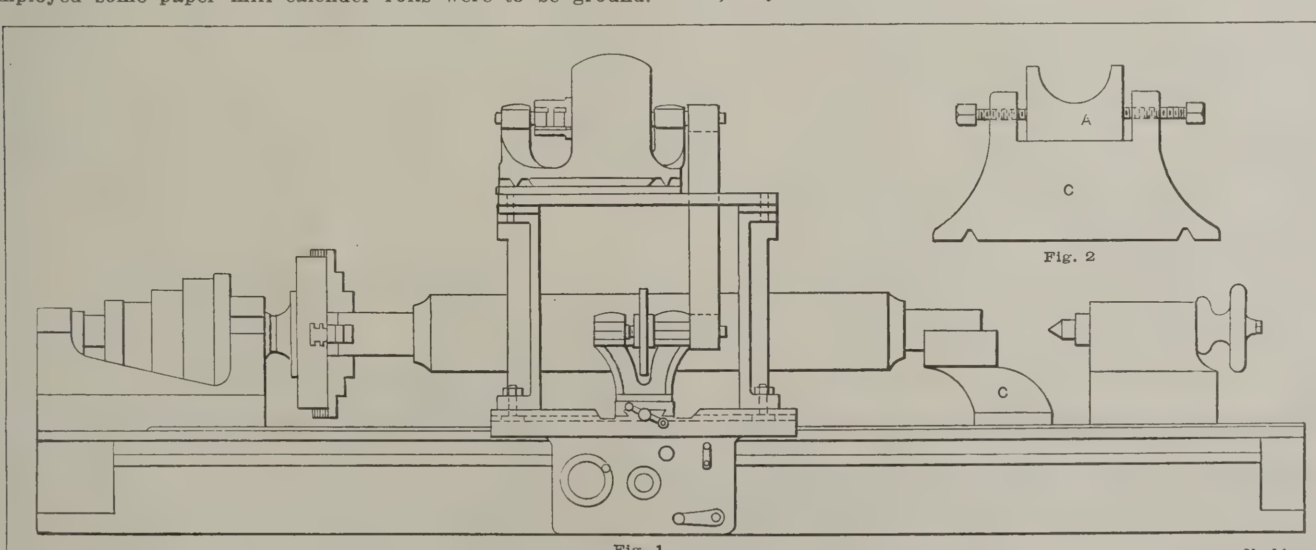
Detroit, Mich.

GRINDING CALENDER ROLLS

In a small job shop in which the writer was recently employed some paper mill calender rolls were to be ground. The machine in which the work was done was an 18-inch lathe with double back-gears. The length of the lathe over all was about 14 feet, and both ends and the middle support were set on masonry. The length of the face of the rolls to be ground was 74 inches, and as the width of the paper was 72 inches, there was left a margin of about one inch at each end of the roll which had not been subjected to wear, but from which it was possible to approximately obtain the alignment in setting up. After removing the compound rest on the cross-slide, an emery-wheel stand made for the purpose was securely mounted in its place, and so adjusted that the axis of the emery-wheel shaft was in the same horizontal plane as the axis of the spindle. A stand was also set up on the carriage and secured to it by means of bolts in the T-slots of the saddle. This formed a support for a 3 H. P. motor for driving the emery-wheel.

As calender rolls cannot be ground on their centers, but must be ground to their bearings, a bracket C was made, the face of which had grooves fitted to the ways of the lathe and which was clamped in the same manner as a steadyrest. On the top of this was a skeleton pillow-block A (see Fig. 2) that could be moved and secured by means of set-screws. The first roll to be ground was the top roll, which was about 12 inches in diameter and weighed about 3700 pounds. One end was chucked as indicated in the illustration, and the other end was temporarily held by the tail-center, while the chuck end was trued up accurately. The pillow-block was then put under the bearing at the tail-stock end and babbitt was poured into it, after which the tail-center was withdrawn.

As the roll did not need to be ground to any specified dimension, but the one consideration was absolute parallelism, any instrument by which this latter could be ascertained could be used. In this case we used a homemade measuring device which looked like an overgrown micrometer, for it had a range up to 16 inches. The measuring screw had 40 threads per inch and could be clamped in its nut. Both ends of the roll were trued up, that is, ground to equal size within a limit of less than 0.001 inch, this limit being obtained when the micrometer readings on the cross-feed



Figs. 1 and 2. Method of Grinding Calender Rolls in a Lathe

screw coincided at both ends. Then the entire length was ground, but, for some reason, the first roll was badly out of round and some time was consumed before the wheel would take an even cut over the entire length. On testing, we found the difference in diameter to be equal to six thicknesses of cigarette paper (the thickness of each paper was less than 0.001 inch). It took more than thirty hours to grind this roll. It was run at about 40 R. P. M., and the emery wheel was run at 1800 R. P. M. The diameter of the wheel was 10 inches, the face 1/2 inch, and the feed 3/16 inch. No water was used at any time.

Two wheels were used, the first a hard one but not very coarse, for the rough-grinding, and the second, a softer one, but somewhat coarser, for the finishing. The rough-grinding showed even "checks" about ½ inch wide all over the roll, and neither variation in the speed of the roll nor in the feed would eliminate them. In the writer's opinion, the comparatively slow speed of the wheel was the cause of this. The wheel should be run from 500 to 800 more revolutions per minute. After finish grinding with the softer wheel, the rolls were polished with fine emery dust and oil on a pine board. The other rolls, two of which were 6 inches, and two, 9 inches in diameter, were finished in the same way but at a comparatively higher speed. During the operation the oil holes were carefully plugged and the ways covered with canvas strips to protect them from the emery dust.

This was the third job of the same kind done in this shop. The owner said that he had been told, over and over again, that calender rolls could not be ground on engine lathes. He had, however, been able to accomplish this work satisfactorily. The only difficulty he met with was that on the first roll he found that the machine continued to grind several thousandths of an inch smaller in the middle, although sparks indicated an even cut the entire length. This difficulty he succeeded in eliminating by blocking up with paper between the frame and the middle leg on the back side of the machine. It took him, however, nearly two weeks to find this error and correct it.

It may be considered a good method to have one end of the roll gripped in a chuck as indicated. Personally the writer thinks that it would have been better if the roll had been placed in a bearing at the front end similar to that at the back. In one case, when a very heavy roll was ground, a dog engaged in the faceplate and gripping the neck of the roll—the latter being supported in bearings at each end—was used in order to relieve the spindle of the weight. This method, however, did not prove entirely satisfactory, as there seemed to be a certain spring in the tail of the dog that caused the drive to be uneven and produced something like corrugations in the roll, which were difficult to eliminate; hence, it was considered better to grip one end of the roll in a chuck.

As already mentioned, in truing up the chuck end of the roll, the other end was supported by a tail center. After truing the end as close as possible with chalk, the chuck and bearing were cleaned and covered with a thin film of lamp black, evenly smoothed out and neatly wiped off. A finely pointed scriber was clamped to the end of the emery-wheel stand and run up by the cross-feed screw. The roll was then revolved and adjusted by the chuck jaws until the scriber point traced a line evenly in the film all along the bearing.

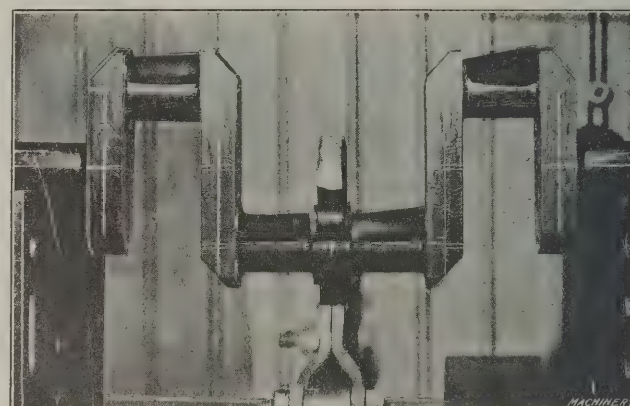
Clinton, Iowa. Olof N. Nord

OBSERVING THE DEFORMATION OF MACHINE PARTS BY PHOTOGRAPHY

It was required to study the deformation caused by deflection in a motor car crankshaft, in order to determine which of the parts should be strengthened. A photographic method was tried and found to be very successful. The crankshaft was covered all over with white enamel, followed by a light coat of a black, opaque varnish; then, by the sharp point of a surface gage, lines were traced on the crankshaft showing the various axes, these lines removing the black varnish wherever drawn, and showing white on a black background.

The crankshaft to be experimented with was of the two-throw type for a four-cylinder motor. The shaft was placed on a cast-iron bed in such a way that it had only two bearing points at the center of its outside bearings, and so that the throws were in a vertical plane. Weights could be applied by means of a hook and a lever, the load being applied to the shaft at a central point. The weights could be attached without moving the shaft in its bearings.

A camera was then placed in front of the crankshaft in such a way that the plate was parallel to the plane of the shaft, and then one photograph was taken without any load on the crankshaft; then without shifting the camera and after having suspended the load from the center of the crankshaft, a second photograph was taken on the same plate, the result



Deformation of a Motor Car Crankshaft as observed by Means of the Camera

being a composite photograph, as shown in the illustration. It will be seen that the white lines traced on the shaft are double, and the distances between two corresponding lines represent the deformation caused by the load at each point of the shaft. It will be seen that it is easy to determine which parts are the weakest, and, therefore, need strengthening. The lines on the central throws remain parallel to each other, which means that this part has not undergone any appreciable deformation. On the two vertical uprights, again, the lines are at an angle with each other which indicates that they have yielded and require greater strength. The distance between the two parallel lines at the place where the weight was attached was ⅛ inch under a load of 6600 pounds.

Turin, Italy. C. Boella

AN ADJUSTABLE PIERCING PUNCH

To pierce a number of strips, as shown at A and B in Fig. 1, the adjustable piercing punch shown in Fig. 2 was designed, which obviated the necessity of making two separate piercing punch holders. This adjustable piercing punch was made so that the punch C could be forced back out of the way when it was necessary to pierce only one hole in the strip, as shown

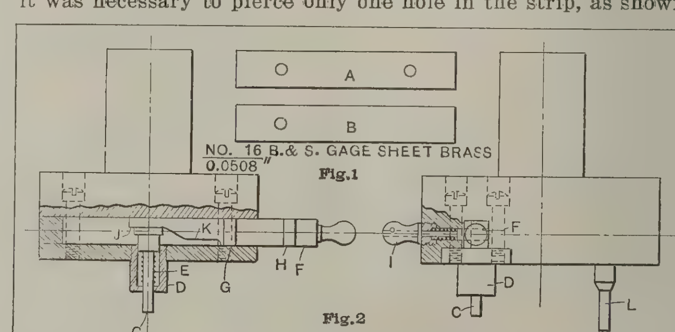


Fig. 1. Blank to be pierced. Fig. 2. Adjustable Punch used in piercing the Blanks

at B in Fig. 1. This was accomplished by holding the punch C in a bushing D which is counterbored to receive the spiral spring E, the bushing D being screwed into the punch holder.

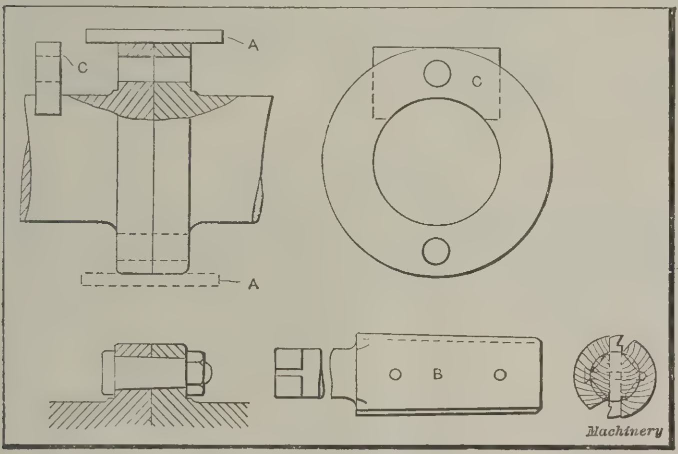
The punch C is provided with a head and is brought into or out of action by means of the cam plunger F, the latter being provided with two slots G and H in which the spring-actuated plunger I fits. When the punch is out of action it rests on the cam face J, the spring-actuated plunger I fitting in the slot G, and when it is in action the cam plunger F is pushed in so that the head of the punch C bears against the

cam face K, the spring-actuated plunger I fitting in the slot H. The other piercing punch L is fastened in the punch holder in the usual manner. The die, of course, is provided with two holes. As can be seen, it is a simple matter to make this punch either into a one- or two-hole piercing punch.

Rochester, N. Y. W. R. HUMELBAUGH

REAMING MARINE ENGINE SHAFT COUPLINGS

As shown in the accompanying engraving, solid flange couplings are used for connecting marine engine shafts. Tapered bolts fasten the flanges together and keep the shafts in alignment. If there is a sufficient amount of work of the same size, a jig may be used for drilling the coupling holes; if not, the holes are marked off and drilled as accurately as possible without a jig. After removing the burrs from the coupling faces, temporary bolts are used to fasten the couplings together, and the edges of the couplings and the holes are brought into alignment. An ordinary steel straightedge A when tried at top and bottom and on both sides of the edges of the couplings will show when they are in line. This part of the work must be carefully done; otherwise the journal portions of the shaft will not run true. The bolt-holes are then reamed, a reamer often used for this work being shown at B in the engraving. It is tapered and consists of a two-edged cutter with pieces of hard wood packing, the whole arrangement being held together by screws.



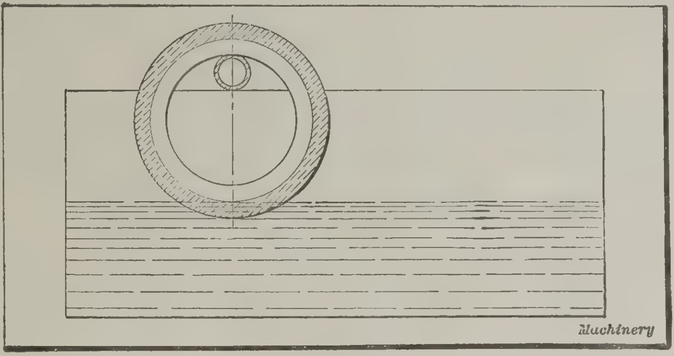
Method of Connecting Marine Engine Shafts, and Reamer used for Reaming the Taper Bolt Holes

The hard wood pieces steady the cutting edges, and the shank is supported, during the reaming operation, in a plain bearing block C of hard wood or cast iron. A slight clearance should be allowed under this bearing block, as the holes may vary slightly in their distance from the shaft center, and the bearing block can be adjusted to the correct distance from the center by packing pieces of tin or sheet iron. If greater accuracy is required, a roughing and finishing reamer may be used, although one reamer is often sufficient. For small holes the reamer is frequently turned by a hand ratchet, no support being required, while, in the larger sizes, some portable means for driving that is available may be used. While reaming the holes, the alignment of the reamer should be tested two or three times to see that it is square with the flange. If the holes are not drilled exactly in line, the reamer may have a tendency to draw to one side. After fitting a tapered bolt in the first hole, the hole opposite should be reamed next and also fitted with a bolt; afterwards there will be no danger of the couplings shifting while reaming the remainder of the holes. The bolts are driven in tight with a heavy hammer. This type of coupling is used when a three-throw crank is built up of separate parts.

Govan, Scotland W. BURNS

REDUCING THE DIAMETER OF A RING

The writer recently met with an interesting job in the form of one thousand cast-steel rings that were to be shrunk on to the hubs of motor truck wheels. The rings were of rectangular section, 10⅜ inches inside, and 16½ inches outside diameter. The thickness was 1¾ inch. These rings were faced on one side and bored to within a limit of 0.002 inch. The work was done in small lots, covering a period of more than six months, and different men and machines were employed on the work; hence, quite a number of the rings were bored too large. The specifications in connection with this work did not permit any forging to be done on these castings, and the appearance of any hammer marks would not have been permissible. A satisfactory method for shrinking the diameter of the rings, however, was developed. The rings were heated to a bright cherry red in a furnace, and then hung on a piece of pipe laid across a tank of water as indicated in the accompanying illustration. The level of the water in the



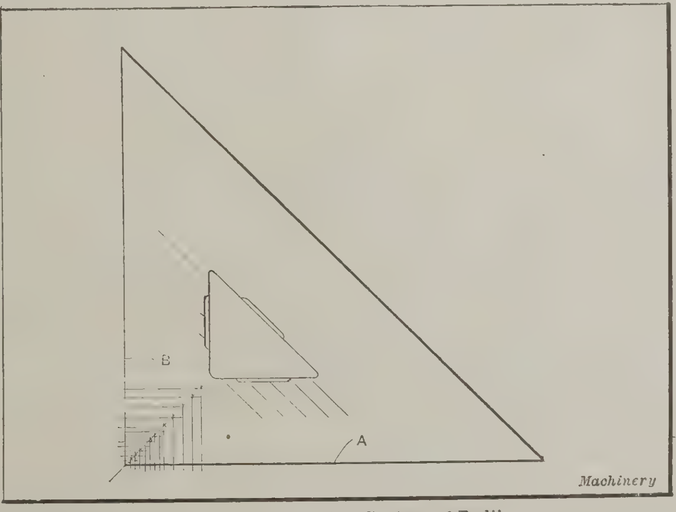
Method of Reducing the Bore in a Ring

tank was so gaged that the outer edge of the ring only was immersed. As the pipe was rolled along the tank, the outside of the ring was rapidly cooled, and in shrinking forced the inside stock inward so as to allow enough stock for reboring.

Rochelle, Ill. J. H. MAYSILLES

USING A TRIANGLE TO FIND CENTERS OF RADII

Anyone who has parts to draw requiring a number of radii no doubt will appreciate this method of locating the centers. An ordinary draftsman's triangle is laid out as shown in the accompanying illustration, for radii varying from 1/16 to 1/2 inch, advancing by sixteenths of an inch, and from ½ to 1 inch, advancing by eighths of an inch. An easy way to lay out the holes in the triangle is to use a surface gage to scribe the



Triangle for Locating Centers of Radii

lines, placing the triangle on a surface plate. The holes drilled in the triangle should be of the same diameter as the needle point on the compass.

To use the triangle, place the sides A and B tangent to the lines to be connected with the radius, usually a quadrant, and prick the center with a needle point. If the holes in the triangle are accurately spaced, any radius within the range of the triangle can be easily and quickly laid out.

New Britain, Conn. J. M. HENRY

* * *

A writer in the *Iron Age* states that by the extrusion process zinc may be transformed into a fine, crystalline structure, the tensile strength of which is 23,000 pounds per square inch.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

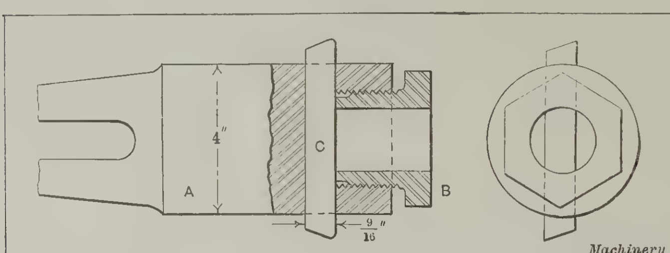
Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

TO PREVENT THE FILE FROM CLOGGING

The following kink is probably known by most machinists but it may be helpful to some of the young fellows. When filing a poor quality of wrought iron in the lathe I had much trouble with the file clogging up, until I found that by bearing down slightly on the return stroke the offending chips would be removed. W. K.

EFFECTIVE MEANS OF HOLDING A CUTTER IN A BORING-BAR

The accompanying illustration shows a simple and effective means of holding a cutter in a boring-bar, which has been used successfully for boring car-wheels. The end of the boring-bar *A* is tapped out to receive the hexagon clamping

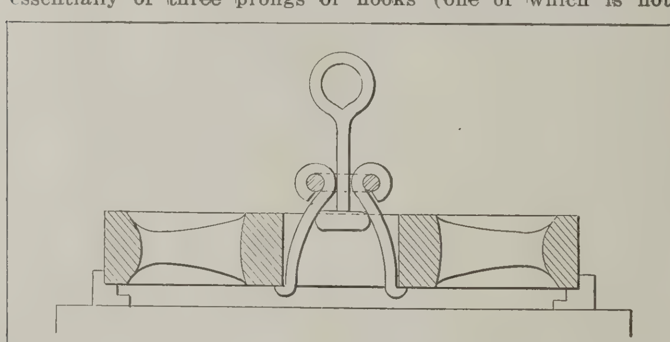


screw *B*, which holds the cutter *C* firmly in the bar, preventing it from chattering or moving. The clamping screw *B* is case-hardened on the end, and is made hollow so that the cutter will be held more firmly.

Vancouver, B. C. J. C. MATTISON

DEVICE FOR LIFTING LOCOMOTIVE DRIVING WHEELS

The accompanying illustration shows a simple device which the writer recently saw employed in a Western shop for lifting locomotive driving wheels. This device could also be used to advantage for lifting large pulleys, etc. It consists essentially of three prongs or hooks (one of which is not



shown) made from ¾-inch round iron, a welded ring and an eye having an enlarged end for opening the hooks which grip the wheel by the hub. M.

BABBITTING BOXES

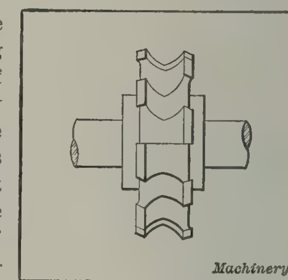
In using a shaft as a mandrel to babbitt boxes with, I have found from experience that wrapping a piece of paper around the shaft before placing it in position will make a good clean piece of work—smooth and glassy. The paper may be pasted on the shaft with shellac or glue where the edges meet. Let the paper extend the full length of the box and the edges just meet on the shaft. The paper, besides making the babbitt run smooth, also provides a little clearance, and the bearing does not require so much scraping. Those who do not care to use paper will get a smooth bearing by rubbing chalk on the shaft before babbitting.

I have seen a good many mechanics pour babbitt in boxes without venting them and then wonder why it is that they have to patch so much. I have always worked under these rules in running babbitt and have had good success: First, always have plenty of vents; second, make the babbitt good and hot; third, pour the babbitt as fast as it will flow through the pouring hole, and always use a few drops of oil on the risers.

Montpelier, Ind. J. T. CROMACK

PREVENTING A ROUND BELT FROM SLIPPING ON A GROOVED PULLEY

It is sometimes found necessary to use a round belt and a V-pulley in order to avoid a complicated mechanism. One of the difficulties which arises from using a small V-pulley is the slipping of the belt. This can be avoided by making the pulley as shown in the accompanying illustration. It is made in the ordinary manner but is provided with spaces which are cut out at intervals in the sides of the face. This type of pulley completely overcomes any slipping of the belt. F. D.



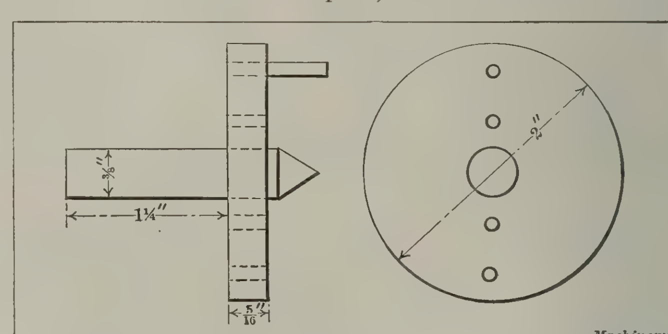
TO PREVENT SCALE ON DIES WHEN HARDENING

A good way to prevent scale on dies when hardening is to dip them in water before they are heated and then put them into dry salt, letting all the salt that will cling to them. After this the pieces are heated and immersed in brine as usual. The scale or crust of salt will fall off in the water. The piece so treated will have the appearance of a piece which has been heated in cyanide. DONALD BAKER

Syracuse, N. Y.

HANDY CENTER FOR SMALL WORK

The writer recently had occasion to turn some small work in a regular 16-inch lathe. It was difficult to drive this work when mounted on the regular centers. Therefore, a small center with a miniature faceplate, as indicated in the accompanying engraving, was made, this center being held in a collet chuck in the lathe. The holes in the faceplate were drilled to fit a standard size wire, the wires being used to drive the work. This device was found to be very handy in turning and threading small thumb-screws and similar work. S. C.



TURNING SOLID DISKS

I had to make six disks about 2¼ inches in diameter from sheet brass; they had to be turned true to size, and as there was no hole through them they could not be placed on an arbor. I cut them out with the shears, about 1/16 inch large, and then put them between two disks of wood a little smaller than the finished size of the brass disks. After knocking out the live center of the lathe, the disks were pressed firmly against the faceplate with the "dead" center. Of course, a steel disk was placed between the "dead" center and the wood, so that the center would not cut into it. After truing the disks central, I found that they could be turned very nicely by taking a light chip, as the pressure of the center against them was sufficient to prevent them from slipping. The object of using the wooden disks was to increase the friction, so the brass disks would not slip.

Mansfield, Mass. LESTER P. BROWN

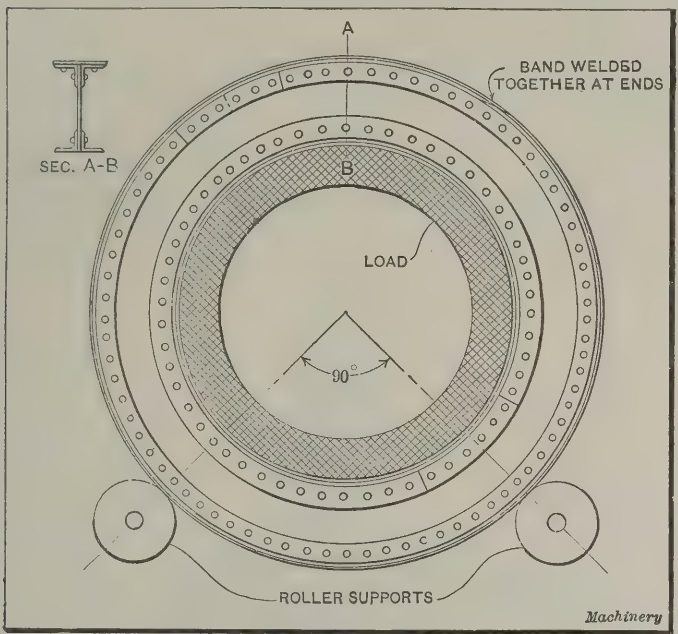
HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

TO DESIGN A CIRCULAR BEAM

G. A. W.—I have a circular beam made of steel angles and plates in I-beam section to design, and would like to know how to calculate the bending moment for a uniformly distributed load around the inside of the ring; also the pitch of rivets in the angles. The illustration shows the method of loading and supporting the ring. The ring revolves once in ten minutes and then stands stationary for twenty-four hours.



Circular Beam to be designed to support Load in Rotation

The question is an interesting problem in machine design which would form the subject of a good article. An answer is desired in this form.

CHANGE GEARS FOR SPIRAL GEAR-HOBBING MACHINE

R. E. N.—Two spiral gears are to be cut on a gear-hobbing machine. Gear No. 1 has 30 teeth, 24.549-inch lead, and a feed of 1/24 inch. The change gears used on the machine for cutting a spur gear with 30 teeth have 48 (driving gear) and 60 (driven gear) teeth, respectively. The hob and gear are of the same "hand."

Gear No. 2 has 60 teeth, 49.098-inch lead and is cut with a feed of 1/16 inch. The change gears used to cut a spur gear with 60 teeth, on this machine, have 48 and 40 teeth, for the driving gears, and 60 and 80 teeth, for the driven gears. The hob and gear are of the same "hand."

A.—The method to follow for calculating these gears was explained in the December, 1911, number of MACHINERY, engineering edition, and the formula there given for calculating gears to use for hobbing spiral gears, was as follows:

$$\frac{L \div F}{(L \div F) \pm 1} \times \frac{P}{p} = \frac{S}{s}$$

in which

L = lead of spiral,
F = feed per revolution,
P = product of driving gears for cutting spur gears with same number of teeth,
p = product of driven gears for cutting spur gears with same number of teeth,
S = product of driving gears for cutting spiral gears,
s = product of driven gears for cutting spiral gears.

Use + sign when gear and hob are of opposite "hand," and — sign when they are of the same "hand."

In the problems given the data are as follows:

	30-tooth Gear		60-tooth Gear
L	24.549	L	49.098
F	1/24	F	1/16
P	48	P	40 × 48
p	60	p	60 × 80

Calculations for Thirty-tooth Gear

By inserting the values given, we find that:

$$\frac{L \div F}{(L \div F) - 1} = \frac{589.176}{588.176}$$

For our purpose, the ratio written above can be simplified to the form $\frac{589}{588}$. Factoring, we have:

$$\frac{589}{588} = \frac{19 \times 31}{12 \times 49}$$

Now, multiply this value with the ratio of the gears for a 30-tooth spur gear:

$$\frac{19 \times 31}{12 \times 49} \times \frac{48}{60} = \frac{76 \times 31}{60 \times 49}$$

Having obtained the gears that should be used, we may now investigate what lead these gears will give. Apparently they will not give the exact lead desired, as we have used an approximate ratio instead of the exact one.

To prove, assume $F = 1/24$ and solve for L.

$$\frac{L \div F}{(L \div F) - 1} = \frac{589}{588}$$

From this we find $L = 24.541$, which is very nearly equal to the required lead.

Calculations for Sixty-tooth Gear

By proceeding in the same way for the 60-tooth gear we have:

$$\frac{L \div F}{(L \div F) - 1} = \frac{785.568}{784.568}$$

We then factor the fraction $\frac{785}{784}$, thus:

$$\frac{785}{784} = \frac{5 \times 157}{4 \times 196}$$

As 157 is a prime number, and gives too large a number of teeth for any of the gears in the train, we try $\frac{784}{783}$ which ratio is very nearly equivalent to that required.

$$\frac{784}{783} = \frac{49 \times 16}{29 \times 27}$$

Multiply this value with the ratio of the gears for a 60-tooth spur gear:

$$\frac{49 \times 16}{29 \times 27} \times \frac{40 \times 48}{60 \times 80} = \frac{49 \times 32}{29 \times 135}, \text{ or } \frac{49 \times 32}{87 \times 45}$$

Possibly the 135-tooth gear is impracticable, on account of being too large, in which case the other combination must be tried.

If the lead resulting from the gears found is calculated in the same manner as in the previous case, we find that

$$L = 49.001$$

Influence of Small Changes in the Ratio on the Lead

It is interesting to note that a comparatively slight change in the ratio $\frac{L \div F}{(L \div F) - 1}$ makes a very decided change in the lead obtained. To illustrate, assume that in the first example given the ratio $\frac{589}{588} = 1.001701$ were changed to 1.002; let us see what effect this change would have on the lead obtained ($F = 1/24$):

$$\frac{L \div F}{(L \div F) - 1} = 1.002$$

If we solve for L in this equation we find $L = 20.875$, which is a very different lead from the one we wish to obtain.

DROP-FORGING A WRENCH BAR

B. L. E.—I desire to make drop-forging dies for the piece shown in Fig. 1. This piece is to be a steel forging and the principal point on which I desire information is the proper shaping of the breakdown in order to distribute the stock so

that I can get the head. Also advise me what size bar steel to use and to what length the bars should be cut for forging.

Answered by J. W. Johnson, Revere, Mass.

A.—For drop-forging the piece shown in Fig. 1 a pair of drop-forging dies fitted with forming and finishing impressions, breakdown and anvil will be required. The lower half of a suitable pair of dies is shown in Fig. 2. Fig. 3 shows the right-hand side elevation of the dies, giving an idea of the shape of the breakdown, and Fig. 4 is a left-hand side elevation to show the general proportions of the anvil required for drawing out the stock. The principal requirements of a pair of dies for drop-forging this piece are that the stock be so distributed by means of the breakdown and anvil that there will be little for the face impressions to do except to shape the sides of the piece. Referring to Fig. 2, the anvil shown on the left-hand side of the die should be given the first consideration. The function of this anvil is to draw the steel out for the handle of the wrench to such dimensions as will fill the face impressions when struck therein. Thus, as the size of stock to be used will be approximately 2 by ¾ inches, it is evident that a section of the two-inch width must be drawn down by means of the anvil to such size as will just fill the face impression of the wrench handle. Referring to Fig. 1, it will be seen that the section of the handle of this wrench measures approximately ½ by ⅞ inch. It is not necessary, however, that the stock be drawn to these exact dimensions but it must be drawn to a squared size whose section is about equal to ⅞ by ½ inch, which in this case would be

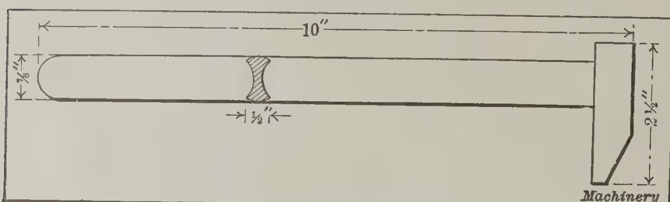


Fig. 1. Wrench Bar to be forged

about 11/16 inch. In making the anvil, therefore, the two faces should be shaped away until these faces are 11/16 inch apart when the dies meet. The removal of the stock back of the anvil faces is merely for clearance. As in all drop-forging operations, after the preliminary roughing down of the stock is accomplished by means of the anvil, it is necessary to strike the steel in the breakdown in order to approximately

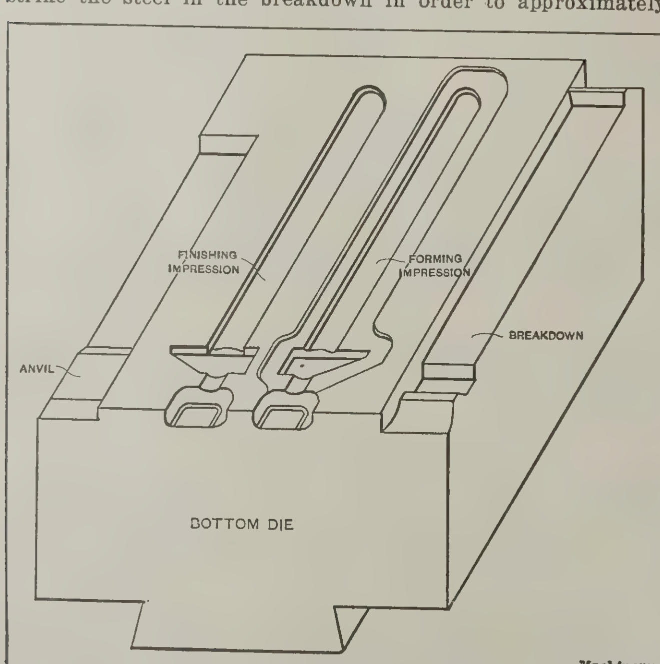


Fig. 2. Lower Half of Drop-forging Die

shape the forging. Referring again to Fig. 2 the lower half of the breakdown may be seen, and by referring to Fig. 3 the outline of the entire breakdown is seen. This breakdown should be about 1/16 inch smaller all around than the finished work is to be, in order to squeeze the stock so that it will lie in the impression for striking the final blows. All corners should be well rounded to avoid cold-shuts. It will be noticed that the width of the stock recommended is 2 inches while the height of the wrench bar head is 2½ inches. This is explained through the fact that the steel will spread the necessary amount to make up the difference. It would be possible to drop-forge this piece with but one face impression, but if many pieces are to be made it would be far more economical

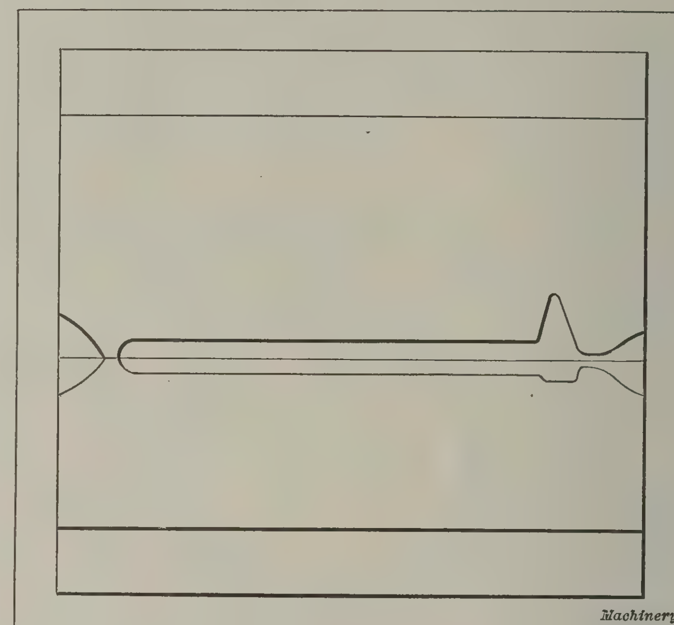


Fig. 3. Right-hand Side Elevation of Dies, showing Breakdown

to provide the dies with forming and finishing impressions as shown in Fig. 2. The forming impression should have all corners and edges well rounded in order to facilitate the flowing of the metal. This impression should be "flashed" and the upper die provided with both flash and gutter. For information in regard to cutting the flash and gutter, see "Drop-forge Die-sinking," Parts 1, 2 and 3, commencing in July, 1911,

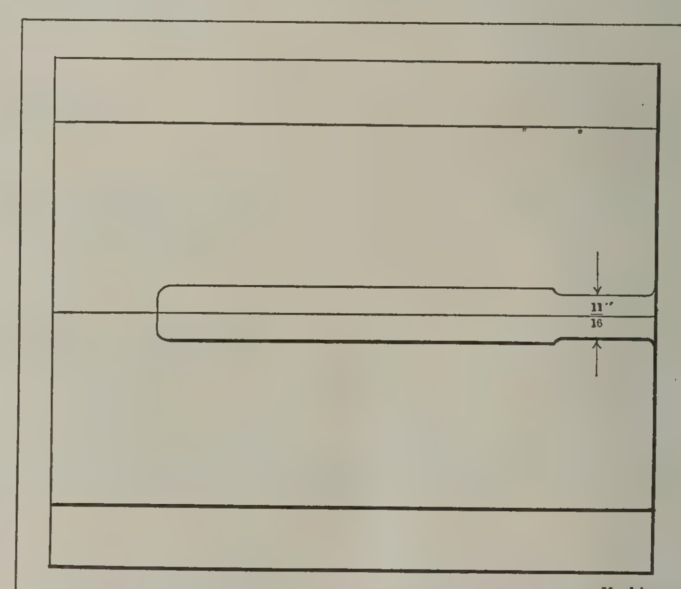


Fig. 4. Left-hand Side Elevation of Dies, showing Anvil

engineering edition of MACHINERY. The finishing impression is, of course, made exactly as the finished part must be shaped and is only used in striking the few final blows.

It is impossible to state the exact lengths to which the bars of steel should be cut for forging. This can best be determined by first cutting a length of stock from the bar as long as can be conveniently handled; say five or six feet in length. At the time of forging the last piece, it can then be seen if the bar could best be used slightly longer or shorter in order to come out with an even number of finished forgings.

* * *

Monel is said to be the only commercial metal that will resist the corrosive action of liquid soaps.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

WALKER "UNIMATIC" TOOL-ROOM GRINDER

The Walker Grinder Co., of Worcester, Mass., is now manufacturing a special grinder which is designed to meet all the requirements of modern tool-room practice. This machine, which is known as the "Unimatic" tool-room grinder, is not intended to replace the well-known No. 2 universal grinder built by this company, as it does not have as great a capacity. The new design embodies, however, all the universal features of the No. 2 size, with the addition of certain adjustments made possible by the novel construction.

The machine is very compact and entirely self-contained, no overhead works being required. The work-spindle is rotated by a flexible shaft, which is shown to the left of the

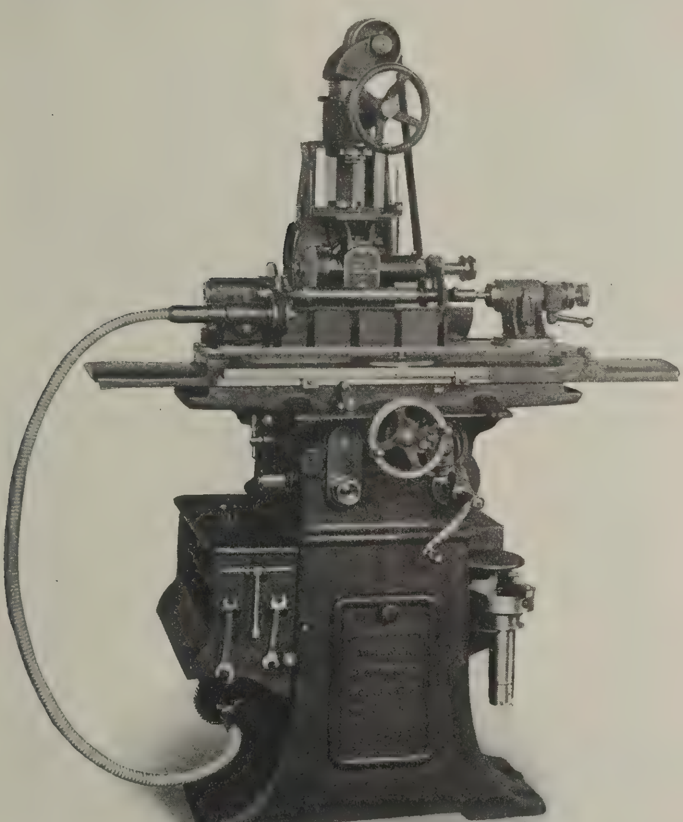


Fig. 1. Universal Tool-room Grinder, built by the Walker Grinder Co.

machine in Fig. 1, so that the overhead belt drum is eliminated. The initial drive is from a shaft in the base which transmits motion to the grinding wheel, the work-spindle and the table reciprocating mechanism. The arrangement of the interior shafts and driving belts, is shown by the end and front elevations, Figs. 4 and 5. The main shaft A carries tight and loose pulleys at the rear end (see also Fig. 2) and a three-step pulley in the center, which drives another three-step pulley mounted on shaft B. Shaft B also carries a large pulley C, which connects by a belt with the grinding-wheel spindle. Shaft A drives the intermediate feed shaft D by means of step pulleys, and shaft D, in turn, transmits motion to the table feed shaft E, which is also provided with step pulleys.

The initial driving shaft A connects with shaft F by means of step pulleys, and F is geared through fiber gearing to a second shaft G, which, of course, revolves in an opposite direction. The front ends of each of these shafts are recessed and arranged for attaching the flexible shaft H, which transmits motion to the work-spindle. This flexible shaft is clamped in

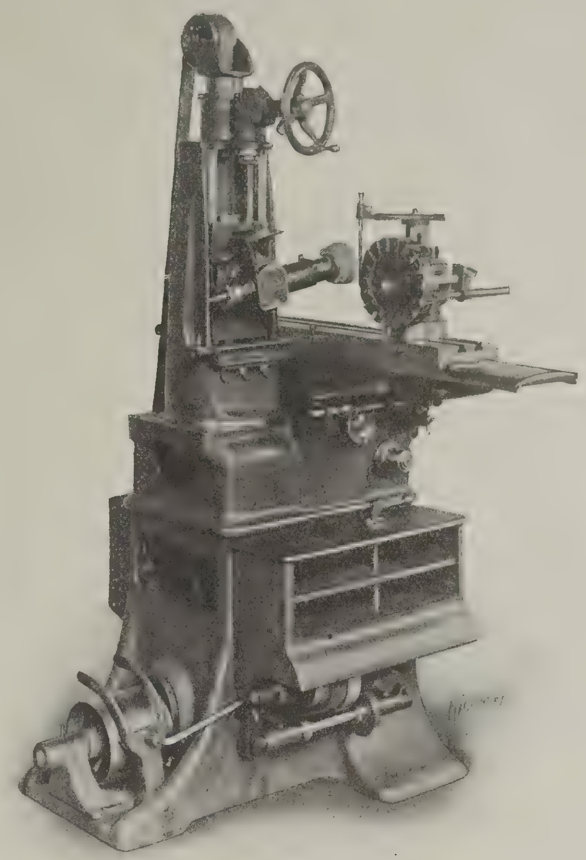


Fig. 2. Grinding an Inserted-tooth Cutter on Walker Grinder

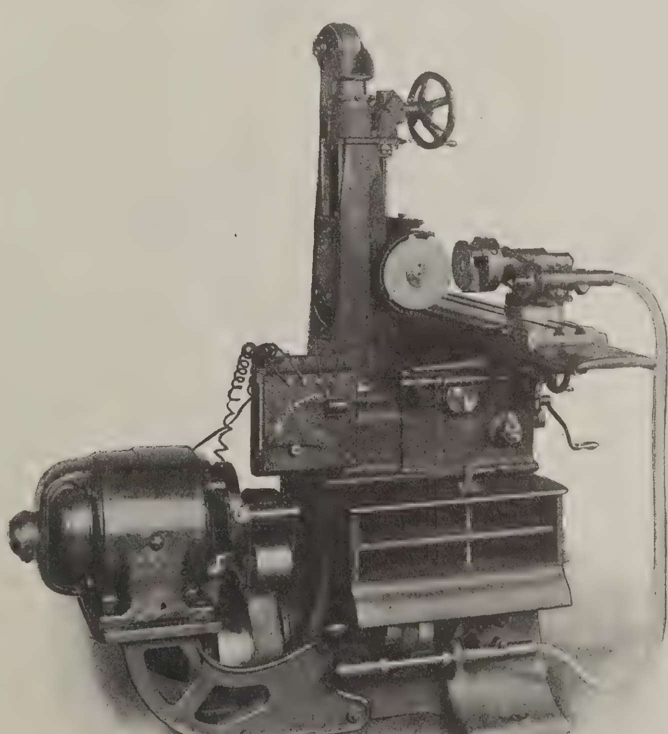


Fig. 3. Application of Motor Drive to Walker Grinder

place by screws and it can readily be attached to either F or G, according to the direction of rotation desired. The motion of the flexible shaft is controlled by handle I which connects with a friction clutch operated by a coil spring.

Hinged in the base of the column there is a frame J carrying an idler which is held against the belt connecting shafts A and B by a coil spring, so that constant tension is maintained. When it is desired to change the belt on the pulley, this tension is removed by withdrawing handle K; then the belt can easily be shifted through an opening in the side of the column. The driving belt operating on the tight and loose pulleys at the rear of shaft A, is shifted by a belt-shifter L, conveniently located at the front of the machine.

Upon the main base of the machine there is a pedestal M carrying the feed gearing and supporting the grinding-wheel housing N, which, by simply loosening one screw, can be swiveled 90 degrees about a vertical axis in either direction. Upon housing N is mounted the wheel-slide O, which is raised or lowered by a vertical screw, operated through bevel gears and the handle seen near the top of the machine. On the top of housing N is mounted an idler bracket P, which is provided at its lower end with a sleeve of large diameter through which the driving belt passes. This sleeve is threaded upon its exterior with a square thread of coarse pitch and the outside of this thread centers the sleeve in housing box Q when the housing is swiveled.

The grinder carriage R is mounted upon the pedestal M and slides on elongated V tracks which are lubricated automatically with rollers operating in oil wells. This method of lubrication is also provided for the platen S, upon which is mounted the swiveling platen S_1. This swivel platen, which carries the headstock and tailstock, can be set for tapers up to three inches per foot and has a fine screw adjustment. Upon the headstock, there is mounted an adjustable bracket T, which carries the pulley that connects with the upper end of the flexible shaft. This bracket is held by three cap-screws passing through slots and providing an adjustment for the short belt which rotates the driving faceplate.

The headstock has a universal chuck-spindle which can also be driven from pulley U. This chuck-spindle is interchangeable with the spindle which carries the revolving faceplate. The chuck-spindle, the driving faceplate and the flexible-shaft bearing are reversible in heads, so that the drive can be from whichever end is most convenient. This feature is found desirable when, for instance, the machine is set up for face grinding, as illustrated in Fig. 3. In this case, both the chuck-spindle and the flexible-shaft bearing have been reversed.

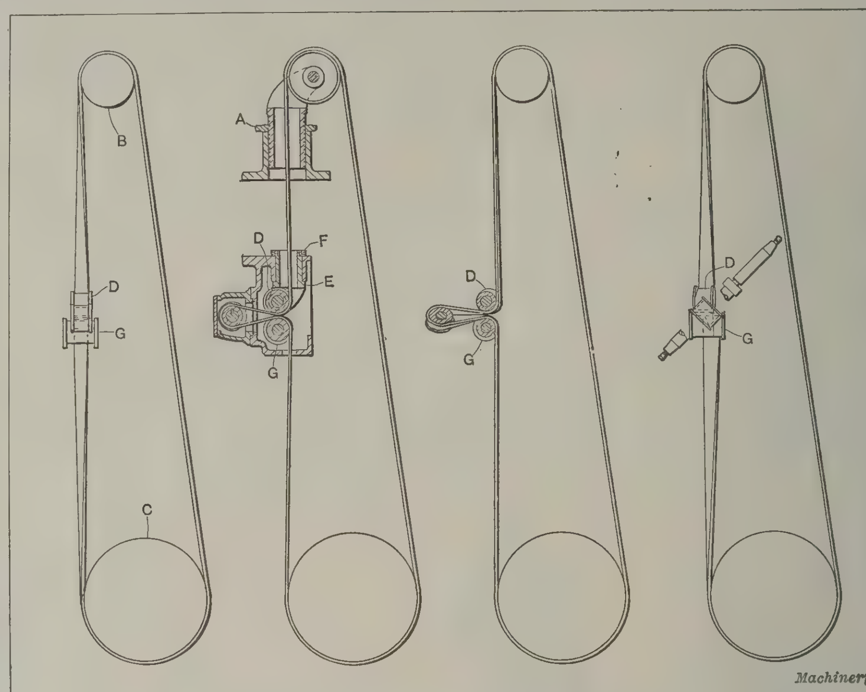
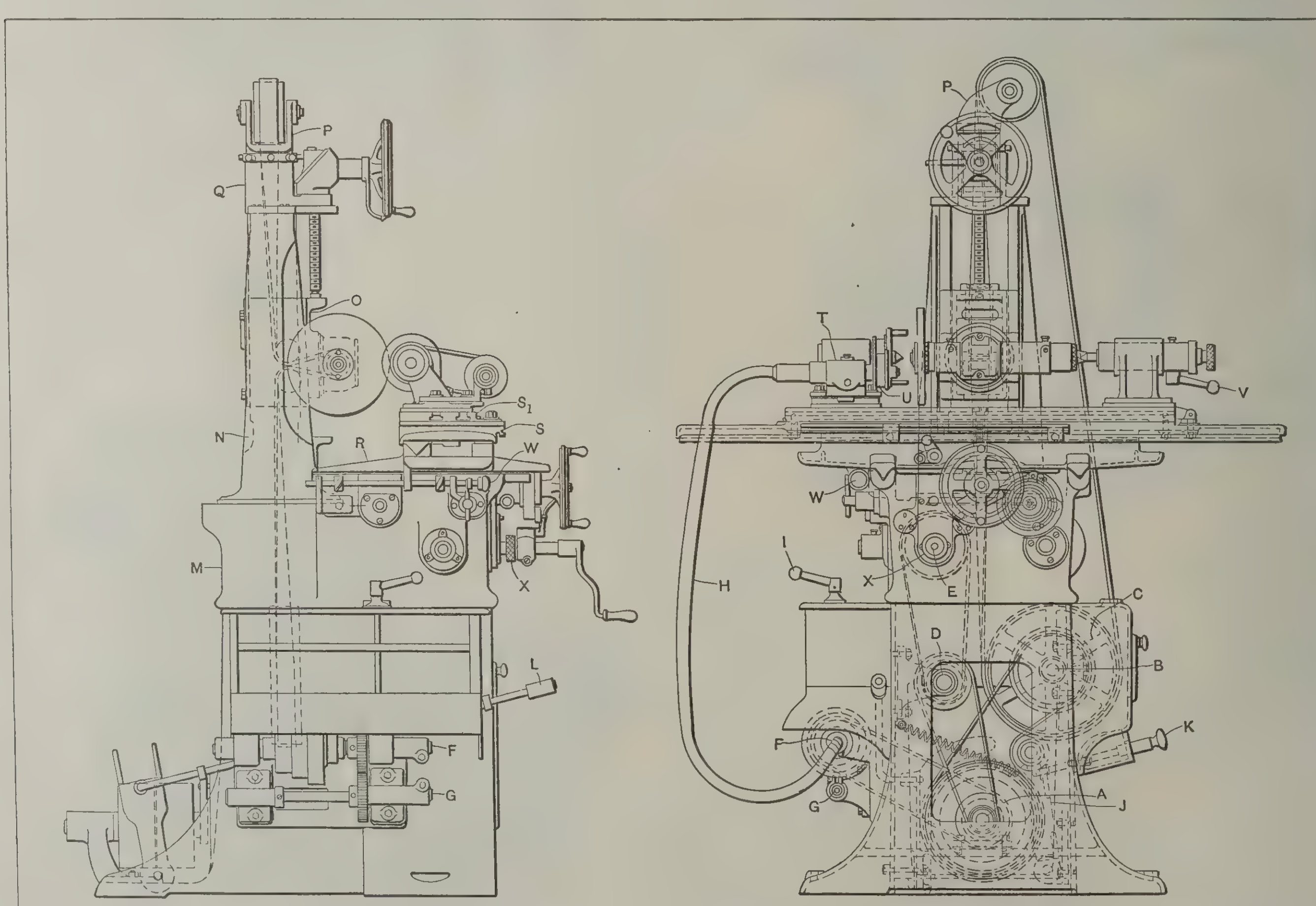


Fig. 6. Showing Course of Spindle Driving Belt for Various Positions of Grinder Head



Figs. 4 and 5. Endand Front Elevations of Walker Tool-room Grinder

The tailstock spindle is provided with an adjustable spring to allow for any expansion of the work.

This grinder is not arranged for wet grinding but sectional shields or guards are provided for the top of the platen to take care of the dust. These shields are shown in position in Fig. 1, which illustrates the machine set up for a cylindrical grinding operation. The machine is equipped with an automatic stop mechanism located at the left side of the carriage as shown in Figs. 4 and 5. The knob *W* is attached to a horizontal rod carrying adjustable collars, which can be set to disengage the automatic cross-feed at any desired point. An instantaneous hand stop is also provided. The hand stop is operated by knob *X*, conveniently placed at the front of the machine, as shown in Fig. 5.

The diagrams in Fig. 6 show the course of the spindle driving belt for various positions of the grinder head. It will be noted that the pulleys *B* and *C* always remain in the same position, and that the various adjustments affect only the vertical side of the belt. The belt idler *D* is mounted in a swivel bracket *E*, which is held in place by nut *F*, and can swivel when the grinding spindle is tilted in a vertical plane. This swiveling action is largely automatic and the various positions are indicated by the diagrams. It will be seen that the part of the belt passing through the idler bracket is vertical, and only one side of the belt is affected by the swiveling action. The belt simply runs in a twist above and below the spindle when it is swiveled in a vertical plane. Bracket *E* turns so that the belt leads in the proper direction towards the periphery of the grinding-spindle pulley, thus obviating the tendency of the belt to crowd on the flanges that would develop if the bracket were not swiveled.

The idler pulley *G* is much wider than idler *D*, so that the belt, when leaving the spindle pulley, finds its own position. It has been found that with this construction, the grinding spindle can, if necessary, be run at a vertical angle of 45 degrees without any distortion. Figs. 2 and 7 illustrate the advantages of the vertical spindle adjustment. Fig. 2 shows the operation of grinding a milling cutter, and Fig. 7 illustrates an application of the tilting head to the grinding of the beveled edge of a machine part.

Fig. 3 shows the method of driving the machine with an electric motor. The latter is mounted on a bracket rigidly attached to the machine base, and the tension of the grinding belt is maintained by a spring-actuated idler. Fig. 8 shows the machine arranged for grinding the beveled seat of gasoline engine poppet valves. The swivel platen is set at an angle of 45 degrees, in which position it could not be operated by an overhead drum, but is readily driven by the flexible shaft. At first thought, it might seem that this flexible shaft would cause vibration of the work, but this has not proved to be the case. Any vibration in the shaft itself is not transmitted to the work, on account of the belt connection. Moreover, the overhang of all parts of the machine has been reduced to a minimum so that the construction is very rigid and the grinding smooth and even.

Fig. 9 shows the machine arranged for surface grinding. An extension to the spindle is provided for work of this kind. Another application of the machine is illustrated in Fig. 10, which shows the internal attachment in use. This grinder is, of course, applicable to a very large range of work, and on account of its rigidity, has proved efficient for all the different operations within its range.

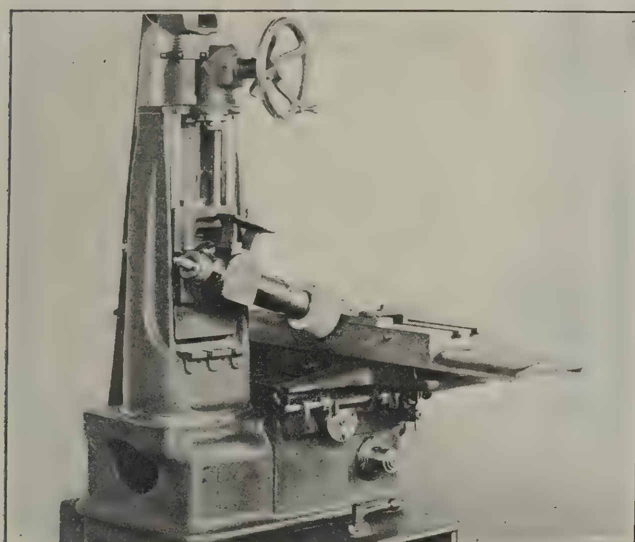


Fig. 7. Example of Work illustrating Use of Tilting Head

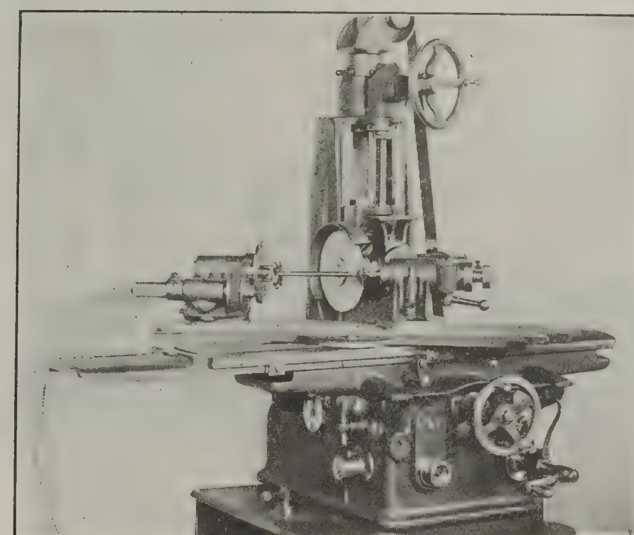


Fig. 8. Grinding Poppet Valves

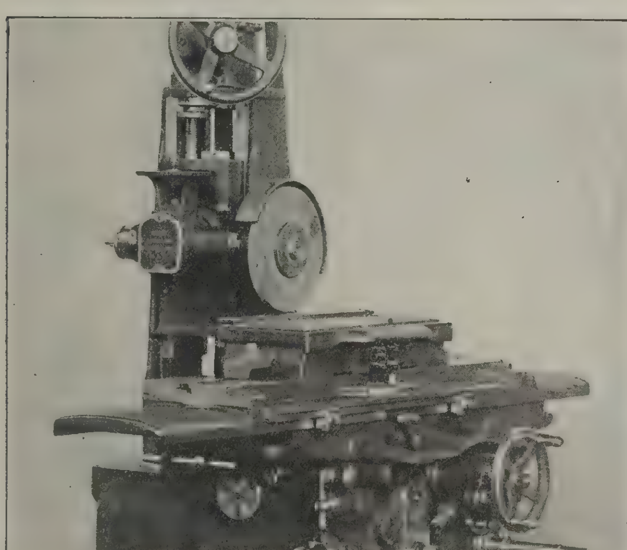


Fig. 9. Surface Grinding—Spindle provided with Extension

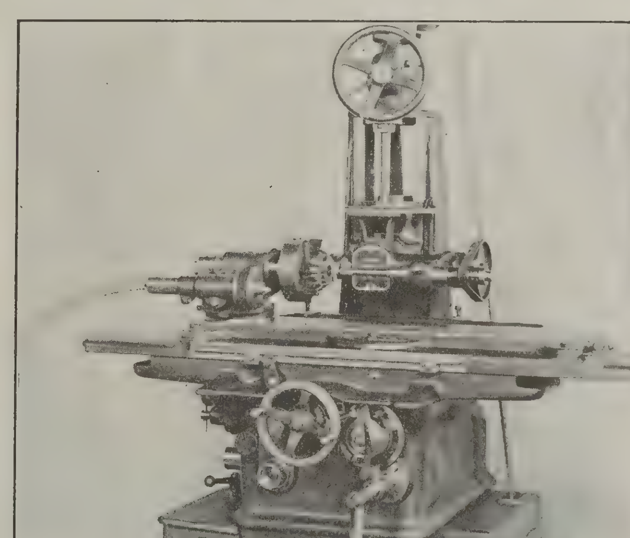
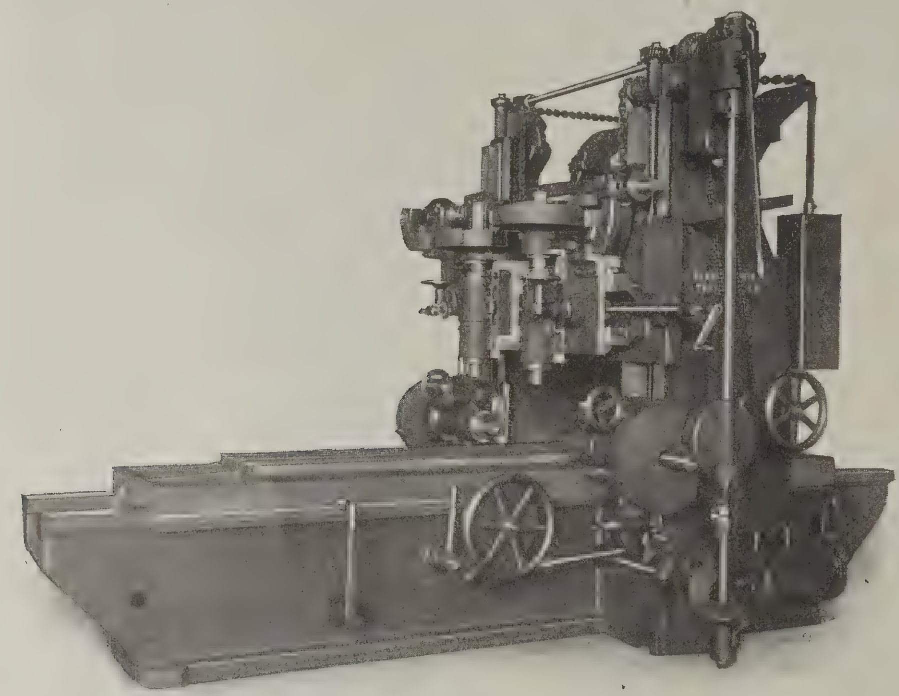


Fig. 10. Example of Internal Grinding

BEAMAN & SMITH FOUR-SPINDLE MILLING MACHINE

The Beaman & Smith Co., Providence, R. I., has developed an improved design of four-spindle milling machine. One of the advantages of this machine is the independent control of the spindles, it being possible to operate the spindles singly or in unison. The vertical spindles can be run at twice the speed of the horizontal spindles and *vice versa.* Provision is also made for reversing the spindles, and there is a second feed-box which gives a reverse feeding movement to the table when the spindles are reversed, thus making it possible to feed the work to the cutters from either direction.



Beaman & Smith Four-spindle Milling Machine

The general construction of this improved design is clearly shown by the accompanying illustration. There are two horizontal spindles carried by the uprights or housings, and two vertical spindles on the cross-rail. The table is of the square-lock construction with one side gib and two under gibs, which provide means of compensating for wear. The automatic feeds can be varied independently of the spindle speeds, and there is a quick power movement in either direction ranging from 7 to 14 feet per minute. The table has a working surface 30 inches wide and 10 feet long and a movement of 11 feet on the bed. There are five T-slots for the reception of clamping bolts and two rows of holes for stop-pins.

The automatic feeds to the table are positive in either direction and are obtained through a geared feed-box. There are nine changes varying from 2 to 12 inches for any spindle speed. As previously mentioned, there is a second feed-box, the gearing of which is so arranged that feeds can be reversed when the rotation of the spindles is reversed.

The spindles are of crucible steel and run in phosphor-bronze boxes. The front bearings are 4 inches in diameter and 6 inches long, and the rear bearings, 3⅝ inches in diameter and 4¾ inches long. Both the front and rear bearings are tapered and means are provided for taking up wear. The speeds vary from 6½ to 50 revolutions per minute. The ends of the spindles are made to fit cutters according to specifications.

This machine can be arranged for either a belt or motor drive. When a motor is used, one capable of developing 15 H. P. is employed. The cross-rail is raised or lowered by power, and it also has a hand adjustment. The spindles have a 6-inch independent longitudinal adjustment, effected by the handwheels shown, by means of worm gearing and a rack-and-pinion movement.

The centers of the vertical spindles are 6 inches in advance of those on the uprights. The minimum distance from the ends of the vertical spindles to the top of the table is 1 inch, and the maximum 30 inches, whereas the minimum and maximum distances between the centers of the vertical spindles are 12 and 30 inches, respectively. The horizontal spindles have a minimum distance between the ends of 18 inches, and they can be adjusted longitudinally to give an opening of 30 inches. The minimum height from the top of the table to the center of the horizontal spindle is 1 inch, and the maximum height, 26 inches. The weight of this machine is approximately 28,000 pounds.

STANDARD PORTABLE ELECTRIC DRILLS AND GRINDERS

The Standard Electric Tool Co., Cincinnati, Ohio, is placing on the market a line of high-power electric tools. One of the portable electric drills is shown in Fig. 1. This machine has ball bearings throughout and the bearings are dust-proof. The gears are generated from chrome-nickel steel, case-hardened, and are mounted on ball bearings packed in grease. The motors have a strong series winding which gives an excess of power over the rated capacity, thus preventing overloads and "burn-outs." The mechanical construction is high grade

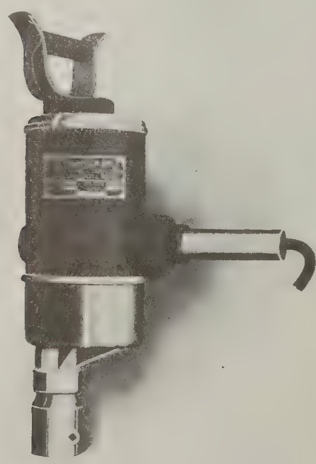


Fig. 1. Portable Electric Drill

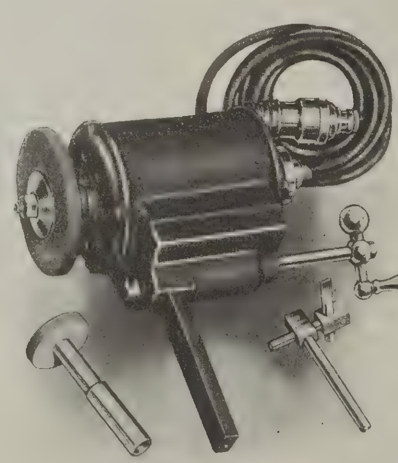


Fig. 2. Grinder with Toolpost Attachment

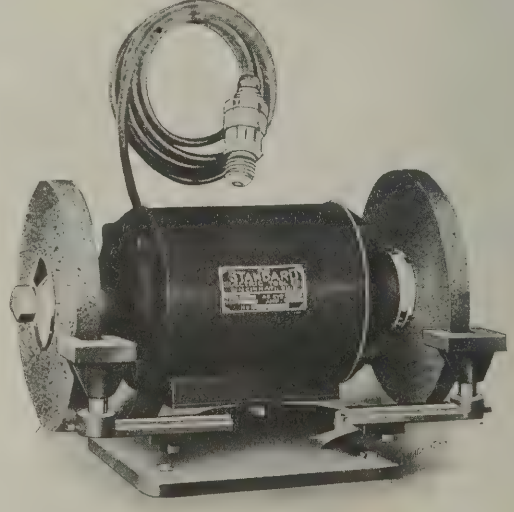


Fig. 3. Grinder shown in Fig. 2 converted into Bench Grinder

throughout. The drills are built in ⅜- and ½-inch sizes for direct or alternating current. The ½-inch direct-current drill is guaranteed to ream metal up to a thickness of 7/16 inch. This company also manufactures a universal drill of ⅜-inch capacity that will operate on either direct or alternating current.

The grinders are made for toolpost and bench work. The toolpost or center grinder, illustrated in Fig. 2, can be converted into a bench machine by removing the dovetail slide and placing the motor on top of a suitable base having a corresponding dovetail groove, as shown in Fig. 3. This feature greatly increases the range and utility of the tool.

All motors in both drills and grinders have forced ventilation by means of fans of a special design. The armatures and poles in both drills and grinders, are made of the best soft electrical sheet steel and are uniformly insulated. The grinders are equipped with ball bearings, when specified, instead of adjustable phosphor-bronze bearings.

ROCKFORD UNIVERSAL MILLING MACHINE

The universal milling machine illustrated in the accompanying halftone Fig 1 is manufactured by the Rockford Milling Machine Co., Rockford, Ill. This new machine is known as the No. 2 size. The table has a working surface of 38 by 9 inches, an automatic longitudinal travel of 25 inches, an

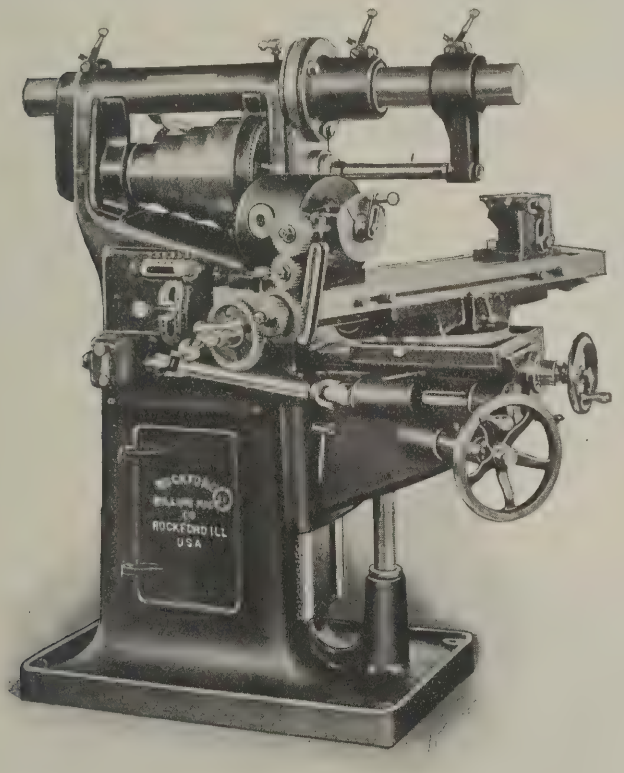


Fig. 1. Rockford No. 2 Universal Milling Machine

automatic transverse travel of 7½ inches, and a vertical power movement of 18 inches. The feeds are all positively driven through gearing and 14 changes are available. The levers for changing and reversing the feeds are conveniently located on the left side of the column, as shown in the illustration. The gears in the feed-box are cut from machine steel and the bearings are of bronze. The automatic feeds can be changed or reversed while the machine is in motion.

The main spindle of the machine has taper journals which run in bearings fitted with felt oil retainers. The wear of the spindle bearings can be quickly taken up by means of a nut at the rear of the spindle. The overhanging arm is equipped with a flanged support which reduces vibration and increases the cutting capacity. The knee has an extended top and an extra long bearing on the column, and the telescopic elevating screw is fitted with ball thrusts. The handwheels for the cross and vertical feeds are fitted with disengaging clutches.

Sixteen spindle speeds are available (with a two-speed countershaft) which range from 22 to 309 revolutions per minute. The equipment includes a two-speed countershaft, a swivel vise, an arbor, a flanged support for the overhanging arm, a dividing head and center-rest, a universal chuck, the necessary change gears, index plates, wrenches, etc.

The new dividing head is illustrated in Fig. 2. This head has been designed to combine rigidity and accuracy with simplicity and convenience. The worm-wheel, which is securely keyed to the spindle inside the head-block between the front and rear spindle bearings, has a diameter of 5⅜ inches on a 10½-inch head. The worm runs in oil, and there is an eccentric adjusting screw on the outside to take up wear

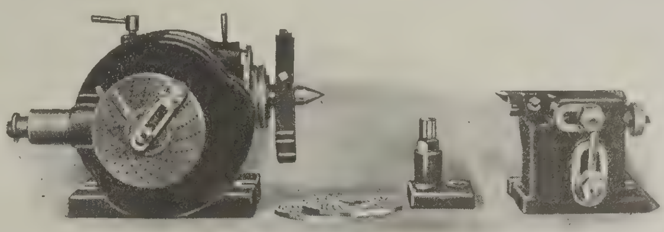


Fig. 2. Universal Dividing Head and Tailstock

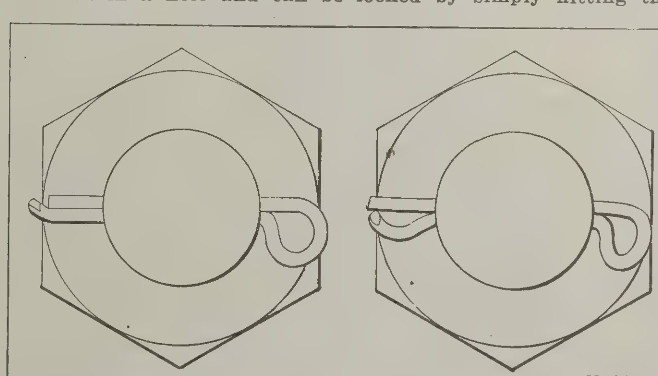
between the worm and wheel. The worm can easily be disengaged from the worm-wheel for rapid indexing.

Three index plates are regularly furnished, providing standard divisions up to 380. The spindle has adjustable taper bearings and is provided with a powerful and simple locking device. The front end has a No. 10 B & S taper hole and the nose is threaded to receive a chuck. The taper hole and threaded nose correspond in size to the main spindle so that tools can be interchanged. The swivel block carrying the spindle, swings from a position 10 degrees below the horizontal to 10 degrees beyond the perpendicular.

The center of the tailstock is held at an angle in order to locate the center close to the rear side and top, thus permitting the use of large end-milling cutters for squaring shafts, etc. The center is easily and quickly adjusted and is elevated for milling tapers by a cam. Ten change gears are supplied for spiral milling, and the worm is driven direct from the change-gear shaft.

CAMPBELL SELF-LOCKING COTTER-PIN

A. C. Campbell of Waterbury, Conn., has placed on the market an ingenious form of cotter-pin designed to replace the well-known spring cotter. This new cotter-pin is easily inserted in a hole and can be locked by simply hitting the



Campbell Self-locking Cotter-pin before and after Locking

loop or eye with a hammer; it is also removed easily. The cotter is made of half-round stock, the same as the ordinary type, but it is bent to a different shape. The eye is offset instead of being central, and the two limbs forming the body of the pin are of unequal length, as will be seen by referring to the left-hand view in the accompanying illustration. The long half of the pin is bent at an angle across the tip of the short member, in order to form a lock for the pin. This

bent end also forms what is practically a conical point, which makes it easy to enter the pin in a hole.

The method of using this pin is indicated by the illustration, which shows its application to a nut and bolt. The pin is placed in the hole as far as the head or eye will permit, as shown to the left, and then the head is flattened to about half its original height by striking it with a hammer. This forces the straight half of the pin farther into the hole which causes the bent end to be pushed downward, as shown by the view to the right. When the ends are forced apart in this way, the pin is securely locked so that it cannot work out of the hole.

This pin is not only easily inserted, but quickly and easily removed by the use of a common screw-driver, the tang of a file, or any tool having a thin, flat point which can be inserted in the loop or eye. After the point of the tool is inserted, it is twisted in the proper direction to draw back the straight half of the pin to its original position. This releases the bent or locking end and the pin can readily be withdrawn with the fingers. These pins can be inserted, locked and removed from the same side, so that they can be used in places quite difficult of access.

DIFFERENTIAL RECORDING GAGE

The Industrial Instrument Co., Foxboro, Mass., is now manufacturing a new differential recording gage which is illustrated in Fig. 1. This gage can be used for recording the differences between pressures, and it is also adapted for recording the flow of fluids by means of venturi or pitot tubes. The moving element consists of a patented pressure-

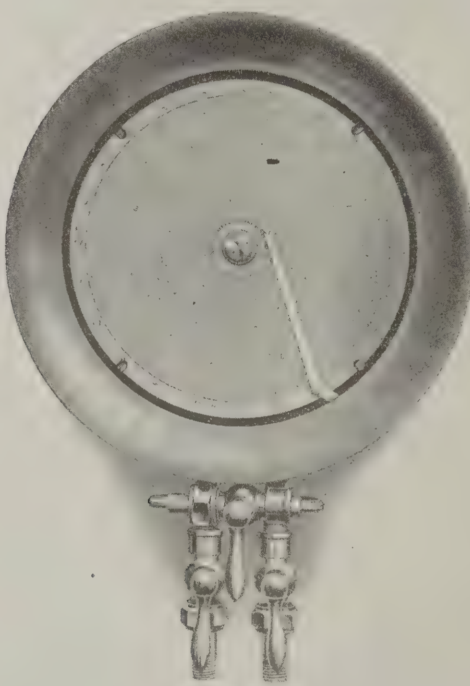


Fig. 1. Differential Recording Gage made by Industrial Instrument Co.

tube movement, which, for pressures below 10 pounds per square inch, is similar to the diaphragm tube shown in Fig. 2; whereas, for differential pressures exceeding 10 pounds per square inch, the helical tube movement shown in Fig. 3, is used.

The pen arm is attached directly to the shaft in both of these movements, which gives a rigid support. A friction joint in line with the shaft, makes adjustment possible without affecting the length of the pen arm. A pressure tube is employed having a range sufficient to cover the differential pressure desired. One of the two pressures, the difference between which is to be recorded, is applied internally to the pressure tube, and the other externally, the principle being the same as in ordinary practice except that one pressure, instead of being atmospheric, is replaced by some other pressure. Transmission from the movement to the pen arm is obtained by means of a special bearing passing through the wall of the chamber enclosing the movement.

This gage can be employed to advantage for recording the height of water in a boiler. When so used it is applied to the water column and gives a record not only of the height of the water, but an accurate record of the time the water column or gage glass is blown, the time the boiler blows off, or of any other disturbance affecting the height of the

Fig. 2. Diaphragm Tube Movement

Fig. 3. Helical Tube Movement

water in the gage glass. This continuous record will result in keeping a more uniform water level and will be an efficient check against unsafe high or low water, thus insuring greater economy and safety. The recorder can be placed at a distance from the boiler, if so desired, so that in case of an explosion, the responsibility can be placed where it belongs.

SHADOWLESS DRAFTING TABLE

The drafting table shown in the accompanying illustration has a plate-glass top beneath which is an illuminating chamber containing three electric lights. Among the advantages claimed for this construction are, the elimination of shadows and a good light regardless of the position of the windows or the time of day. The light can be intensified to any desired degree and it can also be subdued, either by the addition of tissue sheets or by reducing the electric lamp power.

The illumination from beneath makes it possible to easily trace from blueprints or drawings of any kind. Tracings can

Ulrich Shadowless Drafting Table

also be made on stiff drawing paper or bristol board, by intensifying the light, as may be required. The glass top has a cork pine frame to which the drawings may be attached with either ordinary thumb-tacks or a special suction clamp furnished with the table. The construction of the table is such that the angular position or height can be quickly adjusted, and it is rigidly held in position.

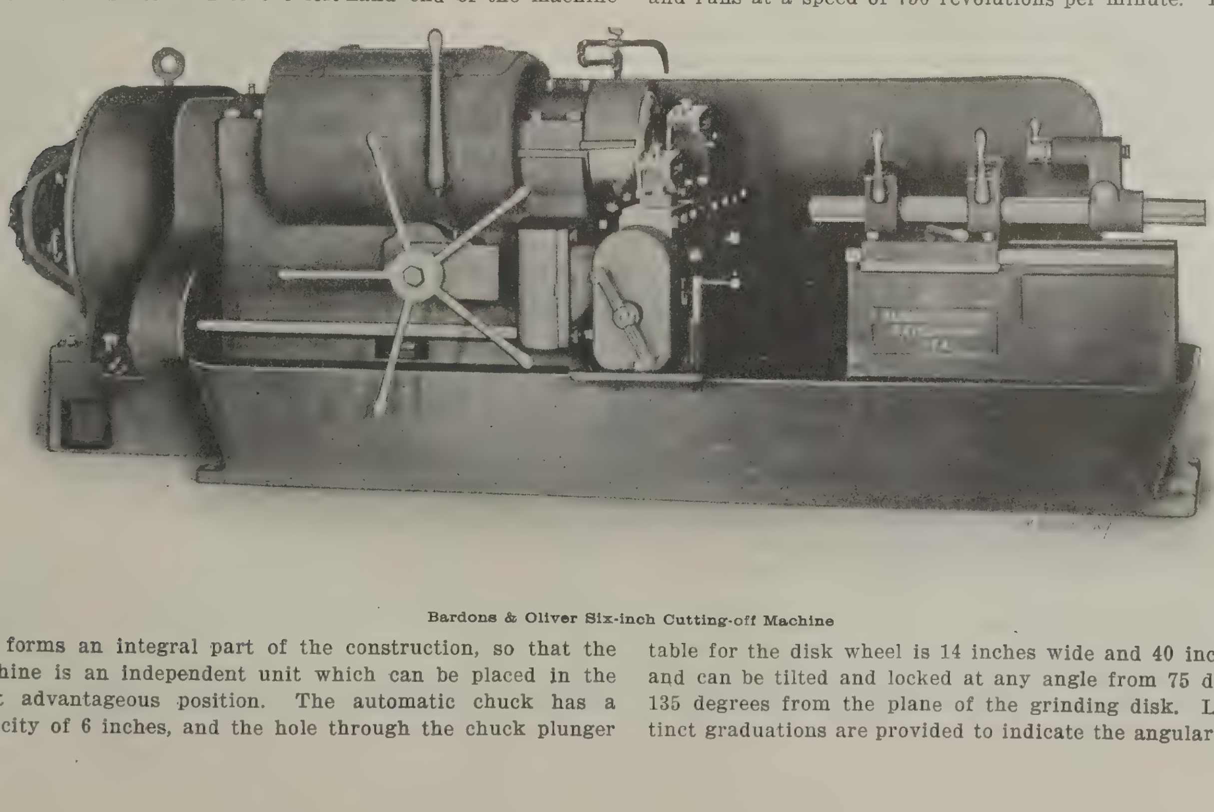
By adjusting a ventilator beneath the drawing board, the warmth from the electric lamps under the plate-glass top, can be so regulated that the ink will dry as rapidly as it is applied, thus making it possible to work over these lines immediately. There is a shelf on the left side of the table and a cabinet on the opposite side, which are very convenient for holding drawing instruments and other equipment. This table is manufactured in five different sizes by Eugene Dietzgen Co., 166 W. Monroe St., Chicago, Ill.

BARDONS & OLIVER CUTTING-OFF MACHINE

The cutting-off machine shown herewith is a 6-inch size built by Bardons & Oliver, Cleveland, Ohio. This is an exceptionally heavy and compact machine designed for rapid and efficient operation. The spindle speeds vary from 20 to 152 revolutions per minute with 10 per cent speed increments. The changes are obtained by means of a geared head and a Westinghouse 15-horsepower, adjustable-speed motor having a variation of from 300 to 1200 revolutions per minute. The motor is regulated by a drum controller having 16 points. This wide range of speeds makes it possible to use the most economical cutting speed.

The time required for inserting and removing the stock has been reduced to a minimum by means of the automatic chuck, the adjustable stop and the drum controller. The cutting-off tool-slides are so designed that all interference from chips is avoided. The support for these slides is fastened to the front of the head which has an extension on the side, as the illustration shows. This support or bracket has openings between the slide and head, thus allowing the chips to fall directly into the pan without interfering with the operation of the slides. This construction also permits shortening the main bed. There is an open space to the right of the cutting-off tool-slide which makes it convenient to remove the chips. An ample supply of oil for the cutting tools is furnished by a suitable pump, and there is a pan to catch the lubricant.

The motor is attached to the left-hand end of the machine and forms an integral part of the construction, so that the machine is an independent unit which can be placed in the most advantageous position. The automatic chuck has a capacity of 6 inches, and the hole through the chuck plunger is 6⅜ inches, whereas the hole through the spindle is 7 1/16 inches. The front spindle bearing has a diameter of 9¼ inches and is 8 inches long. The rear bearing has a diameter of 8⅝ inches and a length of 6¾ inches. The cutting tools measure ⅜ x 2½ inches. The weight of the machine, including the motor, is about 16,000 pounds.



Bardons & Oliver Six-inch Cutting-off Machine

BESLY PATTERNMAKERS' DISK GRINDER AND DRUM SANDER

The patternmakers' combination disk grinder and drum sander shown in Fig. 1 is manufactured by Charles H. Besly & Co., Chicago, Ill. All gear guards have been removed in order to show the arrangement of the driving mechanism. The machine is driven by a 3 horsepower motor mounted on a bracket bolted to the rear of the bed. This motor connects with the main spindle through sprockets and a Link-Belt silent chain.

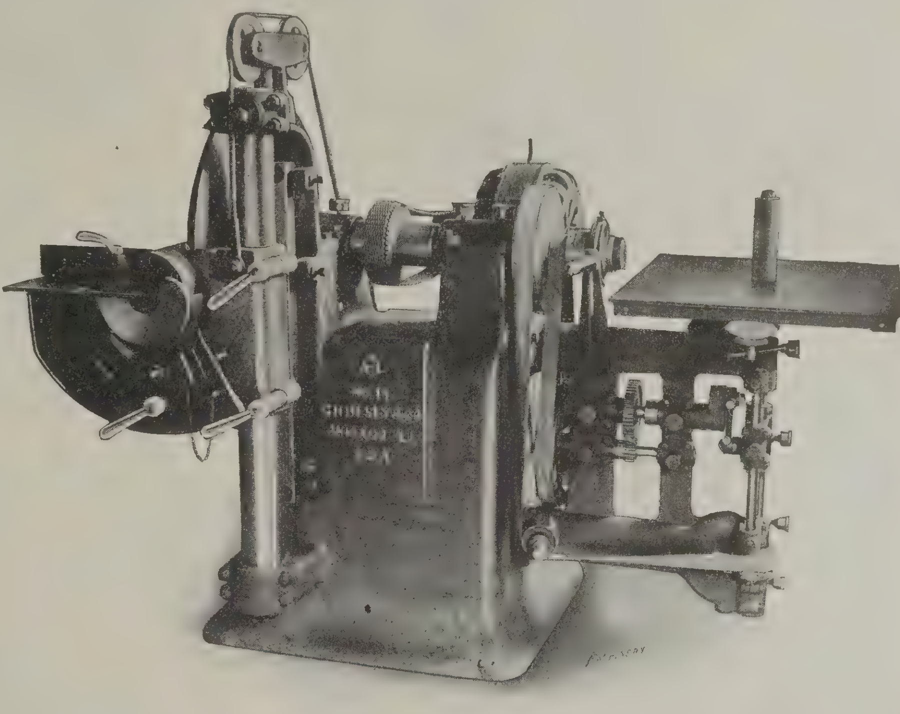


Fig. 1. Besly Combination Disk Grinder and Drum Sander for Wood Patternmaking

The steel disk wheel is 30 inches in diameter, ¾ inch thick and runs at a speed of 750 revolutions per minute. The work-table for the disk wheel is 14 inches wide and 40 inches long, and can be tilted and locked at any angle from 75 degrees to 135 degrees from the plane of the grinding disk. Large distinct graduations are provided to indicate the angular position.

The work-table is so arranged that the inside or working edge remains within 1/32 inch of the grinding disk, regardless of the angular position, and the supporting mechanism is back of the disk wheel and below the face of the work-table, so that there are no obstructions to interfere with the work. The work-table has a vertical adjustment of 25 inches and is supported by a round vertical shaft which permits swinging the table away from the grinding disk for convenience when re-setting a wheel or facing off extra large patterns.

The machine is equipped with four work-table attachments which include a sizing circle gage for cylindrical and conical grinding, a sliding bevel gage for simple and compound angle grinding, a sizing bevel gage for simple and compound angle grinding to dimensions, and an angle-plate for the free-hand cornering of thin work. There is a telescoping dust hood which may be piped to an exhauster for withdrawing the grinding dust.

The drum sanding attachment at the right is driven through a Johnson self-oiling friction clutch which enables the operator to stop the drum sander independently of the disk wheel. This is very essential, as the disk wheel is usually allowed to run continuously, whereas the drum sander must be stopped in order to attach drums of various sizes for different classes of work. The work-table of the drum sanding attachment measures 24 by 28 inches. It can be tilted and locked at any angle from 85 degrees to 105 degrees from the axis of the sand drum, and the position of the table is shown by large graduations which can easily be seen.

Fig. 2. View illustrating Use of Drum Sanding Attachment

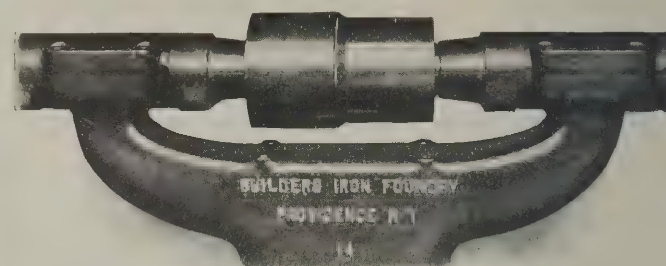
The sand drum illustrated is 2½ inches in diameter and 8 inches long, but drums varying from 1 to 6 inches in diameter and of any reasonable length can be used. The work-table has a central annular opening 8½ inches in diameter into which are fitted circular plates with center holes to accommodate drums of different sizes. The sand drum runs at 2250 revolutions per minute and when in operation, it is given a vertical reciprocating movement to equalize the wear of the abrasive. This reciprocating movement is obtained from the crank seen beneath the table, and it is adjustable from 0 to 4 inches. The sand drum spindle is driven by a 2-inch quarter-turn belt, and the reciprocating crank is driven by a 1½-inch belt, which transmits power to the crankshaft through the intermediate shaft and gearing shown.

Fig. 2 illustrates how the sand drum attachment is used for finishing straight and curved inside surfaces. The table is tilted to an angle of 1½ degree, in this particular instance, to give the required draft.

This machine occupies a floor space of 54 by 84 inches and weighs 2800 pounds. It is made with either 30- or 40-inch disk wheels and for a belt or motor drive.

IMPROVED POLISHING MACHINE

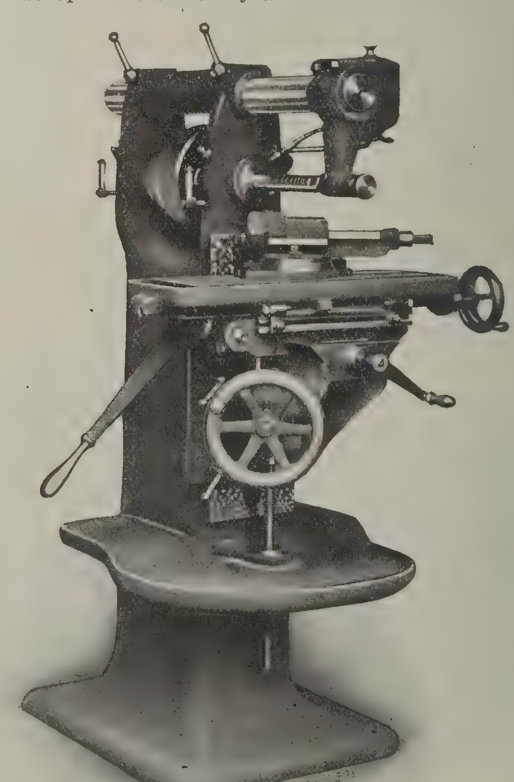
The accompanying illustration shows an improvement which has recently been made on the 12- and 14-inch ring-oiling polishing machine manufactured by the Builders Iron Foundry, Providence, R. I. The loose pulley has a diameter ½ inch less than the diameter of the tight pulley in order to relieve the tension on the driving belt when the spindle is stationary. This well-known feature permits the use of an extra-tight belt without subjecting the loose pulley to excessive strain; consequently there is less wear on both the belt and pulley. The loose pulley has a beveled flange on the tight pulley side, so that the belt can be shifted easily. This polishing machine has a positive method of lubrication which permits it to be run at very high speeds without lubrication troubles.



Spindle Mounting and Belt Pulleys of Polishing Machine made by Builders Iron Foundry

STEPTOE HAND MILLING MACHINE

The hand milling machine illustrated herewith is of a recent design now being built by the John Steptoe Shaper Co., 2951 Colerain Ave., Cincinnati, Ohio. The table of this machine can be operated either by a lever feed or a screw feed.



Steptoe Hand Milling Machine

The lever feed is intended for the rapid milling of small parts, but when desirable, either because of accuracy or for some other reason, the screw feed can be employed. This screw feed has a collar accurately graduated to thousandths of an inch.

This machine is also built with a lever elevation for the knee, when so ordered, and it will be manufactured later

with a power feed for the table. The vise has a graduated base for setting it to any angle. The pan seen below the knee prevents chips and oil from falling on the floor, and it is also convenient as a tool rest. The bearings are of high-grade phosphor-bronze and are tapered and threaded on the ends to take up wear. The bearings are thoroughly oiled by means of felt oilers.

DALLETT PNEUMATIC TOOLS FOR PATTERNMAKING

In view of the fact that pneumatic tools have proved so efficient for chipping metals, carving stone, etc., it seems rather strange that they have not come into general use in woodworking establishments. In the pattern shops, for instance,

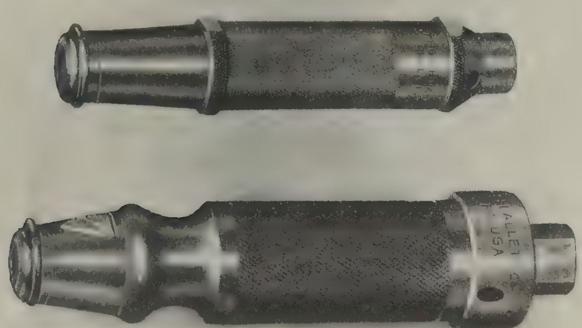


Fig. 1. Dallett Pneumatic Tools for Wood Carving and Patternmaking

there is always more or less hand carving which could doubtless be done easier and quicker with the aid of pneumatic tools. The Thomas H. Dallett Co., York and 23d Sts., Philadelphia, Pa., has placed on the market pneumatic tools for wood carving which are an adaptation of the pneumatic stone-working tools which this company has been manufacturing for years.

Fig. 2. Sectional View of One-inch Pneumatic Wood-carving Tool

These tools for wood carving are made in two sizes, which are illustrated in Fig. 1. The upper tool is a ¾-inch size intended for fine carving and finishing, whereas the 1-inch size below is more powerful and is adapted for gouging and heavy roughing work.

It is claimed that these tools enable one man to accomplish a great deal more than would be possible by the old method of hand carving. They can be regulated to give a light or hard blow, either by placing the thumb over the exhaust hole or cutting down the air supply by means of a stop-cock in the hose. Both tools are of the valveless type and operate on the same principle, although there is a slight difference in the design. The head of the ¾-inch tool is locked by a pin and spring, whereas, in the 1-inch "finger grip" design, the head is locked by a ratchet and pawl.

The sectional view, Fig. 2, shows the construction of the larger size. The tool-steel piston is the only moving part, and it strikes as high as two or three thousand blows per minute, the rate depending upon the pressure. The cylinder is of hardened steel and, in the case of the "finger grip" design, it is one solid piece. A renewable hardened bushing is inserted in the end of the barrel for the reception of a shank having a special "quarter-octagon" shape instead of being round. With this arrangement, the chisel can be held steady and secure without any effort on the part of the workman. Furthermore, by having a shank of this shape, the chisel can be twisted when gouging or roughing, in order to split or pry off a chip, which could not be done with a round bushing.

As wood chisels are made with both tang and socket ends, three fittings known as a plug, shank and socket shank are

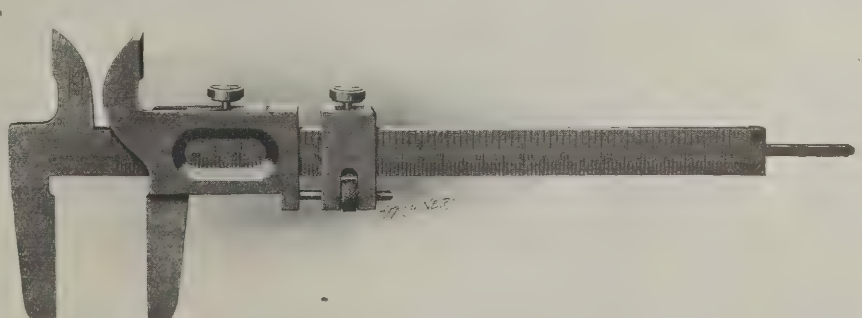
Fig. 3. Using the Dallett Pneumatic Tool for Patternmaking

furnished to adapt the pneumatic tools for any style of chisel. The shanks are provided with a recess on one side which is engaged by a locking spring to prevent the shank from dropping out when the tool is in operation. This feature makes it unnecessary for the workman to hold the chisel in place.

Fig. 3 illustrates the application of this tool to patternmaking. The air consumption of the ¾-inch size is approximately four cubic feet of free air per minute, and that of the 1-inch size, about five cubic feet. The air pressure required depends entirely upon the character of the work and the kind of wood being operated upon. The pressures range from 40 to 100 pounds, but pressures between 70 and 90 pounds are most commonly used for general work.

SCHUCHARDT & SCHUTTE VERNIER CALIPER

Schuchardt & Schutte, Cedar & West Sts., New York, has placed on the market the improved form of vernier caliper shown herewith. This is a combination tool which can be used for measuring inside and outside diameters and also as a depth gage. The extension jaws seen above the regular caliper jaws, are used for internal measurements, and the depth gage slides in a groove on the rear side and projects



Combination Vernier Caliper for Inside, Outside and Depth Measurements

beyond the end of the bar or scale, as shown to the right. The jaws and depth gage move together, so that all three measurements are obtained at one setting, and the scales give a direct reading.

The general arrangement of this caliper is similar to the type formerly sold by this company, but the construction is

quite different. The fixed jaws for internal and external measurements are integral with the bar instead of being riveted in place, and the sliding jaw completely encircles the bar, instead of being retained by a flat spring, as with the older design. This construction makes the tool much stronger and adapts it for hard usage in machine shops.

The bar is 6 inches long and is graduated on the upper and lower edges. Two sets of graduations can be furnished. The upper and lower scales of one set are graduated to sixteenths and twenty-fifths of an inch with verniers reading to one-hundred twenty-eighths and one thousandths inch, respectively. The other set has one-sixteenth-inch graduations on the upper scale and millimeters on the lower scale with verniers reading to one-hundred twenty-eighths inch and one-tenth millimeter, respectively.

BATH GRINDING MACHINE FOR MULTIPLE KEY-SHAFTS

The grinding machine illustrated herewith has been designed for grinding integral multiple key-shafts or sliding-gear shafts for automobile transmission cases. A formed grinding wheel is used and the sides of two keys as well as the circular surface between them, are ground simultaneously. This machine is built by the Bath Grinder Co., Fitchburg, Mass. Fig. 1 is a front view showing the water guards in place; Fig. 2 is an end view illustrating the construction and arrangement of the grinding wheel head; and Fig. 3 shows a key-shaft in place and the wheel in position for grinding. Before taking this latter view, the water guards were removed to expose the details of the machine.

The vertical column has two wide bearing surfaces upon which the grinding wheel head is mounted. The column is strongly ribbed internally and firmly bolted to the base of the machine. The wheel-head is rigidly constructed and careful attention has been paid to the oiling system. The wheel-spindle is made of tool steel, hardened and ground, and runs in adjustable phosphor-bronze bearings, which are thoroughly protected from grit. The handwheel for feeding the grinding wheel vertically, is graduated to read to 0.00025 inch, and it is equipped with a stop for grinding duplicate parts. The thrust of the vertical feed screw is taken by ball thrust bearings.

The machine is provided with an indexing work-head, firmly bolted to the table. The indexing mechanism consists of an index dial, a tooth ratchet wheel and an index plunger-bolt, all of which are protected from water and grit. The index plunger-bolt is released by a slight backward movement of the handle shown; then by a forward movement, the work is revolved and the plunger-bolt engaged in the next taper notch. This mechanism is so designed that the dial cannot revolve backwards when free of the plunger, which insures a positive indexing action. The number of divisions on the dial are determined by the number of keys in the shaft to be ground.

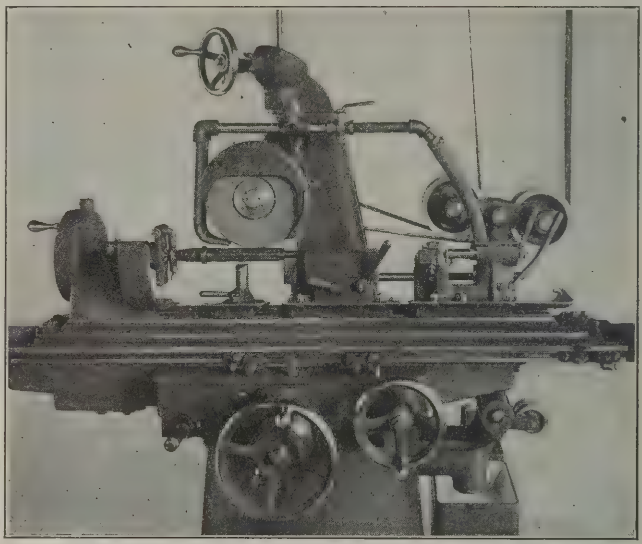


Fig. 3. View of Bath Grinder with Water Guards removed

The footstock furnished on this machine is very compact and rigid in construction. The center carrier is flat and is set into the base at an angle, thus bringing the center within one-half inch of the top and one-half inch of the inner side of the footstock. This allows the grinding wheel to pass the footstock, without disturbing its position. The center carrier is operated by a spring controlled by the lever seen at the right-hand end of the footstock. The carrier may be locked firmly in position by the handle at the left. All operating parts are thoroughly protected from water and grit.

Fig. 1. Bath Multiple Key-shaft Grinding Machine

Fig. 2. End View of Bath Grinding Machine

The wheel truing device, which is illustrated in Fig. 4, is provided with three black diamonds. One is for forming the radius of the wheel and is operated by the short lever seen at the end of the fixture. The other two diamonds are for forming the sides of the wheel and are operated simultaneously by the long lever shown at the end of the fixture. The diamond for forming the radius is carried by a steel spindle which

revolves in a taper bearing, and is provided with a very sensitive adjustment. The alignment of the side forming diamonds is insured by adjustable taper keys. These bearings are carefully protected from grit and water.

After this device has been properly located at the back of the footstock, it should not be disturbed. When truing the grinding wheel, the table is moved so as to bring the center of the grinding wheel over the center of the diamonds, the

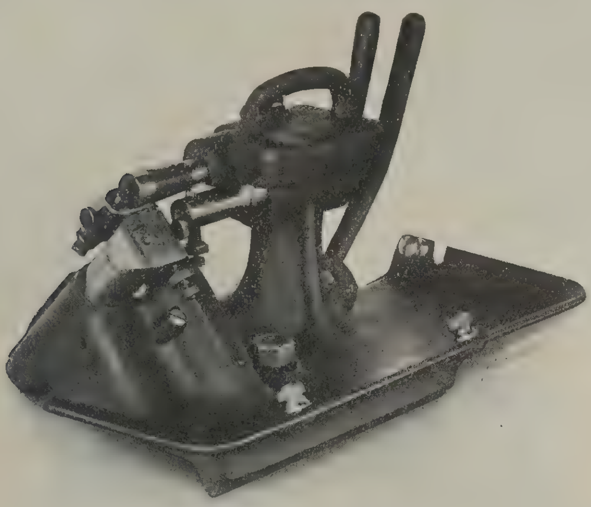


Fig. 4. Device for Truing Sides of Wheel and Forming Radius

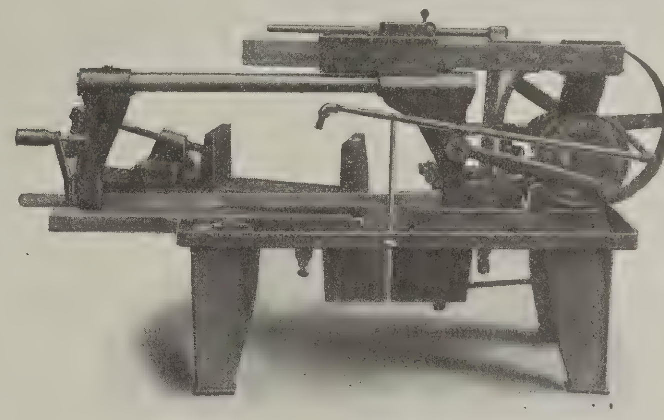
table being provided with a twin stop for locating it in the correct position. The master block for setting the diamonds is clamped on top of the wheel truing device base, which is provided with a dovetail to insure alignment. The master block carries a hardened tool steel plug, to which the diamonds are set. A shield is furnished to cover the bearing on the wheel truing device when the master block is not in use.

A combination centering and rest base is furnished for centering work rapidly, and also for supporting slender work. This fixture is clamped to the table and is provided with a plunger, the top of which is formed to fit between two keys on the shaft to be ground. The plunger is actuated by a spring, and is controlled by a lever which has a cam cast integral and engages the plunger. A slight turn of this lever to the left relieves the plunger, and, when used as a support, the plunger may be clamped firmly in position by moving the lever in the opposite direction.

The table is controlled in the usual manner by adjustable dogs operating against a reversing lever which actuate a clutch of the "load-and-fire" type. The table can also be controlled by a hand-reversing lever, which provides means for automatically stopping it at the end of its traverse, by simply giving the lever part of a turn at any time during the traverse of the table. All operating levers, handles and adjustments are within easy reach of the operator from the front of the machine. The water tank is separate from the machine, thus making it convenient for cleaning.

ROBERTSON POWER HACKSAW

In the June, 1912, number of MACHINERY a power hacksaw, known as No. 2, manufactured by the W. Robertson Machine & Foundry Co., 32 Greenwood Place, Buffalo, N. Y., was illustrated and described. The accompanying illustration shows a larger size of hacksaw, known as No. 5, built by the same company. This machine is designed for cutting off structural shapes and solid stock, round or square, the maximum capacity being 8 by 15 inches. The saw frame is adjustable and allows the use of a 10-inch blade for cutting small stock, which involves a great saving when large stock is not being cut continually. The vise has strong wide jaws and is provided with a quick adjustment so that the operator can open or close it instantly to take stock from 1 to 15 inches. The vise swivels to a 45-degree angle, and is graduated.



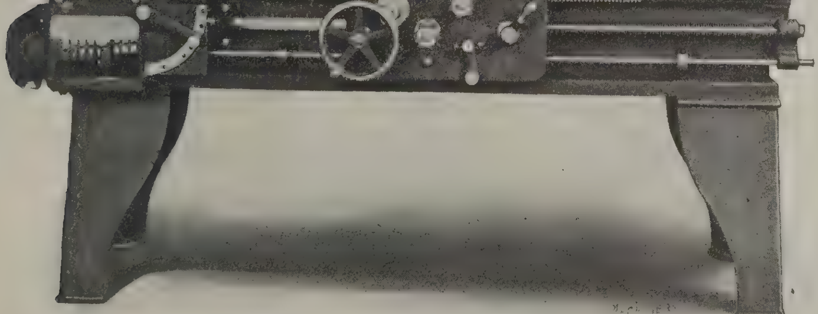
"Economy" Power Hacksaw

The saw cuts on the draw stroke, and is raised on the return stroke by an arrangement which is very simple mechanically, yet positive and durable. The saw stops automatically when the cut is completed. The tank shown under the bed is for cooling liquid, which is pumped to the blade by a rotary pump connected to the driving gear at the rear of the head.

The maximum length of the blade is 24 inches, the minimum being 10 inches; the stroke is 6 inches. The driving pulley speed is 140 R. P. M., and the net weight of the machine is 360 pounds.

GREAVES-KLUSMAN 17-INCH LATHE

Greaves, Klusman & Co., Cincinnati, Ohio, have added to their line of lathes, a 17-inch quick change-gear type having a three-step cone and friction double back-gears. The bed is a new form designed to minimize twisting strains by means of heavy reinforcements under the V's, which extend below the top of the girths. The headstock is massive and the spindle is made of high-carbon steel and runs in self-oiling phosphor-bronze bearings. The front spindle bearing is hardened and ground in position. The self-adjusting, friction, double back-gears can be engaged by the operator in any position along the bed, by simply shifting the horizontal bar shown.



Greaves-Klusman Quick-change 17-inch Engine Lathe

With the two-speed, friction countershaft regularly furnished with this lathe, eighteen speeds are obtainable. As six of these speeds are secured without shifting the belt, it is convenient to obtain the proper speed for roughing and finishing.

The frictions of the double back-gear mechanism are of simple construction and have two rings which engage recesses in the gears. There are two toggles fitted in each ring which expand the frictions when the longitudinal bar is shifted. These frictions are self-adjusting for wear and have ample strength to transmit the maximum belt pull.

The tailstock has an extra-long spindle which is gripped by two sets of double-plug clamps at both ends of the barrel. This clamping device is operated by a single handle. The carriage has a full length bearing on each V and a flat bearing inside the front V, which shortens the bridge and gives a direct support under the tool-rest. The apron is the double-plate box form. The quick-change gear-box at the left is a simple, compact design having but two handles which control the entire range of threads and feeds. The lathe is fitted with a chasing dial for "catching" threads, and all threads from two to fifty-six per inch can be cut, including the 11½ pipe thread. There is a clutch for independently engaging or disengaging the lead-screw on the feed-rod. This clutch is operated by a handwheel on the gear-box.

This lathe has a swing over the bed of 18⅜ inches, a swing over the carriage of 13⅛ inches, and it takes 31 inches between the centers, with a 6-foot bed. The front spindle bearing is 3 3/16 inches in diameter and 5⅛ inches long, and the rear bearing is 2⅝ inches in diameter and 4 5/16 inches long. The back-gear ratios are 3.5 to 1 and 12 to 1.

BLISS TOGGLE DRAWING PRESS

The accompanying illustrations show the front and rear views of a toggle drawing press recently designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This is said to be one of the largest drawing presses of this type ever built. This press is intended for drawing and forming sheet metal automobile parts made of thick stock, such as brake drums,

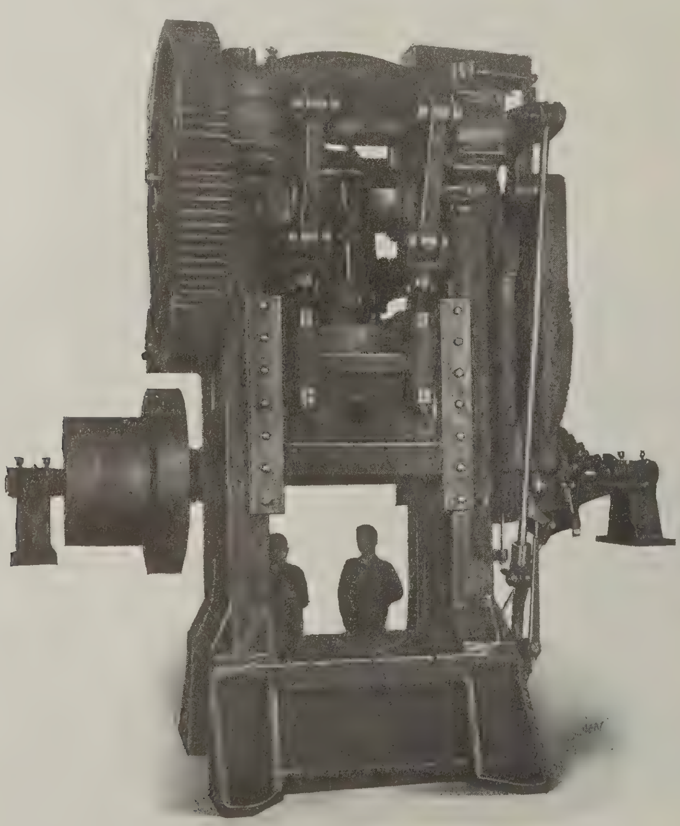


Fig. 1. Large Toggle Drawing Press built by E. W. Bliss Co.

rear axle housings, etc., but it is equally well adapted for other lines of manufacture in which very heavy stock is drawn.

The construction is of the built-up type, the bed, the crownpiece and uprights being separate and bound together by four 7-inch steel tie-rods, which take all the working strain. These tie-rods are heated and shrunk into place. The frame columns are of cored box section, and impart great rigidity to the entire structure. The main crankshaft is 12 inches in diameter and has a stroke of 24 inches. The stroke of the blankholder slide is 16 inches.

The entire construction of the machine is in proportion to the 12-inch crankshaft and 7-inch tie-rods, and the calculations were based on the bending strength. With a factor of safety of 2½, the machine has a safe working capacity of 600 tons. Attention is called to the basis of the calculations, because in many instances, the capacity of presses is figured on the shearing strain. If the latter method were adopted in this case the press shown would have a capacity of 1000 tons, but to have this capacity with the bending strength taken as a basis, would require 9-inch tie-rods and a 16-inch crankshaft.

The Bliss toggle movement is applied to the press and all pressure on the blank is transferred through straightened

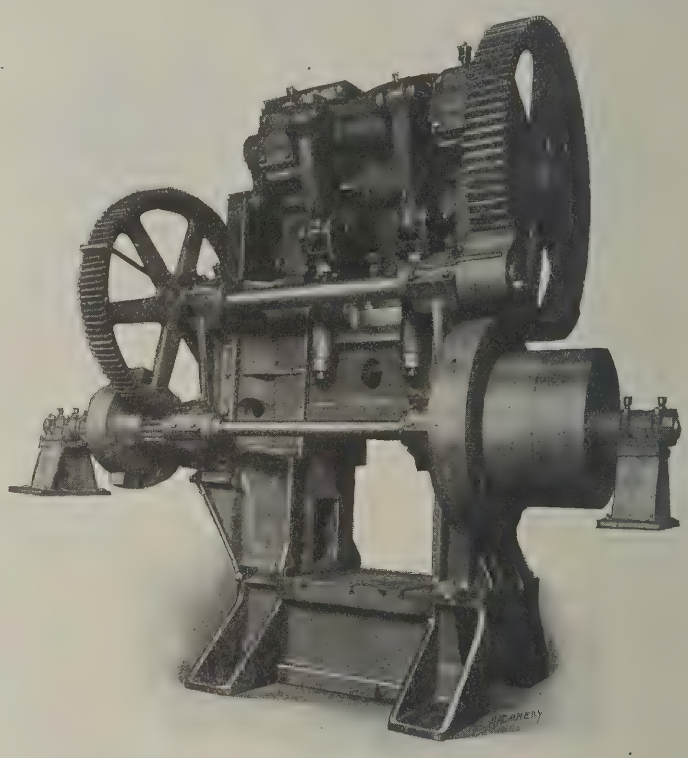


Fig. 2. Rear View of Bliss Toggle Press

toggles directly to the frame, relieving the bearings from all friction and wear due to blank-holding, with a consequent reduction in power consumption.

The press is double geared, and the entire train of gears are of steel castings, and machine cut. The press is controlled by a powerful hand-actuated friction clutch of the double-grip type, the action of which is practically instantaneous. This clutch, in connection with the semi-automatic brake, places the movements of the press entirely under the control of the operator, so that it can be started or stopped at any point.

It will be noted that the bottom of the outboard bearing standards are very high from the base of the press. This arrangement was necessary because of the low ceilings in the building at the place of installation, which requires the press to be placed in a pit of considerable depth. The actual shipping weight is 170,000 pounds.

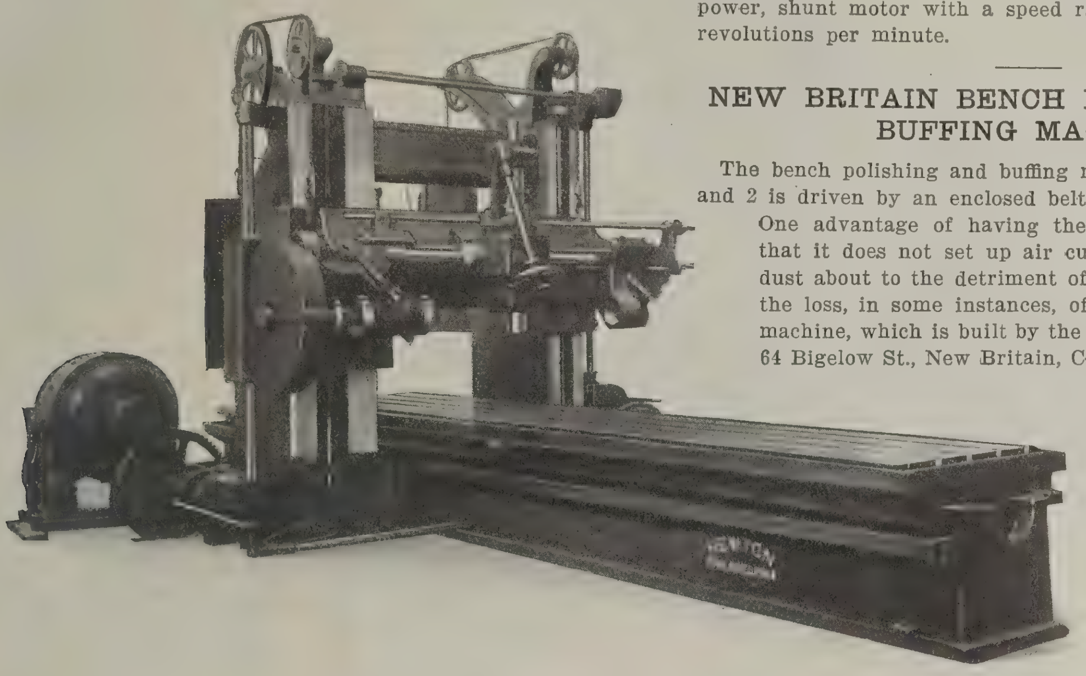
NEWTON HORIZONTAL MILLING MACHINE

The Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., has recently designed a heavy type of horizontal milling machine for forge work. The bed of this machine is of an extra-heavy, double-ribbed, box-type construction having oil pans cast integral and bearings with square gibs for the table. The sides of the bed are fitted with tongues for attaching the uprights which extend to the floor line. The work-table is also exceptionally heavy, of double-ribbed box-type construction, and has an angular steel rack bolted to the bottom which is engaged by a bronze worm-gear of steep lead and large diameter.

The rail is of the inclined face type and is of large propor-

tions. It is fitted to the uprights with square lock bearings. Adjustments are made by taper shoes, and the alignment is maintained by the narrow guide bearing on the left-hand upright. The bearing of the rail on this upright, for alignment, is on both sides of one shear, to prevent any distortion of the bearing surfaces. The bearing for the driving worm-wheel sleeve and the driving worm are cast solid with the rail, which gives a strong resistance to thrust and tends to eliminate chatter.

The spindle revolves in a bronze bushed capped bearing, which has a hand side adjustment on the rail for convenience in setting cutters. The rail is of sufficient length to permit removing the cutters without taking off the outer support. The spindle is arranged to drive the cutter arbor by means of a broad face key, and the arbor is held in place by a through retaining bolt. The outer end of the cutter arbor is supported in bushings that have parallel internal and taper external bearings, fitted with adjusting nuts to compensate for wear. Individual screws fitted with micrometer measuring collars



Newton Horizontal Milling Machine for Forge Work

are furnished for moving both the horizontal spindle and the vertical spindle saddles. The outer support is adjusted rapidly by means of a rack and pinion. The cross-rail elevating screws have a top and bottom bearing, and as the counterweights are heavier than the rail, tension is always maintained and lost motion eliminated.

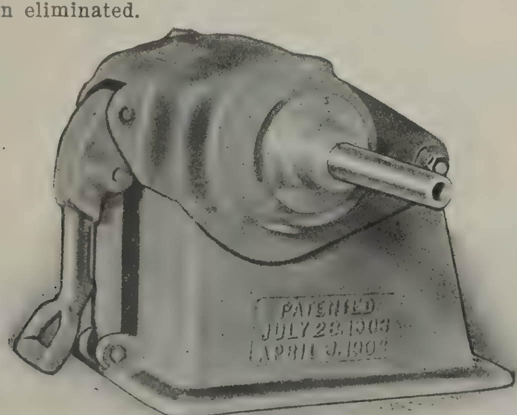


Fig. 1. The New Britain Bench Polishing Machine

As many forgings, such as large driving shafts, require feather keyways, this machine has been equipped with a vertical spindle to mill the ends of the keyways. The vertical spindle is five inches in diameter, and is arranged to drive the cutters by a broad face key. It is fitted with a No. 6 Morse taper, retaining and drift key slots, and a micrometer measuring shoulder. The vertical spindle is driven from a spur gear placed beside the worm-wheel for the horizontal spindle. The motion is transmitted through a clutch so that the vertical spindle can be disengaged when not needed.

This machine has a reversing fast power traverse, positive geared feeds with nine changes, and a reversing fast power elevation for the cross-rail, in addition to hand adjustment for the table and rail. One handwheel controls the hand movement of the rail and table, and the lever controlling the direction of the rapid traverse for the table always controls the movement of the cross-rail.

The diameter of the horizontal spindle is 6⅜ inches; side adjustment of the spindle by hand, 12 inches; distance from the center of the spindle to the under side of the cross-rail, 4 inches; independent hand adjustment of the vertical spindle, 9 inches; width of work-table on the working surface, 42 inches; length that can be milled, 12 feet; width between the uprights, 48 inches; maximum distance from the center of the spindle to the top of the work-table, 52 inches.

This machine is driven by a General Electric 50–60-horsepower, shunt motor with a speed range of from 400 to 1200 revolutions per minute.

NEW BRITAIN BENCH POLISHING AND BUFFING MACHINE

The bench polishing and buffing machine shown in Figs. 1 and 2 is driven by an enclosed belt from beneath the bench. One advantage of having the driving belt enclosed is that it does not set up air currents which would carry dust about to the detriment of the worker's health, and the loss, in some instances, of valuable material. This machine, which is built by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has been designed to facilitate cleaning, there being plain, smooth surfaces with rounded corners, so that all valuable material that is polished and buffed off can be recovered.

The drive from beneath keeps the spindle down in the bearings, which is said to give a smoother running head than when the pull of the belt holds the spindle against the box cap. The drive from beneath also makes possible a simple means of starting and stopping without any loose pulleys. This is accomplished by swiveling the upper portion of the head which is hinged at the rear and is held by a toggle lever. When the head is lifted by pushing the lever down, as in Fig. 1, the belt is tightened and the spindle set in motion.

Fig. 2. Starting Toggle raised to disengage Belt from Driving Pulley

On the other hand, when the lever is raised, as in Fig. 2, the spindle is dropped onto a brake-block which stops it quickly, and the belt sags away from the driving pulley beneath the bench. The toggle lever is so designed that as the belt tightens, the leverage increases, and, at the end of its downward movement, the toggle becomes self-locking.

The machine is equipped with either a double- or single-end

spindle. The boxes are self-aligning and have a ball section in the center which allows the bearings to adjust themselves, if the shaft is sprung either by heavy belt pull or excessive polishing pressure on the end of the spindle. The spindle is oiled by solid internal collars which dip into the oil and carry it up to the strippers above, which distribute it to each end of the bearings. This collar also serves to take up end motion.

GORTON HEAVY-DUTY CUTTING-OFF MACHINE

The accompanying illustrations show a 16-inch heavy-duty, high-speed cutting-off machine recently built by the George Gorton Machine Co., Racine, Wis. This machine has been under development by the Gorton company during a period of several years, the various details being covered by numerous patents both in the United States and abroad. The special feature of the machine is its great capacity; it will sever round, 30 to 40 point carbon open hearth steel bars, 6 inches in diameter, in thirty seconds, and 12-inch bar can be cut off in one minute; but the working speed recommended is one minute for a 6-inch bar of the material mentioned, other sizes being operated upon in the same proportion.

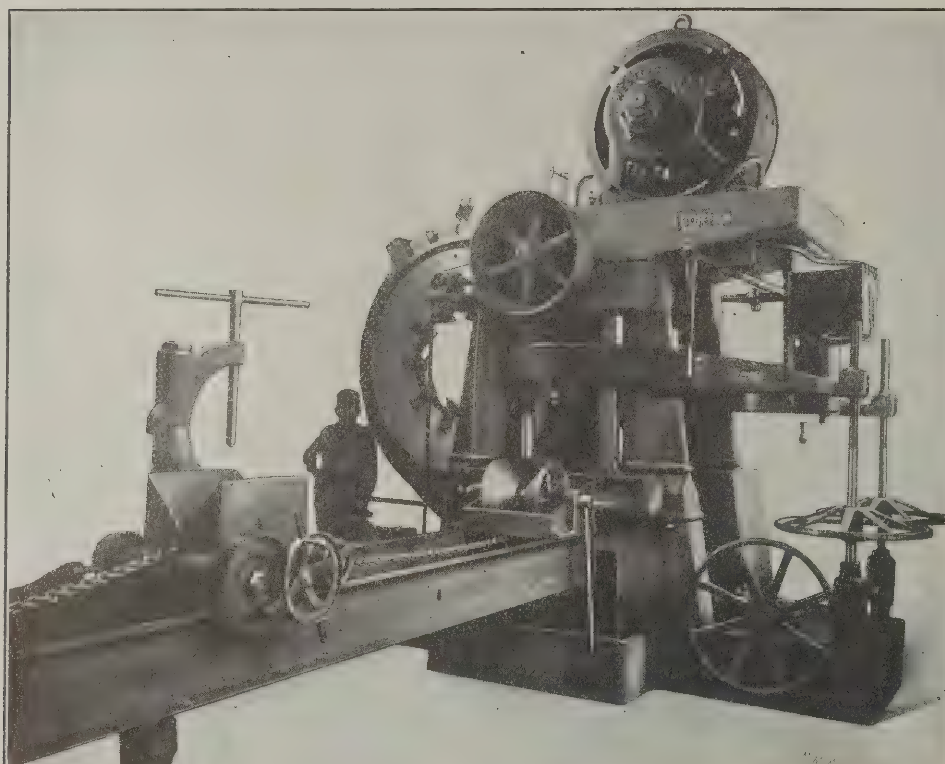


Fig. 1. Gorton Sixteen-inch Cutting-off Machine with Drum raised to provide Access to Cutters

The machine is driven by a 40 H. P. variable-speed motor. The main driving gear is 72 inches in diameter with a 4½-inch face, and is made of semi-steel. It meshes with a main driving pinion, integral with its shaft, made of a crucible steel forging. The diameter of the pinion is 5 inches, and as the cutter points are 10 inches from the center of rotation of the saw drum, this arrangement makes an exceedingly powerful drive. The outside clutch gear, shown in Fig. 3, is 36 inches in diameter and is driven directly from the motor through an intermediate gear as indicated. The cutter travel can be varied from 17 feet per minute up to 51 feet per minute, according to the kind of stock being cut. The cutter blade is ¾ inch thick, and the opening between the cutter points is 20 inches in diameter. To avoid accidental breakage of cutters, the main clutch is provided with a shearing pin which will release the driving mechanism when undue strain is placed upon the cutter. This shearing pin is so located that the cutter is disconnected from all parts of large diameter which continue to revolve until the motor is shut down. This arrangement avoids any flywheel effect which would tend to continue to rotate the cutter after the shearing of the pin.

The stock is fed through the machine by means of a stock carriage, as indicated in Fig. 2. The amount of stock fed may be measured off accurately by means of a measuring bolt. The stock severed is forced on through the V-block at the rear of the machine, indicated in Fig. 3. Simple and powerful clamping arrangements are provided. These may be operated either by hand, or by hydraulic or pneumatic means.

An important feature of this machine, as well as of other Gorton cutting-off machines, is that the cutter blade with its drum is driven through spur gearing, as this means of driving is most economical in power consumption, most durable, and

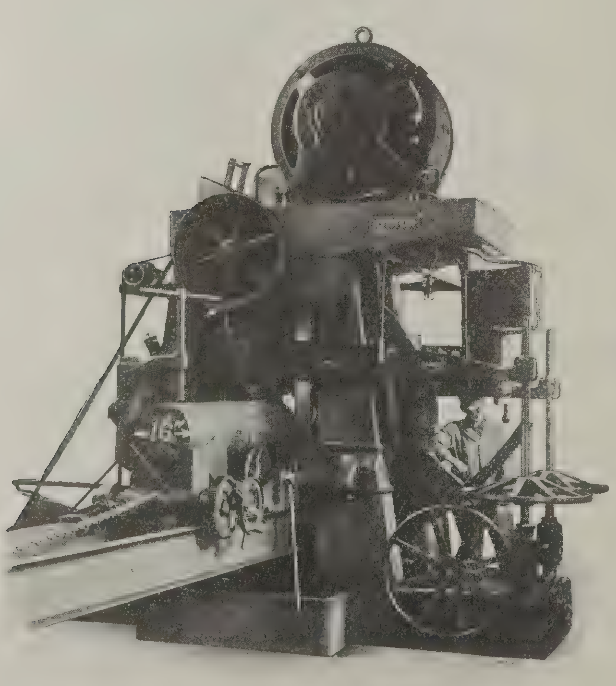


Fig. 2. Cutting-off Machine with Bar in Place ready for Cut

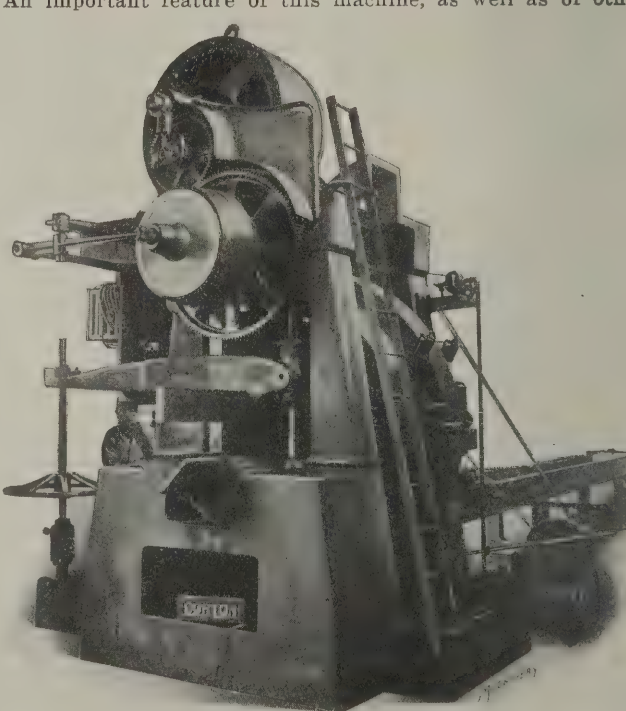


Fig. 3. Rear View of Gorton Cutting-off Machine

least expensive to manufacture and to maintain. The feed is by means of a worm and worm-gear segment.

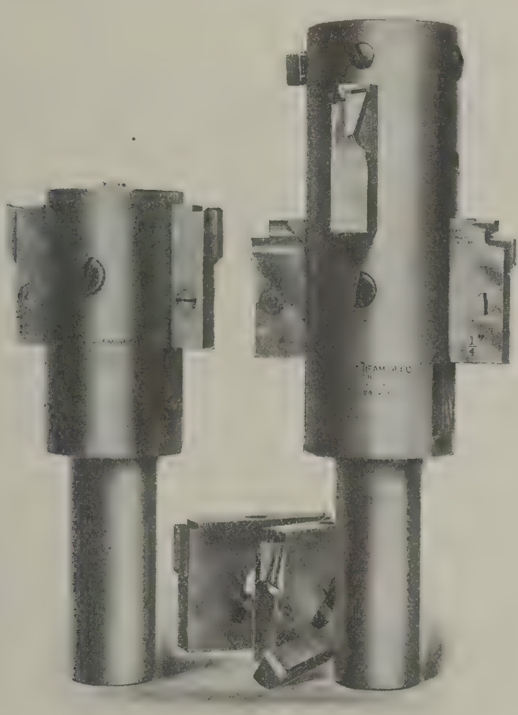
The question of lubrication has been given special attention. The saw drum bearings operate in a flood of oil, and the construction is such that it is impossible for the cutting compound, chips or dirt to enter these bearings. The main pinion bearings, which are 3½ inches in diameter, also operate in a flood of oil. The feed work cases are also flooded with oil, and the main driving clutch is partially so lubricated. A pump is provided for flooding the cutters with lubricating compound when in operation.

The total net weight of the machine, as shown in the illustrations, exclusive of the stock rack, is 55,000 pounds. The total height of the machine, including the motor, is 12 feet, the shipping height, with motor removed, being 9 feet 6 inches. The length of the base on the floor line is 9 feet 6 inches, the width being 7 feet.

KELLY AUTOMOBILE HUB REAMERS

The accompanying illustration shows a boring and reaming outfit for automobile wheel hubs made by the Kelly Reamer Co., Cleveland, Ohio, the tools as shown being especially intended for use on the Jones & Lamson turret lathe. The tool shown to the right is the boring tool used for roughing only, while that shown to the left is the finishing reamer. The tools shown at the bottom, between the shanks of the holders, are exchange-tools used for the small end of the hub.

One of the improvements introduced in these tools as compared with the ordinary design of Kelly reamers, illustrated



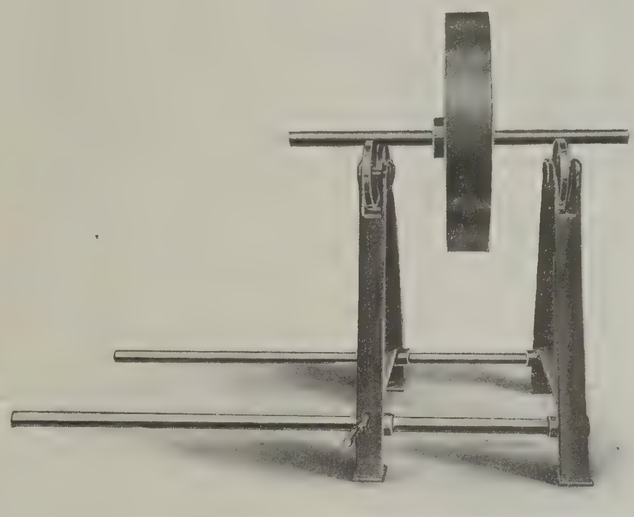
Kelly Roughing and Finishing Reamers for Automobile Wheel Hubs

and described in the July, 1908, number of MACHINERY, is that the reamer blades do not extend outside of the flat reamer holder body in the lengthwise direction. Thus the tools can be easily slid in and out of the holder and rapidly exchanged. This feature is especially valuable for crankcase work, where it is imperative that the boring and reaming be done at one setting of the work, to insure alignment. The special construction then permits the change from boring or roughing reamer bodies to floating finishing reamers to be made rapidly and without difficulty.

TWENTIETH CENTURY BALANCING STAND

The balancing stand shown in the accompanying illustration has been brought out by the Rockford Tool Co., Rockford, Ill., and is designed for balancing pulleys, flywheels, armatures, etc. It will swing wheels 8 feet in diameter, and has a carrying capacity of 5 tons. The distance between the standards is adjustable, the maximum distance being 8 feet and the minimum distance 2 feet. The adjustment is by means of a rack and pinion, the hand-crank shown in the foreground being used for this purpose.

The size of balancing stand shown in the illustration is known as No. 4. Besides this one, four other sizes are built, known as Nos. 1, 2, 2A and 3. Size No. 1 is intended for bench use and is 20 inches between the standards. It will swing 22 inches, and carry a weight of 1000 pounds. No. 2 and 2A both swing 46 inches and have a distance of 30 inches be-



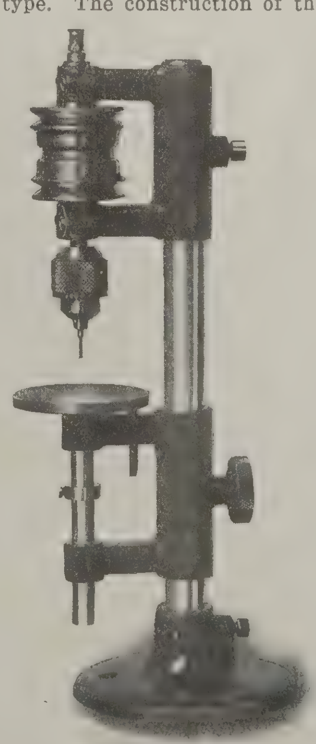
Twentieth Century Balancing Stand, built by the Rockford Tool Co.

tween standards. No. 2 has a carrying capacity of 1000 pounds, while No. 2A will carry one ton. Size No. 3 has a carrying capacity of 2½ tons with a maximum distance of 6 feet between standards, and a swing of 6 feet.

The rotating disks which carry the shaft of the wheel to be balanced run in ball bearings. The disks on stands Nos. 1 and 2 are made from steel, hardened and ground, while the disks on sizes 2A, 3 and 4 are made from chilled cast iron and ground.

ELGIN BENCH TAPPING MACHINE

The Elgin Tool Works, Elgin, Ill., has brought out a new tapping machine of the bench type. The construction of this machine is very simple, as will be seen by referring to the engraving. The two heads which carry the tapping spindle and the work table respectively, are mounted on a vertical column or shaft which can be furnished in different lengths so that holes in the side of a box or frame can be tapped. The tap spindle is driven through a friction clutch interposed between the belt pulleys shown. One of these pulleys carries an open belt, and the other a cross belt for obtaining a reverse movement.



Elgin Bench Tapping Machine

To operate the machine, the work is placed on the table and is lifted up until the tap enters the hole. A stop-collar on the table spindle is set for the required depth, and when this collar comes against the under side of the table bracket, the upward movement is arrested and the tap spindle is drawn downward, thus disengaging the friction clutch from the upper driving pulley. A slight downward pressure then

engages the reversing clutch, and the tap is backed out of the hole.

SANDERSON PORTABLE BORING-BAR

The accompanying illustrations show a portable boring-bar for straight and taper holes, which has been brought out by the Sanderson Tool Sales Co., 438-439 Brown-Marx Bldg., Birmingham, Ala. Fig. 1 shows the general appearance of the tool, while the line engraving, Fig. 2, shows the details of the design. The special features of the boring-bar are that it is readily adjusted, easy to operate, and simple in construction; it can be applied to ordinary drill presses, radial drills, lathes, electric or air motors, and in fact to any machine or appliance having a revolving element.

Fig. 1. Sanderson Portable Boring-bar

The tool consists, as shown in Fig. 2, mainly of a tool carriage *A*, a tool bar guide *D*, and a driving bar *I*. The tool carriage consists of a rack and worm, and a holder with a graduation segment. The rack holds the cutting tool *B* which is inserted at right angles to it at the bottom end. The tool is operated by a star feed at *C*. The rack is guided by the tool bar guide *D* which is dovetailed so as to hold the rack and tool firmly and prevent the tool from chattering or vibrating. Adjustment for different tapers is easily obtained by loosening the nuts *E*, *F* and *G*. If a straight hole is to be bored, the tool is merely set over by means of the nuts and slots to any diameter within the capacity of the bar.

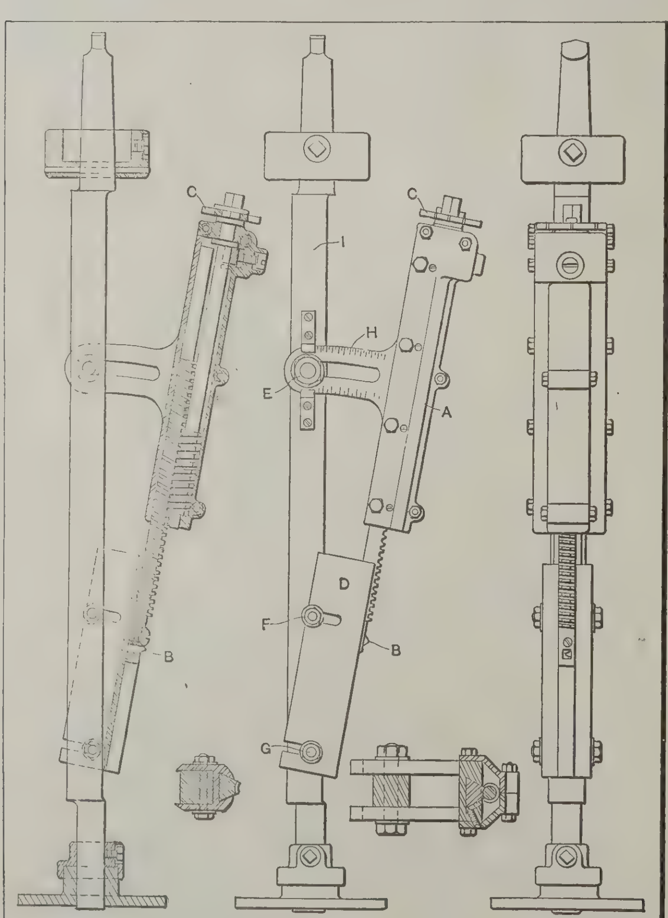


Fig. 2. General Design of Portable Boring-bar for Straight and Taper Holes

The length over-all of the device is 32 inches. The taper shank fits a No. 4 Morse taper socket. The tool has a capacity for boring holes varying from 2½ to 5 inches in diameter, straight or taper, to a depth of 8 inches. The taper adjustment allows tapers up to 6 degrees to be bored. Special bars can be made to take care of holes of other dimensions and tapers.

* * *

NEW MACHINERY AND TOOLS NOTES

Knurling Tool: A. B. Campbell, Fairport, N. Y. Hand-operated knurling tool having three knurls. The part to be knurled is placed in a vise and the tool, which is turned like a die, feeds itself along the surface of the work.

Die-head: Pottstown Machine Co., Pottstown, Pa. Die-head having a machinery steel body and four chasers which are securely held in internal slots, the angle of which conforms to Briggs standard pipe tapers. These heads are made in several sizes having capacities from 1 to 6 inches.

Radial Drilling Machine: Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio. Plain radial drilling machine of an improved design. This machine is equipped either with a cone drive, speed-box drive, variable-speed motor drive, or a motor and speed-box drive. All gearing is enclosed and the construction throughout is along modern lines.

Sensitive Drill Press: Francis Reed Co., Worcester, Mass. Sensitive drilling machine which is provided with six spindle speeds. Three speeds are obtained from cone pulleys and this number is doubled by shifting the position of the quarter-turn idler at the top of the column. This idler is controlled by a lever and is automatically locked in position.

Electric Welders: Geuder, Paeschke & Frey Co., Milwaukee, Wis. Automatic electric spot-welders made in four sizes, ranging from 10 to 50 kilowatts capacity. The machine is set in motion by a foot pedal, and all welding operations are entirely automatic. The capacity is from 100 to 200 welds per minute when operating on sheets of from 19 to 31 gage thickness.

Tap Grinder: Wells Bros. Co., Greenfield, Mass. Machine for grinding taps correctly. The tap to be ground is held between centers and it is kept in the proper position by an adjustable spring-finger which regulates the clearance. The grinding is done by a cup wheel. The machine has a self-contained countershaft, and will take taps up to 12 inches in length.

Bench Lathe Attachments: Elgin Tool Works, Elgin, Ill. Auxiliary equipment for the bench lathe, including a filing attachment, two milling attachments and cylindrical and surface grinding attachments. One of the milling attachments has a horizontal spindle carried upon a vertical slide, and the other a vertical spindle which can be set in any desired position.

Turret Lathes: Warner & Swasey Co., Cleveland, Ohio. Hollow hexagon turret lathes of recent design, known as Nos. 2A and 3A machines, respectively. The 2A size has a capacity for bar stock up to 2¼ inches in diameter and, with a chucking outfit, will take castings or forgings 12 inches in diameter. The 3A machine has a capacity for bar stock up to 3¼ inches in diameter and for chuck work up to 15 inches.

Drilling, Boring and Milling Machine: Detrick & Harvey Machine Co., Baltimore, Md. Heavy drilling, boring and milling machine of the horizontal type, having a box-shaped runway on which a large vertical column is mounted. The latter has a traverse of 168 inches and the saddle a vertical movement of 144 inches. Power for traversing the column and saddle is obtained from a 7½-horsepower motor, and the spindle is driven by a 20-horsepower motor.

Drilling Machine Vise: Easton Tool & Machine Co., Easton, Pa. Vise for use on table of drilling machine. The front jaw has a travel of 3½ inches and the rear jaw can be turned to present different sides to the clamping or front jaw. One side of the rear jaw corresponds to the clamping jaw; another side serves as an angle-plate, and the two remaining sides are provided with V-grooves for holding cylindrical work, one groove being vertical and the other horizontal.

Bevel Gear Shaper: Browning Engineering Co., Cleveland, Ohio. Automatic bevel gear shaper having a revolving templet which gives the proper shape to the teeth, so that epicycloidal, involute or any special form of tooth can be cut by providing the proper templet. Twenty-five templets are supplied with the machine. When the shaper is in operation two tools plane opposite sides of the same tooth, alternately, and a gear is finished complete in one revolution of the blank.

Automatic Bevel Gear Shaper: Fred Mill, 622 William Ave., Detroit, Mich. When this shaper is in operation, cuts are taken from first one tooth and then the next, and so on around the blank. The arbor bearing is then moved on its horizontal axis to give a new depth of cut, and the teeth are planed successively as before. This operation is repeated until the teeth are formed to the required depth. The tool is relieved on the backward stroke and all movements are automatic.

Spring Coiling Machine: F. H. Sleeper, 12 Shafner St., Worcester, Mass. Universal coil-making machine which will

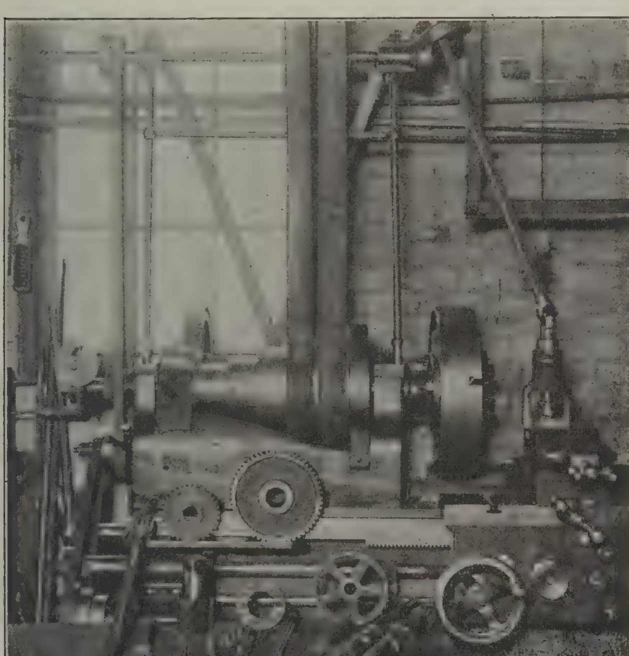
coil and cut springs of various shapes, and has a capacity for diameters varying from ¼ to 2 inches. The wire enters the machine between rolls and it is pushed through guides to the coiling and cutting-off mechanism. The rolls have two grooves for receiving either large or small stock. On the main shaft of the machine there are three cams; one of these varies the diameter of the coil, another gives the pitch or opening between the coils, and the third is for cutting off. The output of this machine varies from 35 to 100 springs per minute.

Inverted Spindle Drilling Machines: Foote-Burt Co., Cleveland, Ohio. One machine is a special design for drilling oil holes ¼ inch in diameter and 8 inches long. It is a 4-spindle inverted type, the spindles projecting through the table and the work being held in the upper heads. When drilling, the heads are fed downward either by hand or power. This company has also built two other machines of the inverted type, each of which has six spindles. One is designed for machining 6-cylinder automobile engine castings, and the other is for drilling long oil holes in cast-iron belt conveyor brackets. One of the advantages of this inverted construction is the absence of overhang and the ease with which chips may be disposed of.

* * *

LATHE MILLING ATTACHMENT

The Haase Machine Works, 411 Fifth Ave., So., Minneapolis, Minn., is manufacturing an attachment for converting a lathe into a milling machine, whenever milling operations can be performed to advantage in connection with turning. This attachment is shown applied to a lathe, in the accompanying illustration. The milling spindle is vertical and is carried by a housing clamped to the toolpost. The drive to the spindle is through a square, universal-jointed shaft connecting through gearing with an overhead countershaft, which, in turn, is driven by a belt from the headstock cone. The feeding movement for the milling cutter is also obtained from the overhead countershaft, which connects by belt with the regular carriage feeding mechanism, as the illustration shows.

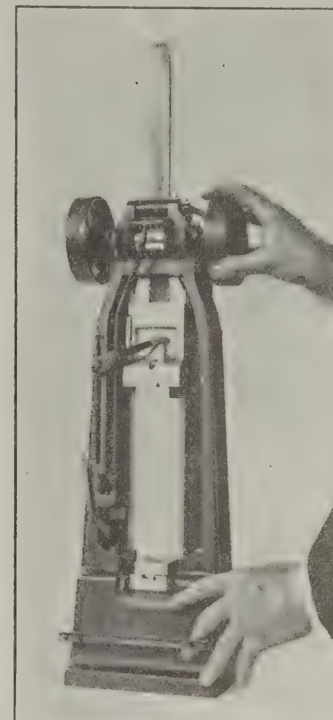


Haase Lathe Milling Attachment

This attachment is intended for cutting teeth in spur and bevel gears, fluting taps and reamers, splining, etc. When the lathe is to be used for milling, the cone pulley is disengaged from the face-gear, so that the spindle remains stationary. The spindle is indexed for gear cutting, fluting, etc., by the index-plate and worm-gearing seen attached to the left-hand end of the spindle. This indexing mechanism is held stationary by the yoke extending from the lathe, and it is expanded in the end of the hollow spindle by a bolt which holds it in position. The overhead driving mechanism for this attachment does not interfere with the regular operation of the lathe, and it can be attached without drilling any holes. The countershaft has, in addition to the two vertical supports, diagonal braces at the rear, which are attached to the back-gear spindle. Some examples of the work done by this milling attachment are shown in front of the lathe in the illustration.

DROP-HAMMER MODEL FOR SALESMEN

When selling or attempting to sell any machine or tool, it is often difficult to make a prospective customer fully appreciate the good points of the design by a verbal description, even though photographs and drawings are used for illustrating the noteworthy features. The Billings & Spencer Co. has adopted a novel plan of using a model in connection with the selling of drop-hammers, for demonstrating the advantages. This miniature drop-hammer, which is illustrated in the accompanying illustration is an exact duplicate of the 3000-pound hammer built by this company. The model only weighs sixteen pounds, whereas the large hammer has a base weighing approximately 5000 pounds and has a height of about twenty feet. This working model is shown to every prospective customer called upon, and it enables the salesman to back up his claims in a very forceful way.



Miniature Drop-hammer used by Billings & Spencer Salesmen

The Billings & Spencer Co. also uses one of these models in the plant at Hartford for instructing new workmen in the proper operation of drop-hammers. This makes it unnecessary to use a large hammer for purposes of instruction.

* * *

PORTABLE MOTOR OUTFIT

The portable motor outfit shown herewith is used in a printing press manufacturing plant for testing presses on the assembling floor. The motor is carried on a four-wheeled truck so that it can be moved about easily, and the starter is mounted on top of the motor, which makes a very compact arrangement.

Reliance Adjustable-speed Motor and Starter mounted on Truck for Testing Printing Presses

A 7½-horsepower Reliance adjustable-speed motor of the armature-shifting type, is used. The motor has a speed range of from 470 to 1880 revolutions per minute, and, in addition, the starter is provided with a special heavy resistance which gives a further speed reduction of 50 per cent for very slow speeds. The main line switch and fuses are mounted on the rear of

the starter. An insulated cable of any desired length may be used for connecting the motor to line plugs at different points about the shop. A similar outfit in another printing press plant is equipped with a flexible shaft and is used for certain boring, drilling and facing operations which can be done to better advantage while the press is being assembled.

* * *

BAR AND CHUCK WORK IN CLEVELAND AUTOMATICS

Automatic and semi-automatic machines are employed at the present time for doing such a large variety of work that a study of the tool equipment used in the production of different machine parts should be of value to the designer and shop man, as well as educational to the builder who is interested in economical manufacturing methods. Fig. 1 of the accompanying illustrations shows three interesting examples of work recently done on some of the machines built by the Cleveland Automatic Machine Co., Cleveland, Ohio.

Sectional and end views of a phosphor-bronze bearing for a gas engine are shown at *A*, and Figs. 2 and 3 illustrate the method of turning this part in a standard model turret machine, which is fitted with a tilting magazine attachment. The part is finished in two operations. The rough castings are taken from the magazine and placed in the chuck by means of conveyer *B*. Fig. 2 shows the position of the turret just after the conveyor has received the casting from the magazine, and Fig. 3 shows the conveyor after it has been indexed in line with the chuck.

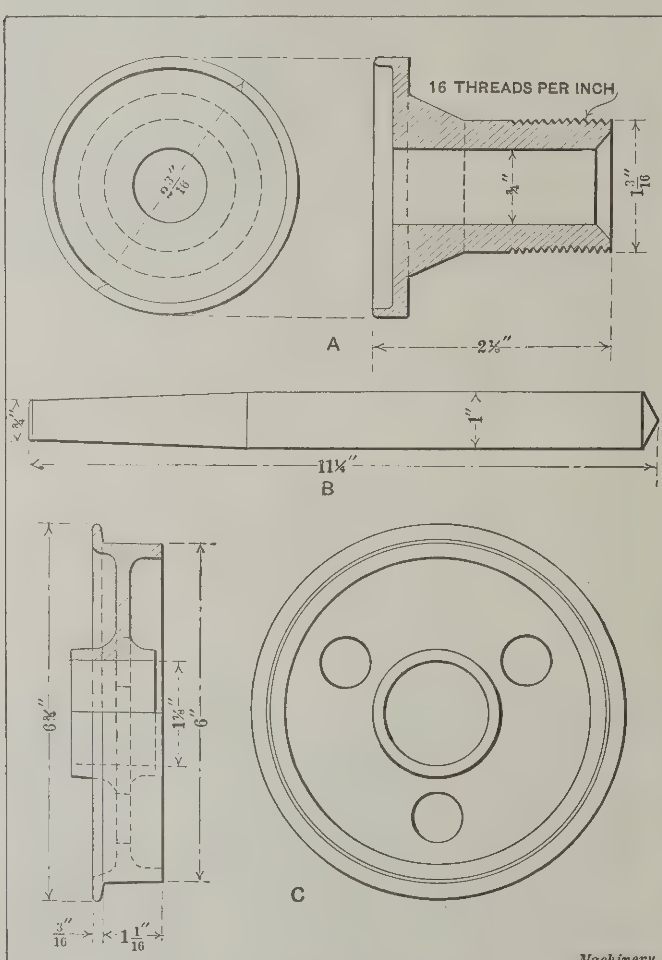


Fig 1. (A) Phosphor-bronze Bearing. (B) High-speed Steel Drill Blank (C) Cast-iron Flanged Wheel

The end of the casting is faced and the hole drilled and chamfered by the tools shown at *C*, which include a three-fluted drill, a chamfering tool for the mouth of the hole and a facing tool for the end. The center turning tool *D* carries a cutter for roughing the taper part next to the flange (see Fig 1), and there is also a cutter for roughing the straight part and a chamfering tool for the corners. These outside roughing operations are performed at the same time that the tools at *C* are in operation, so that six tools are working simultaneously.

Tool *E*, mounted on the tool-block at the rear of the cross-slide, finishes the taper part next to the flange and also the side of the flange. The boring tool *F*, which is mounted in an adjustable tool-holder in the turret, next comes into operation, after which the hole is accurately finished by a floating reamer *G*. While the reaming operation takes place, an overhanging tool which is mounted in the same holder with the reamer finishes the outside diameter of the flange.

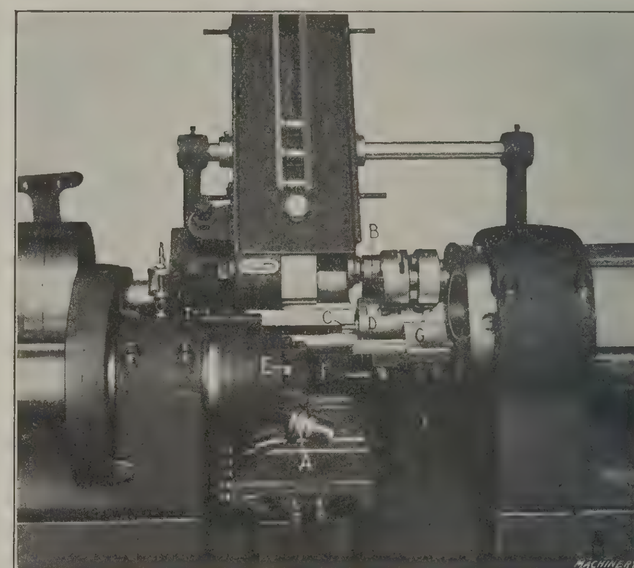


Fig. 2. Cleveland Standard Model Turret Machine equipped with Magazine for Turning Part shown at A, Fig. 1

The thread on the end of the casting is cut by a button die. At the time the thread is being cut the peripheral speed of the work is 59 feet per minute, whereas the speed while the other tools are in operation is 90 feet per minute. This completes the first operation, which requires 2 minutes and 30 seconds.

The second operation is that of recessing the flanged end (see Fig. 1). This work is done on the same machine and with the same magazine, but there is a cross-slide tool held in the turret for finishing the flange and counterbore. The second operation requires 50 seconds, so that the casting is finished complete in 3 minutes and 20 seconds. The rough casting weighs 17 ounces, and the finished piece 9 ounces. The principal dimensions are given in Fig. 1.

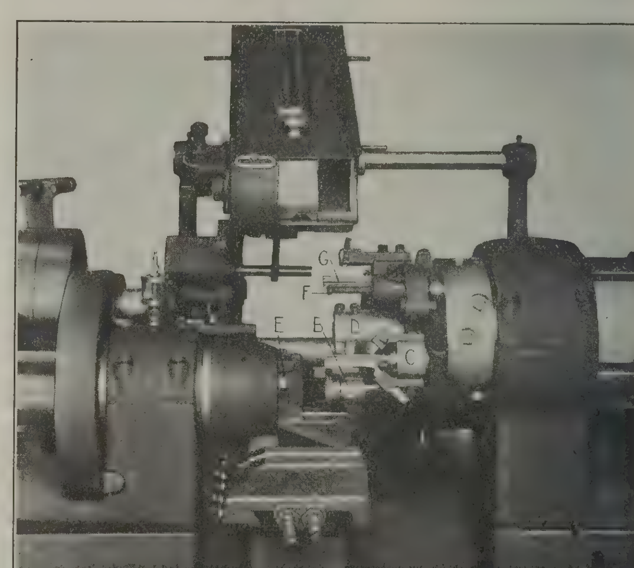


Fig. 3. Conveyor in Position to insert Rough Casting in Chuck

Another example of work done on the automatic is shown at *B*, Fig. 1. This is a high-speed steel drill blank which is finished in 6 minutes 35 seconds. It is 1 inch in diameter, 11¼ inches long and has a No. 3 Morse taper shank. The machine used for this work is a regular plain screw machine which is

cammed double, one drum being used to operate the box turning tool, and the other the longitudinal slide and tool for turning the taper shank.

The bar stock is fed through the spindle against a swinging gage stop; then a roller-rest box-tool *A* (Fig. 4) which is mounted on the tailstock spindle, advances and starts turning the body of the drill blank. On the front cross-slide there is another slide *B* which moves in a longitudinal direction and is set at an angle for turning the taper shank of the drill blank. This slide is operated by the cams *H* and *I* on the large cam drum. These cams control the movement of a sliding guide *D*, which moves independently upon the tailstock spindle and connects with slide *B* by connecting-bar *C*. The tool which turns the taper shank of the drill is shown at *E*. This tool and the box-tool for turning the straight part start and finish their cuts at the same time. The taper shank is considerably shorter than the straight part of the drill blank, so that a slower feed can be used, which is desirable owing to the gradual increase in the depth of the cut. The slide *B* is adjustable so that it can be set for different tapers.

At the rear of the roller-rest box-tool *A* there is a holder carrying another set of steadying rolls and a tool *F* which finishes the point of the drill to the correct angle. A combination tool *G* on the rear of the cross-slide rough-turns the point of the next drill and breaks the corner of the taper shank end of the finished blank as the latter is being cut off. The actual labor cost for producing this drill blank is about 7 mills per blank.

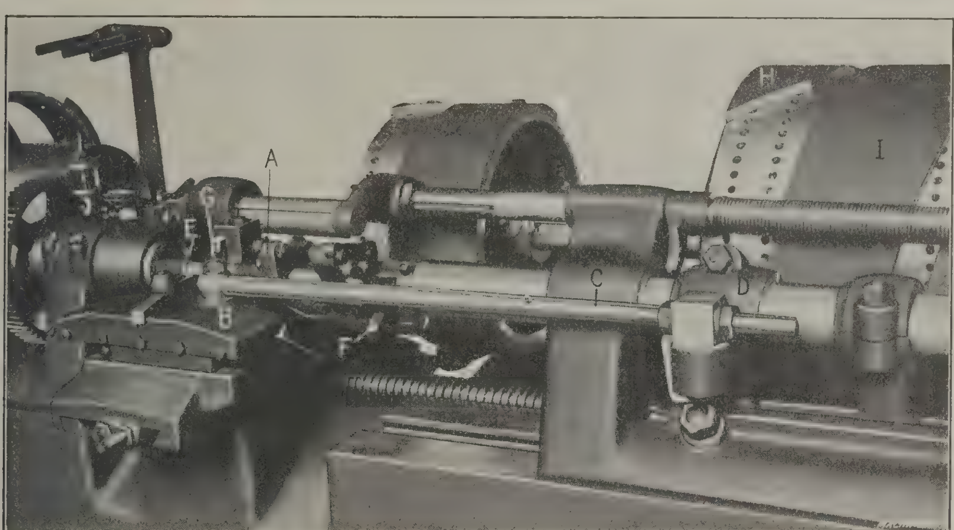


Fig. 4. Cleveland Plain Automatic fitted for Turning Drill Blanks

An example of chuck work is shown at *C*, Fig. 1. This is a cast-iron flanged wheel having a diameter of 6 inches. These wheels are turned in a standard-model, convertible automatic turret machine having a special equipment for this particular job, as illustrated in Fig. 5. The outside of the wheel is turned to within 0.0015 inch of the given size, and because of the accuracy required, a single-pointed tool is used instead of a forming tool, and two cuts are taken. The machine is fitted with a three-jaw universal chuck which has special jaws that engage the three cored holes in the web of the casting. The work is chucked by hand as in any ordinary chucking machine.

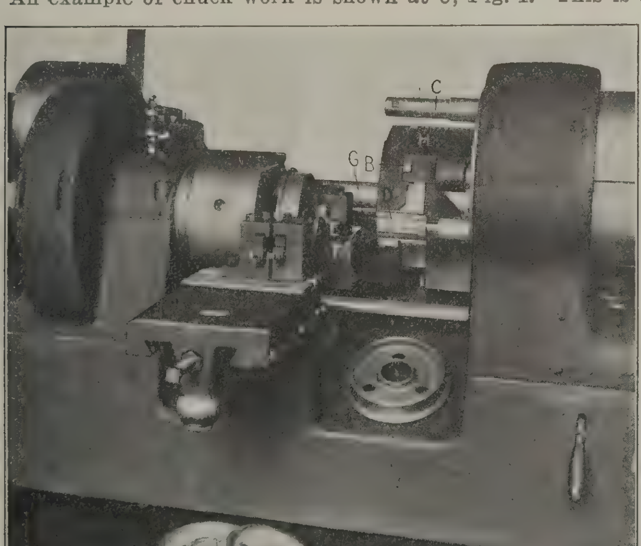


Fig. 5. Cleveland Convertible Automatic Turret Machine having Special Equipment for Turning Flanged Wheel C, Fig. 1

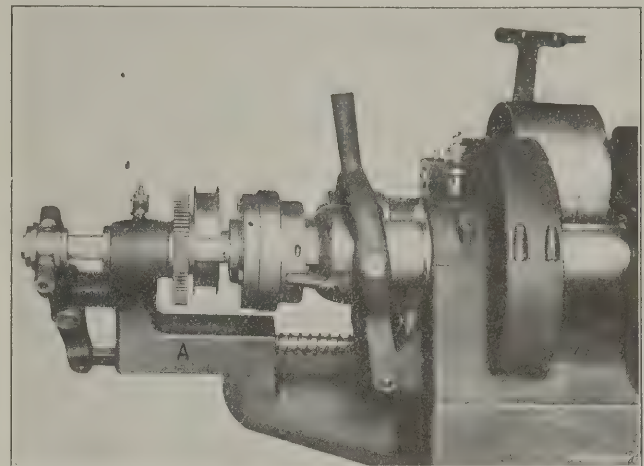


Fig. 6. Driving Mechanism for Boring and Back-facing Attachment

There is a boring and back facing attachment having an independent drive mounted at the left-hand end of the spindle head. The rear end of this bar and the driving mechanism are supported by a framework *A*, as illustrated in Fig. 6. The bar extends through the spindle and, in this particular case, carries a boring tool for roughing and a facing cutter which faces the rear end of the hub. At the same time, tool *B*, which is mounted in the turret, rough-faces the front end of the hub, and a tool on the rear cross-slide rough-turns the outside diameter of the wheel and also the top of the flange, so that five tools are working simultaneously at this time. The outside of the wheel has a peripheral speed of 50 feet per minute, and the boring cutter is operated at the rate of 80 feet per minute by the independent driving mechanism previously referred to. By changing the driving pulley on the countershaft, the speed of the bar can be varied to suit different classes of work.

The next tools which come into operation are the two held in bar *C*, which is mounted in the turret. These are finish-boring and facing cutters. While these cuts are being taken, the spindle speed is increased to give a peripheral speed inside the hole of 80 feet per minute. After the finish-boring cut is taken, the speed is reduced to 50 feet per minute on the outside diameter. The hole is then accurately sized by reamer *D*, and the tread of the wheel is finished by tool *E* on the rear cross-slide. The flange of the wheel is finished by one of the two tools mounted on the front cross-slide, while the other faces the rim of the wheel.

The tools on the rear cross-slide move in a longitudinal direction, and the slide upon which the rear tool-block is mounted can be seen at *F*. The longitudinal movement is obtained by cam drum *H* which imparts motion to the slide through connecting-bar *G*. A bell and stop-motion attachment stops the machine after each piece is completed. One of these castings is finished in 3 minutes 45 seconds. This operation shows the adaptability of this machine for chucking operations, as well as for handling bar work of various kinds.

* * *

Always have all bearing surfaces for nuts or heads of cap-screws spot-faced.

THE ABILITY OF BILL

By A. P. PRESS

Bill came in to see us the other day. Bill was one of our apprentice boys five years ago, and he was noted more for what he didn't do than for what he really accomplished—not but that his ability to turn off work was good enough, but his inherited ability to get clear of doing it was greater still. So putting the two together his abilities seemed to be largely of the last described order.

When Bill came in looking pretty prosperous, and seated himself in the best chair in the office, and took out a fat cigar with a gold band around it, and offered us one of the same brand, we knew that we were right.

"Yes," said Bill, as he got warmed up a little, "I was down to Baltimore one day last week, and as I was strolling around, I wandered into a big machine shop, that had just gone into the assignees' hands. The auctioneer was showing off the machinery in the usual manner, and, of course, I was interested. I did not have any money, but I had on a good suit of clothes, good friends, and a pocket full of these same cigars (which, by the way, are some that my wife gave me at Christmas), pretty good aren't they?

"I was inspecting a big boring mill which was a fine machine, when I noticed a little bunch of buyers over in the corner. When I had sized up the mill, and some of the other large tools pretty well, one of the bunch came over to me."

"Say, Mister, are you interested in this outfit?"

"Sure I am."

"Well, how high do you think you could go?"

"The sky is my limit."

"Now say, stranger, we are making up a little pool on this to buy the whole shop. Do you want to come in?"

"No, I think I had better stick by my lonesome."

"Now see here, that's going to queer the whole thing. What will you take to keep out?"

"Well, I have come quite a ways. I don't like to go home with an empty pocket. What is it worth to you?"

He went back and the bunch got together and back he came.

"Now then if you will keep out of it entirely we will give you an even $500."

"Yes, $500 is all right, but it looks to me as though there was more than $500 in it. Is that cash?"

"No, we will have to give you a check."

"I don't seem to see that. Make it $500 cash and it is a bargain."

Back he went and there was a great taking out of pocketbooks for a few minutes, and then he came back.

"We have got just $450. If you will take it we will make it cash."

"And take it I did," said Bill, "and that is where these good clothes came from, and the vacation too."

Bill has gone, although the flavor of that cigar still lingers in the office, and our opinion of Bill is that he will be noted all his life, not for the things he does, but for the things that others think he is going to do.

And there are others.

* * *

In a paper entitled "The Effect of the Relation of Stroke and Bore in Automobile Engines," presented by Mr. John Wilkinson, before the summer meeting of the Society of Automobile Engineers, at Detroit, June 27-29, 1912, the author stated that as a pure thermal question there is no apparent reason why the stroke to bore ratio cannot be carried up to and even exceed a ratio of 2. In the mechanical design, however, difficulties begin to appear when the ratio exceeds 1.33, and when the ratio exceeds 1.5 the objections become so strong that there appear to be no compensating features for the increase in weight and expense. An excessively long stroke involves too much weight in the valve mechanism. It might, therefore, be fair, according to the author, in placing general limits on the stroke to bore ratio, to say that it is limited in one direction to 1 by the cooling limit of the piston, and in the other direction to 1.5 by the limits of mechanical adaptability.

COLORING ALUMINUM

A process for coloring aluminum is described in the *Brass World*. This process has been patented by S. Axelrod of Oberschoneweide, Germany. It consists in treating the aluminum surfaces with a solution of cobalt nitrate and then heating the object. The heat changes the color of the surface, and gradations ranging all the way from steel gray to brown and finally black may be obtained, according to the temperature to which the article is heated. The salts should be either neutral or alkaline. The aluminum article is dipped in the salt solution, or the solution may be applied with a brush, the salt having been dissolved in water previous to application. The exact temperature to be used is not stated, but it is rather low, as aluminum melts at a comparatively low heat. It is stated that the colors thus produced will not rub or scale off, and that they are permanent. The inventor also claims that zinc, tin and other metals may be colored by cobalt nitrate or other cobalt salts in the same manner.

* * *

During the first week in August, the centenary of the great Krupp works at Essen, Germany, will be celebrated. The celebration will be attended by the Emperor and many other German rulers, military officers, admirals and civil officials. The festivities will be largely military in nature in order to give emphasis to the important part that the Krupp works have played in military and naval armaments. One feature will be a series of sham battles. Men armed with weapons of the era of the Emperor Maximilian will fight with an army equipped with modern rifles and artillery.

* * *

PERSONALS

John Bath, designer of the Bath grinder and formerly manager of the Bath Grinder Co., Fitchburg, Mass., has been made sales manager of the Reed-Prentice Co., Worcester, Mass.

Robert H. Lasch has resigned his position of chairman and managing director of the Selson Engineering Co., Ltd., London, England, and Mr. Henry M. Sonnenthal has been appointed in his place.

Ira J. Peat has resigned as assistant foreman of the Simplex Time Recorder Co., Gardner, Mass., to take the position of general superintendent of the Long Mailing Machinery Co., of Minneapolis, Minn.

Edward Rivett of the Rivett Lathe Mfg. Co., Boston, Mass., who sailed for Europe in June, will return in October to resume his duties as president of the reorganized company now known as the Rivett Lathe & Grinder Co.

H. A. S. Howarth, a valued contributor to MACHINERY, who for the past year has been assistant professor of mechanical engineering of the Lehigh University, South Bethlehem, Pa., has been appointed assistant professor of machine design at the Carnegie Technical Schools, Pittsburg, Pa.

Edwin Rust Douglas, mechanical and electrical engineer, has resigned the position of works manager of the Hero Mfg. Co., Philadelphia, Pa., and is now acting as consulting engineer with that company and with David Lupton's Sons Co., and S. L. Allen & Co., all of Philadelphia. Mr. Douglas will be able to serve others also, to a limited extent, in problems concerning manufacturing and factory organization.

Joseph E. Martin, formerly in charge of the estimating and boring mill department of the Bullard Machine Tool Co., Bridgeport, Conn., has resigned his position to take that of superintendent of the Foster Engineering Co., Newark, N. J. Mr. Martin was with the Bullard Machine Tool Co. for eight years. His friends in Bridgeport and associates in the Society of Mechanical Foremen, of which he was president, gave him a farewell reception.

Gilbert H. Pearsall has been made vice-president of the Jacobs-Shupert U. S. Firebox Co., and will be in charge of the Eastern sales office of that company with headquarters at Room 732, 30 Church St., New York City. Mr. Pearsall will retain his position as secretary of Joseph T. Ryerson & Son with which concern he has been identified since May, 1901. He has been in general charge of the sales of the Ryerson company since January 1, 1905. Prior to that connection he held positions in the traffic and transportation departments of several railway companies.

Charles B. Moore has resigned as vice-president of the American Arch Co., and has been elected vice-president of the Jacobs-Shupert U. S. Firebox Co. Mr. Moore will be in charge of the Western sales department of the company with offices in the Railway Exchange Bldg., Chicago, Ill. Mr. Moore organized the Columbia Boiler Co. in 1900 for the

purpose of manufacturing house heating apparatus and boilers. In 1902 he organized the American Locomotive Equipment Co., and was general manager and a director of that company until 1911, when he was elected its president. He assisted in the organization of the American Arch Co. in 1910 and was elected vice-president and a director of that company in 1911. He also organized the Boss Nut Co., of which he is a director. Mr. Moore is the inventor of a number of locomotive devices, the best known of which are his locomotive brick arches.

* * *

COMING EVENTS

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 9-11.—Ninety-third meeting of the National Association of Cotton Manufacturers at the Griswold, Eastern Point, New London, Conn. C. J. H. Woodbury, secretary, Boston, Mass.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

September 30-October 4.—Autumn meeting of the Iron and Steel Institute at Leeds, England. G. C. Lloyd, secretary, 28 Victoria St., London.

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association. Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Upper Iowa University, Fayette, Iowa. Catalogue for **1911-1912**.

University of New Mexico, Albuquerque, N. M. Catalogue 1911-1912, and announcements for 1912-1913.

Working Men's College, Melbourne, Australia. Prospectus for 1912. Frederick A. Campbell, director.

Louisiana State University, Baton Rouge, La. Catalogue for 1911-1912, and announcements for 1912-1913.

New Mexico School of Mines, Socorro, N. M. Annual Register for 1911-1912 with announcements for 1912-1913.

Delaware College, Newark, Del. Catalogue of the officers and students for the year 1911-1912, and announcements for the year 1912-1913.

University of Utah, Salt Lake City, Utah. Catalogue of students for 1911-1912 and announcements for 1912-1913 in the schools of arts and sciences, education, mines and medicine.

Iowa State College of Agricultural and Mechanic Arts, Ames, Iowa. Directory of graduates of the division of engineering, giving the individual records of between 1100 and 1200 graduates.

NEW BOOKS AND PAMPHLETS

The Polytechnic Engineer. Volume XII, 1912. 129 pages, 6 by 9 inches. Published by the undergraduates of the Polytechnic Institute of Brooklyn.

Personal Efficiency. By Charles Frederick Loweth. 16 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 5 of the College of Engineering Series.

Organization in Engineering. By Henry Marison Byllesby. 14 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 4 of the College of Engineering Series.

Molding Concrete Fountains and Lawn Ornaments. By A. A. Houghton. 56 pages, 5 by 7⅜ inches. 14 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

Molding Concrete Flower Pots, Boxes, Jardinieres, etc. By A. A. Houghton. 52 pages, 5 by 7¾ inches. 7 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

Report of the Commissioner of Education for the Year ended June 30, 1911. Vol. I. 675 pages, 6 by 9 inches. Published by the Bureau of Education of the United States, Washington, D. C.

A Rapid Method for the Determination of Vanadium in Steels, Ores, etc. Published by the Department of Commerce and Labor, Washington, D. C., as No. 8 of the Technologic Papers of the Bureau of Standards.

On the Measurement and Division of Water. By L. G. Carpenter. 48 pages, 6 by 9 inches. Illustrated. Published by the Agricultural Experiment Station of the Colorado Agricultural College, Fort Collins, Col., as Bulletin No. 150.

Conference Committee Methods in Handling Railway Legislation on Mechanical Matters. By Charles Arthur Seley. 15 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 2 of the College of Engineering Series.

A New Analysis of the Cylinder Performance of Reciprocating Engines. By Paul Clayton. 104 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 58.

The Strength of Reinforced Concrete Beams; Results of Tests of 333 Beams. By Richard L. Humphrey and Louis H. Losse. Published by the Department of Commerce and Labor, Washington, D. C., as No. 2 of the Technologic Papers of the Bureau of Standards.

The Effect of Added Fatty and Other Oils Upon the Carbonization of Mineral Lubricating Oils. By C. E. Waters. Published by the Department of Commerce and Labor of Washington, D. C., as No. 4 of the Technologic Papers of the Bureau of Standards.

Tests of the Absorptive and Permeable Properties of Portland Cement, Mortars and Concrete, together with Tests of Damp-Proofing and Water-Proofing Compounds and Materials. By Rudolph J. Wig and P. H. Bates. Published by the Department of Commerce and Labor, Washington, D. C., as No. 3 of the Technologic Papers of the Bureau of Standards.

Lectures Delivered at the Centenary Celebration of the First Commercial Gas Company, to sell Gas as an Illuminant. 174 pages, 6 by 9 inches. Illustrated. Published by the American Gas Institute, 29 W. 39th St., New York.

This interesting series of lectures is prefaced with the chronology of the development of gas lighting, beginning 1450 B. C. The importance of gas as an illuminant and fuel, and the growing importance of producer gas in the industrial field, makes this series of lectures of historical and commercial value.

Analysis of Metallurgical and Engineering Materials. By Henry Wysor. 82 pages, 8½ by 10½ inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $2.

This manual, which is the outcome of an effort to raise the efficiency of the students' work in the laboratory, is a systematic arrangement of laboratory methods, compiled by the assistant professor of analytical chemistry and metallurgy in Lafayette College. Each page of text is accompanied by a blank page for the insertion of notes and data by the user. The condensed, step-by-step directions for making analyses should be appreciated by all chemists and students of chemistry.

The Effects of Cold Weather upon Train Resistance and Tonnage Rating. By Edward C. Schmidt and F. W. Marquis. 24 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 59.

The bulletin presents the results of tests made to determine the amount of increase in train resistance in cold weather, and the tests show that even in moderately cold weather there is a very definite increase in train resistance over the resistance which prevails at air temperatures above 30 to 40 degrees F. This increased resistance is chiefly due to the lower temperatures of the car journals, and the tests show that the temperature rises very slowly, requiring twelve to fifteen miles travel from the starting point before the resistance has reached its minimum value.

Modern Illumination, Theory and Practice. By Henry C. Horstman and Victor H. Tousley. 273 pages, 4⅝ by 6¾ inches. Published by Frederick J. Drake & Co., Michigan Ave., Chicago, Ill. Price $2.

This is a handbook of practical information for users of electric light, contractors, electricians, etc. It treats of light, principles of vision, reflection, refraction and diffusion, photometry, calculation of flux from photometric curves, illumination calculations, characteristics of electric illuminants, shades and reflectors, location and height of lamps, color of light, choice of lamps, choice of fixtures, indirect lighting, practical considerations, table of intensities in foot candle for various classes of service, plans and specifications, illumination tables, incandescent light wiring and other tables, glossary of terms and phrases, etc.

Engineering Valuation of Public Utilities and Factories. By Horatio A. Foster. 345 pages, 6 by 9 inches. Published by D. Van Nostrand Co., New York. Price, $3 net.

The demand for information regarding the valuation of public utilities has been growing rapidly during the last few years mainly because, with the increase in supervision of public utilities by commissions which require valuations of properties when permission is asked to change rates or to add to securities for any purpose, engineers have extended their field of activity to include problems of ratemaking. This fact and the public demand that corporations shall receive a fair return on the fair value only of their properties, make it important that those in charge of appraisals shall be familiar with the elements which courts and commissions will consider in passing upon the merits of a valuation. The investigation leading to a decision as to a satisfactory schedule of rates requires the services of a technical expert. Mr. Foster, who has been extensively engaged in appraisals, has produced an excellent work on a subject which is now of broad public importance. After a short discussion of "value," the purposes of its determination, and the directions for obtaining it, an important court opinion by Judge Savage of Maine is given in full, as embodying the best instructions for valuation yet pronounced. An excellent feature of the book is the compilation of forms to be used in making an appraisal, and there are included also extended depreciation tables at various percentages and for various terms of usefulness, which will be found of much service in making valuations. After a short chapter devoted to the cost of appraising a property, the value of "good will" and "going concern value" are defined and discussed, and the opinions of commissions, courts, and individuals are given at some length. Considerable space is devoted to the subject of depreciation, which, like the author's treatment of "intangible value," contains a number of original views. The chapters on amortization, handling of depreciation, and appreciation are interesting. The study of the court decisions as to franchises should go far toward elucidating this complex subject. A clear discussion of capitalization and the control of public utilities follows, and the book closes with copies of some of the decisions of the courts and the syllabuses of a large number of others. In one volume are thus brought together the gist of virtually all important rulings bearing on the subject of valuations, so that not only the engineer but the layman may learn their application in any given case. Mr. Foster's work is distinctly of value.

The Human Factor in Works Management. By James Hartness. 159 pages, 6 by 9 inches. Published by McGraw-Hill Book Co., New York. Price $1.50 net.

The views on works management of a manufacturer who is a mechanic and inventor, and the president of a well-known and highly successful concern would attract attention, and when those views are on the neglected human factor element, they become extraordinarily interesting. This work by Mr. Hartness sets forth some of the essential principles of industrial economics as represented by his experience and that of many who regard some of the theories of scientific management laid down by its leading exponents with doubt and misgivings. In the discussion of habit the idea is brought out that success depends more on the man than the plan, and that systems are but a means and not the end. Repetition forms habit, and is necessary for success. Contrary to the popular idea, repetition does not degrade, but simplifies and makes work easy. The mere size of an organization does not give it strength; but whether the organization is large or small the advantage lies with that one in which each operation is repeated the most times per individual. Skill is due to continued application. A lathe hand does the most and best work with his own lathe and tools under the conditions with which he has become familiar. But there are all kinds of minds, and not all have the same ambitions and aspirations. There is often lack of sympathy and understanding between those who would lift the masses to what they conceive to be a better plane of thought and living. Inertia of habit and consequent dislike of change of methods is characteristic of workers generally. When the conditions of work are such that methods must be continually changed, inefficiency results. The notorious inefficiency of plumbers on repair work is attributed by the author largely to the strange surroundings of each job and the new conditions that must be met. To make a business pay in the long run, it must be conducted so as to build up those conditions most conducive to the well-being of the workers as a whole; hence the folly of trying to "make a business pay" from the financial side alone. Space will not permit quoting or paraphrasing many more interesting statements bearing on the human factor element in business. The chapters "Some of the Non-Technical Phases of Machine Design" and "Machine Building for Profit." deal with some of the intangibilities of manufacturing. Courage to

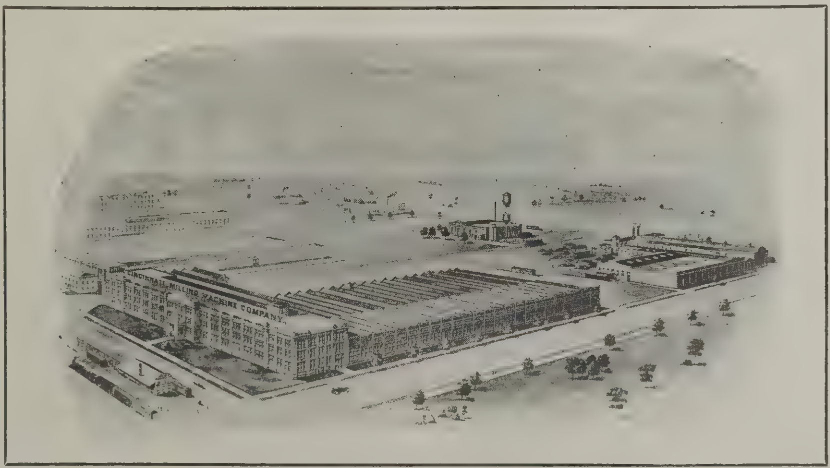
COME AND SEE OUR NEW PLANT

SOME OF OUR VISITORS

This is part of a group of Superintendents and Foremen who made a trip from Chicago especially to see our new plant. When are you coming? It will pay you to visit us, because you will see one of the most up-to-date machine tool plants in the world. It contains more than 6¼ acres of floor space. The buildings have all been constructed to provide as nearly as possible ideal conditions as to lighting, heating, ventilation, sanitation and the routing of materials. We would like to show you how we accomplish these things.

Our equipment includes many special machines for individual operations requiring a high degree of accuracy and special devices for manufacturing in large quantities. Our advanced foundry practice produces iron castings of the highest quality for the service required of each important part of our machines.

These are some of the things that make it possible for us to supply you with Milling Machines of the highest quality in all particulars.



THE PLANT DRAWN TO AN EXACT SCALE

The Cincinnati Milling Machine Company

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester. Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Ayres.

discard is as desirable as courage to accept and use. The hero of the drafting-board is the one not afraid to use the eraser, and the hero manufacturer is he who sticks to one thing and makes it successful. The weakness of many concerns and a prolific cause of failure is a constantly changing policy and product. The tendency of individuals to be jacks-of-all-trades is exemplified by manufacturers who will not concentrate on one line long enough to become proficient in its production. "The manufacturer of a great variety of machines in response to a demand by the selling organization is a relic of other days", expresses the perception of the author. His own experience has amply demonstrated the value of developing a specialty and then sticking to it. The book is full of interest and value for manufacturers and students of industrial economics.

NEW CATALOGUES AND CIRCULARS

GREEN FUEL ECONOMIZER Co., Matteawan, N. Y. Catalogue No. 142 on the Green boiler economizers.

INTERNATIONAL GAS ENGINE Co., Cudahy, Wis. Catalogue No. 12 of "Ingeco" engines operating on gas, gasoline, oil and producer gas.

J. FAESSLER MFG. Co., Moberly, Mo. Bulletin No. 28 illustrating and describing "Faessler" safety sectional boiler tool expander with quick-acting knockout.

SANDERSON TOOL SALES Co., Brown Marx Bldg., Birmingham, Ala. Circular of Sanderson adjustable portable boring-bar for boring straight and taper holes.

C. W. HUNT Co., West New Brighton, N. Y. Catalogue No. 12-1 on industrial narrow gage railways for handling raw and finished materials in foundries, iron mills, power plants, factories, etc.

CHICAGO PNEUMATIC TOOL Co., 1010 Fisher Bldg., Chicago, Ill. Instruction booklet for operating the "Little Giant" car, containing directions for the operation of gasoline engines and motor cars.

WESTINGHOUSE ELECTRIC & MFG. Co., E. Pittsburg, Pa. Circulars 1516, on Baldwin-Westinghouse Electric Locomotives; 1155, on Series Arc Lighting Systems, with Westinghouse Cooper-Hewitt Rectifiers.

WATSON-STILLMAN Co., 192 Fulton St., New York. Catalogue No. 85 on hydro-pneumatic wheel presses, listing and describing over seventy variations in types and sizes of from 60 to 600 tons capacity.

ELECTRIC CONTROLLER & MFG. Co., Cleveland, Ohio. Bulletins 1022 on Automatic Motor Starters for Non-Reversing Direct-Current Motors; 1023, on Type A Knife Switches; and 1024, on Type MC Solenoids.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J. Booklet entitled "Painting the Smokestack," setting forth the qualities of Dixon's silica-graphite paint that meet the trying service demanded of a smokestack paint.

CROCKER-WHEELER Co., Ampere, N. J. Bulletin No. 151 on "Remek" distributing transformers. The bulletin is well printed on pebbled paper which brings out very clearly the characteristics of the halftone illustrations.

FORT WAYNE ENGINEERING & MFG. Co., Fort Wayne, Ind. Circular of Paul pumping machinery, air compressors, water supply systems, suction pressure systems, deep well pressure systems and pneumatic displacement systems.

BECKER MILLING MACHINE Co., Hyde Park, Mass. Catalogue of carbon and high-speed steel standard cutters, form cutters, hobs for spur and spiral gears, saws, shell end-mills, T-slot cutters, arbors, spring collets, inserted tooth cutters, etc.

FOSDICK MACHINE TOOL Co., Cincinnati, Ohio. Circular illustrating and describing new style 2½-foot and 3-foot National radial drills having back gears and tapping attachment, and adapted for belt, variable speed motor or constant speed motor drives.

F. B. SHUSTER Co., New Haven, Conn. Catalogue of automatic wire straightening and cutting machinery and sheet metal straightening and cutting machinery for straightening and cutting wire and sheet metal to exact lengths from the coil; elastic blow riveting machines; etc.

THOMAS H. DALLETT Co., York and 23rd Sts., Philadelphia, Pa. Bulletin No. 304 describing the Dallett pneumatic wood carving tools. These tools are useful in any branch of the woodworking industry where gouging, roughing and carving work of any description is being done in the usual manner with hand chisels.

AMERICAN VANADIUM Co., 325 Vanadium Bldg., Pittsburg, Pa. Pamphlet on vanadium steels and classification of heat-treatment with directions for application to iron and steel. This valuable treatise should be of great interest to all concerned with the use of steels required to withstand repeated shocks without crystallization.

MONTGOMERY & Co., 105-107 Fulton St., New York. Price list of Grobet Swiss files, illustrated. These are the original Swiss files made by F. L. Grobet, the business of which was originated over 100 years ago. The catalogue shows a large variety of toolmakers' files, and should be in the hands of everyone ordering fine files.

LAMSON CONSOLIDATED STORE SERVICE Co., Boston, Mass. Bulletins of pneumatic tubes, wire cash carriers, cable cash carriers, parcel carriers, message carriers, pickup carriers, sweep-off carriers, selective carriers, tray conveyors, library conveyors, mail conveyors, belt conveyors, special conveyors, small lifts, and light elevators.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletins 4953, Large Shell Type Transformers; 4959, The Electrical Operation of Railroad Shops; 4960, Lightning Arresters for Electric Railways; 4962, Electric Power in the Lumber Industry; 4963, Small Direct and Alternating Current Motors Drawn Shell Type; and 4966, Hydro-Electric Power Development.

INDUSTRIAL INSTRUMENT Co., Foxboro, Mass. Bulletin No. 65, of Foxboro improved recording gages, listing nearly 2000 ranges in three sizes covering all purposes and pressures from full vacuum to 10,000 pounds per square inch. Lists are arranged to facilitate quick and easy selection of instruments, and each instrument is assigned a code word for convenience in identification.

UNITED STEEL Co., Canton, Ohio. Booklet on vanadium steel, giving the results of tests on chrome-vanadium steel, demonstrating that this steel has unusually valuable properties. Illustrations show the results of tests on springs, gears, axles, bars, etc. The company is a pioneer in the manufacture of chrome-vanadium steel, and has specialized in its production ever since its introduction.

VANADIUM-ALLOYS STEEL Co., Latrobe, Pa. Booklet on vanadium steel for all purposes, giving characteristics of "Red-cut" high-speed steels; price list of "Red-cut" disks suitable for milling cutters, and information on "Vasco" special steel, etc. The general effect of vanadium on steel is discussed, and, altogether, the booklet will be found of much interest to users of steels.

KELLY REAMER Co., 1547-65 Columbus Road, Cleveland, Ohio. Catalogue of Kelly adjustable reamers, with high-speed steel blades, for boring automobile cylinders, connecting-rods, jigs and all holes requiring accuracy and smoothness of finish. The Kelly reamer has floating cutters which compensate for errors of alignment by "floating" to the center of holes previously bored true.

WATSON-STILLMAN Co., 192 Fulton St., New York. Catalogue No. 86 on the Chambersburg throttle valve, which is claimed to be superior to the ordinary throttle valve in the following particulars: single seat; regrind without removal; no lost motion; internal boiler inspection without removal; provision of inlet for steam at highest point in dome; perfect balance; easy operation; screw or lever control.

FORT WAYNE ELECTRIC WORKS OF GENERAL ELECTRIC Co., 1616 Broadway, Fort Wayne, Ind. Bulletins 1140, on Single-Phase Repulsion Induction Motors, Type SR; 1137, on Belt-Driven Revolving Field Alternators, Form B; 1136, Direct-Connected Type MPL Direct-Current Generators; 1139, on Motor Drives; also instruction book No. 3053 on Multi-Phase Revolving Field AC Generators and Belted Exciters.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J. Circular on graphite products comprising flake graphite, heavy graphite, machine greases, waterproof graphite grease, "Graphitoleo," "Everlasting" axle grease, pipe joint compound, traction belt dressing and leather preservative, solid belt dressing, automobile lubricants, silica-graphite paint, stove cement, plumbago crucibles, graphite brushes for motors and generators, etc.

TREADWELL ENGINEERING Co., Easton, Pa. Colored card illustrating the coloring of patterns to indicate finished surfaces, rough surfaces and core prints. The standard colors adopted are those recommended at a joint meeting of the Steel Founders' Society and the American Society for Testing Materials, for use on patterns in steel foundries, and are: red for finished surfaces, yellow for rough surfaces, and black for core prints.

CURTIS & CURTIS Co., 8 Garden St., Bridgeport, Conn. Catalogue of Forbes patent pipe cutting and threading machinery for hand, belt, or electric power. The catalogue is a very complete production, giving full data on all of the many sizes and styles of portable machines built. The largest machine cuts off and threads pipe from 2½ to 12 inches diameter, and its approximate net weight is 3650 pounds, while the smallest is adapted for ¼-inch to 2-inch pipe, and weighs 155 pounds.

GOULD & EBERHARDT, Newark, N. J. Catalogue of high-duty shapers and attachments, illustrating details of construction and giving full data of 14-inch, 16-inch, 20-inch, 24-inch and 34-inch sizes. These shapers are regularly furnished with four-step cone pulleys and are also provided with electric motor drive for either direct or alternating current. A large variety of shaper attachments is illustrated, including tilting base for shaper vises, circular or cone mandrel, automatic vertical feed, traverse head, index centers, circular table, concave attachment, convex attachment, auxiliary front cross feed, etc.

NATIONAL TUBE Co., Frick Bldg., Pittsburg, Pa. Booklet entitled "The Modern Boiler Tube," containing the story of its evolution and development and some expert opinions on its efficiency. The booklet is a valuable contribution to the literature on boiler tubes, briefly tracing their development since the patent of Henry Osborn of Birmingham was granted in 1812 for the manufacture of gun barrels by bending wrought-iron plates over a circular and tapered mandrel and welding the heated metal under a tilt hammer. Illustrations show the tests applied by the National Tube Co. to boiler tubes, and the data of tests supplied by the American Society for Testing Materials are included.

TRADE NOTES

REED-PRENTICE Co., Worcester, Mass., requests manufacturers' catalogues for the Prentice Bros. department, 667 Cambridge St.

BLAKESLEE FORGING Co., Plantsville, Conn., is about to erect a three-story machine shop, 30 by 160 feet, and a forge shop 220 by 50 feet; also an annealing room 32 by 76 feet.

TATE-JONES & Co., INC., Empire Bldg., Pittsburg, Pa., report that orders were recently received for large oil burning furnaces from the Falls Hollow Staybolt Co., of Cuyahoga Falls, Ohio, and the Pennsylvania Steel Co., of Steelton, Pa.

TAYLOR IRON & STEEL Co., High Bridge, N. J., has opened an office in Pittsburg at 301 Oliver Bldg., in charge of Mr. James S. Morrison. The office was opened to meet the increased demand for manganese steel castings in Pittsburg and vicinity.

RHINELAND MACHINE WORKS Co., 140 W. 42nd St., New York, will open a place of business in Cologne or Frankfort, Germany, in the near future for the purpose of selling American machinery and tools and other manufactured products. The company is interested particularly in articles which will be used by manufacturers in general, and especially patented devices.

W. M. PATTISON SUPPLY Co., 197-211 St. Clair Ave., Cleveland, Ohio, has purchased the real estate, buildings, factory and power equipment of the Long Arm System Co., of Cleveland, manufacturers of automobile engines, transmissions, axles, gears, etc. The factory equipment consists of 205 machine tools, 10 furnaces, 21 motors and a large assortment of smaller tools which will probably be offered in lots to suit purchasers.

H. W. JOHNS-MANVILLE Co., Madison Ave. and 41st St., New York, has applied the J-N "Line-O-Lite" electric light lamps with much success to showcases in hardware stores, especially those containing machinists' tools, cutters and other tools requiring bright illumination to bring out their characteristics. The "Line-O-Lite" lamp is made in tubular form, twelve inches long, which shape makes it a good light distributor, yet easily concealed.

TATE-JONES & Co., INC., Pittsburg, Pa., report that the Massillon Bridge & Structural Co., Massillon, Ohio, has placed an order with them for a complete oil burning furnace equipment for a new plant. The placing of this order is the result of long-continued and satisfactory use of Tate-Jones & Co's. furnaces by some of the officers of the Massillon Co., while connected with another bridge plant for which Tate-Jones & Co., Inc., installed furnaces several years ago.

HESS-BRIGHT MFG. Co., Philadelphia, Pa., has transferred its offices to its new factory at 17 E. Erie Ave. The old quarters at 21st and Fairmount Aves. have for the past two years been inadequate for the rapidly growing business of the company, and the new site, which covers about thirteen acres, affords ample room for a much-needed expansion. The factory buildings are one-story high and embody the most advanced ideas on modern factory arrangement and construction.

ALLEN MFG. Co., INC., 135 Sheldon St., Hartford, Conn., has moved into the old Henry & Wright Mfg. Co's. plant in order to be able to care for its rapidly growing business of manufacturing the Allen safety set-screw. The company has established a Canadian branch at 29 St. David's Lane, Montreal, Canada, which will manufacture safety set-screws for the Canadian trade. Safety set-screws are now made for lathe dogs, and special safety screws will be made to order from ¼ inch to 1 inch diameter.

WARNER & SWASEY Co., Cleveland, Ohio, has filed an application for an increase of capital stock from $500,000 to $1,000,000. The increase of capital is to be provided for making an extension of the company's business. During the past three years the company has doubled the capacity of the plant, and is now contemplating the construction of an additional building on the east side of its present structure. The new building will be used largely for shipping and storage purposes. The officers of the company are Ambrose Swasey, president; Worcester R. Warner, vice-president; and Frank A. Scott, secretary and treasurer.

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

SEPTEMBER, 1912

MACHINING A LOCOMOTIVE CROSSHEAD*

BY FRANKLIN D. JONES†

IN the construction of any piece of machinery or part of a machine there are usually several ways of obtaining the same result. To illustrate, a casting or forging that requires boring, turning and planing can, in some instances, be bored or turned prior to planing, and *vice versa*, it being possible to vary the order of the operations. There is one way, however, which is the best, and this is usually not only the easiest and quickest way, but the one which gives the most accurate results. To determine just what order should be followed when a number of different machining operations are required is often the most difficult part of the work. Accompanying this article there are a number of views which show how a locomotive crosshead of the "alligator" type is machined. None of the operations is especially difficult, but the successive order in which they are performed is well worth studying, especially by the apprentice or machinist who has had little or no experience in general machine work. These views were taken in the Pennsylvania Railroad's large locomotive shops at Altoona, Pa.

Fig. 1. Reaming a Crosshead in Horizontal Boring Machine

Fig. 2. Turning End of Crosshead

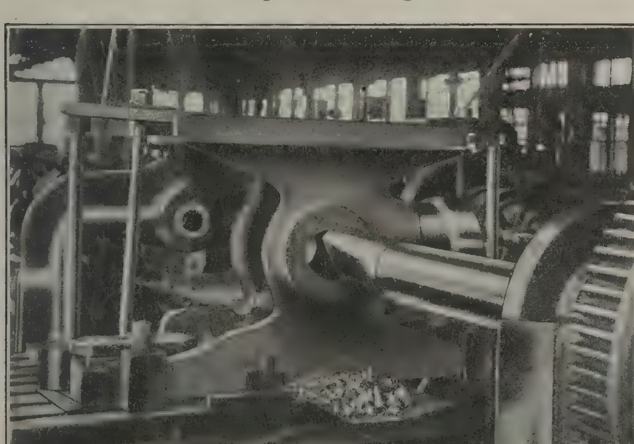


Fig 3. Drilling Wrist-pin Hole

Fig. 4. Drilling Key-slot

Before beginning a job of this kind the relation between the various finished surfaces should be carefully considered in order to determine the best method of starting the work and the successive order of the operations. The machine work includes boring taper holes for the piston-rod and wrist-pin, planing the bearing surfaces for the guides, planing the sides of the crosshead, turning the cylindrical end or "barrel," and cutting the slot for the piston-rod key. The principal requirements, in this case, are as follows: The axes of the piston-rod and wrist-pin holes should be at right-angles to each other; the axis of the piston-rod hole should be parallel to the guide bearing surfaces, as well as the flanges or sides, and the wrist-pin hole should also be parallel to the guide bearing surfaces.

Before the crosshead is machined, center lines are laid off on the ends, as indicated at *A*, Fig. 1. These center lines are used for setting the rough casting prior to boring the piston-rod hole, and they also serve as central points to work from when planing the guide bearing surfaces. The first machining operation is that of boring and reaming the taper hole for the piston-rod. A horizontal boring machine is used for this work, and the crosshead is clamped to the table with the cylindrical end or "barrel" toward the spindle, as shown in Fig. 1.

The latest practice is to bore this hole from the solid metal, although formerly a 2-inch hole was cored in the casting. Recent specifications require the ends of all crossheads to be cast solid, to insure castings free from shrinkage cracks and blow-holes, although the solid castings are, of course, more expensive to machine, as it is necessary to drill out the hole which was formerly cored. After the casting is clamped in the position shown, the table is adjusted vertically until the

* For articles relating to locomotive building at the Juniata Shops of the Pennsylvania Railroad, previously published in MACHINERY, see "Assembling a Locomotive Boiler," August, 1912; "Milling Main-Rods at the Juniata Shops," June, 1912; "Machining Locomotive Cylinders," April, 1912, and articles there referred to.

† Associate Editor of MACHINERY.

center lines A coincide with the axis of the spindle. The required vertical position is obtained by inserting a center, similar to a lathe center, in the spindle and adjusting the table until the lines coincide with this center.

After a hole has been drilled in the solid end it is further enlarged to admit the reamer by using a boring-bar and cutters which are "stepped" down to correspond with the taper of the hole. In this way the hole is rough-bored so that the finishing reamer has about the same amount of stock to remove throughout its entire length. Fig. 1 shows this final operation of reaming. The hole has a taper of ¾ inch per foot, and it is reamed to conform to a standard plug gage.

After the piston-rod hole is finished, the crosshead is mounted on a taper arbor and the cylindrical end is turned as indicated in Fig. 2. This surface is finished more to give the work a neat appearance than anything else, although it provides a smooth surface for laying out the piston-rod key-slot.

The third operation in the regular order is that of planing. Two castings are planed simultaneously, and as the planed surfaces must be in line with the axis of the piston-rod hole, the work is chucked with reference to this hole by using tapered mandrels, as illustrated in Fig. 5. These mandrels are driven tightly into the crosshead and are mounted in V-blocks as shown. The V-blocks are aligned by tongue-pieces which fit into the platen T-slots, and the V's are, of course, so located as to hold the mandrels parallel both with the platen and the line of motion. A four-head planer is used, so that the flanges and pads at the sides can be machined simultaneously with the top surfaces. After the top and one side of each casting have been finished, the work is turned over for planing the opposite surfaces.

The wrist-pin hole is next bored and reamed by again using the horizontal boring machine, as indicated in Fig. 3. The casting is clamped in a crosswise position on the table, at right-angles to the spindle, and the hole is first rough-drilled and then finished to the right taper with a reamer. The adjustment for height is obtained by inserting the conical center previously referred to in the spindle and then adjusting the table vertically until this center coincides with lines laid off from the center of the piston-rod hole.

The next operation is that of laying out and machining a slot for the key which holds the piston-rod in place. This key is located, in a crosshead of this type, at an angle of 45 degrees, because when in this position it can be removed more easily. The method of laying out the key-slot is indicated in Fig. 6. The center of the piston-rod hole is first located by inserting a centered taper plug, as shown. The pointer of a surface gage is next set to coincide with this center, and the center line for the slot is then laid off and circles are scribed for drilling. As the illustration indicates, the diagonal location of this slot is obtained by simply placing the crosshead on a special angle-plate which holds it at an angle of 45 degrees with the table.

The drilling of the slot is shown in Fig. 4. The horizontal boring machine is used and the crosshead is held in the 45-

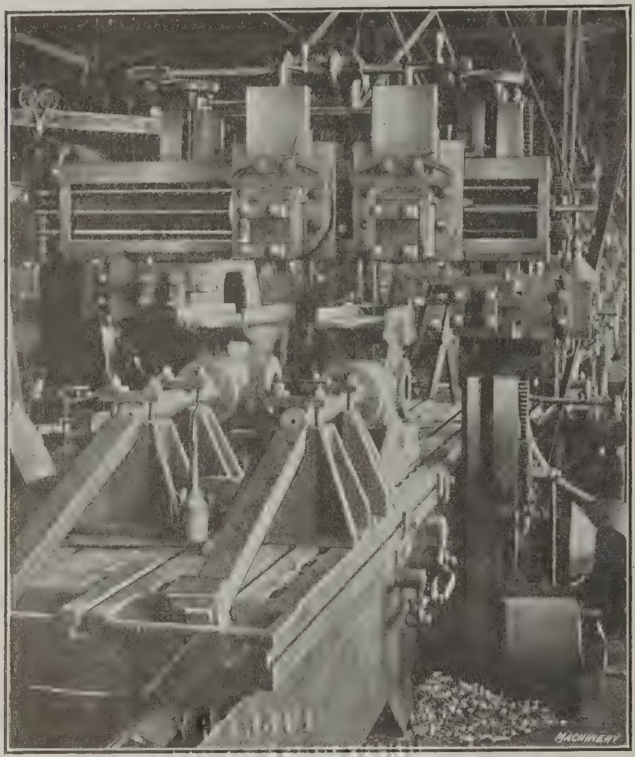


Fig. 5. Planing Two Crossheads Simultaneously

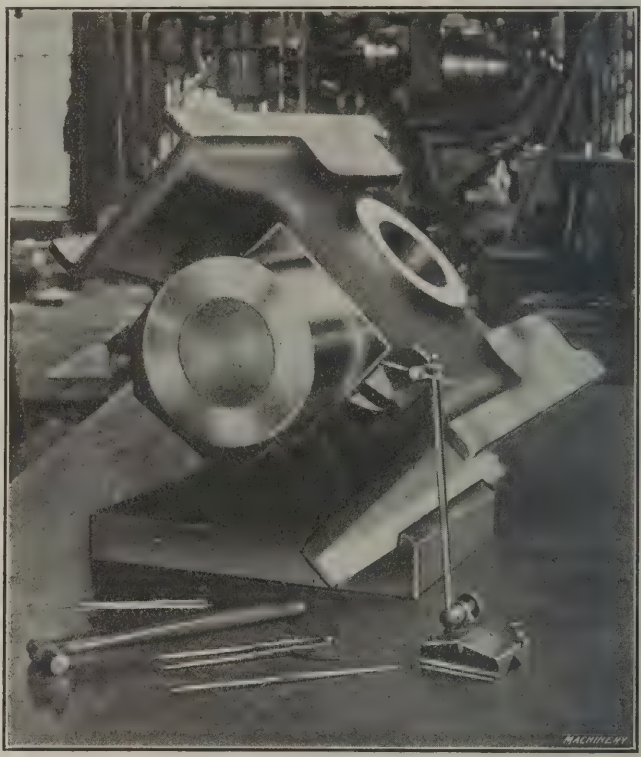


Fig. 6. Laying Out Piston-rod Key-slot

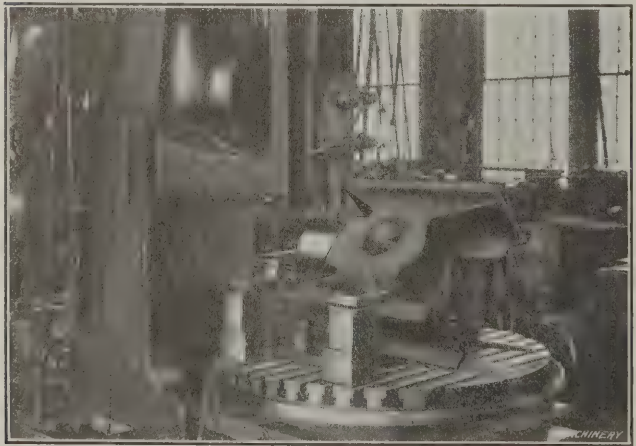


Fig. 7. Slotting Key-slot

Fig. 8. Planing Guide Bearing Surfaces in Open-side Shaper

degree position by employing the same angle-plate used for the laying-out operation. After the required number of holes have been drilled through one side, the crosshead is turned over to bring the opposite side into position.

The rough slot formed by drilling is finished in the slotting machine as shown in Fig. 7. The 45-degree angle-plate is also used for this operation, and when one side is slotted the work is located for machining the opposite side by simply turning it over. It will be noted that the slotter is equipped with a pump and piping for supplying lubricant to the cutting tool. This is a feature not generally found on slotting machines, although it can often be used to advantage, especially when slotting cast steel or forgings.

Before the crosshead can be finished, the top and bottom must be given a tin lining to form a good bearing for the guides. After tinning, the rough surfaces are planed smooth and to the required dimensions, as shown in Fig. 8. An open-side or Richards type of shaper is used for this work, and the crosshead is held on a taper mandrel mounted in V-blocks, the same as for the planing operation. The shaper is preferable to the planer for finishing the tinned surfaces, as it is quicker in operation and less cumbersome to handle. The lining is about 1/8 inch thick on the horizontal surface and 1/16 inch thick at the sides of the flanges, after being planed.

This completes the crosshead with the exception of one or two minor operations, such as drilling and tapping holes for the bracket which operates the "lead-and-lap" lever (sometimes called the combination lever) of the Walschaerts valve gear, cutting a key-seat in the wrist-pin hole, etc. This crosshead is made of cast steel, which is used on modern locomotives not only for crossheads, but for many other parts, because it makes possible a reduction in weight. This matter of weight is especially important in the case of a crosshead, as it is essential to keep the reciprocating parts of a locomotive as light as possible without sacrificing strength.

* * *

STATISTICS OF RAILWAYS IN U. S. FOR THE YEAR ENDED JUNE 30, 1911

The statements in this abstract are based upon compilations for the twenty-fourth annual statistical report of the Interstate Commerce Commission, covering the fiscal year ended June 30, 1911.

Mileage

Substantially complete returns were rendered to the Commission for 246,124.40 miles of line operated, including 11,006.86 miles used under trackage rights. The aggregate mileage of railway tracks of all kinds covered by operating returns was 362,710.18 miles. This mileage was thus classified: Single track, 246,124.40 miles; second track, 23,451.26; third track, 2,414.16; fourth, fifth, and sixth tracks, 1,747.10; yard track and sidings, 88,973.26. These figures indicate an increase of 10,943.59 miles over corresponding returns for 1910 in the aggregate length of all tracks, of which increase 3,391.33 miles, or 30.99 per cent, represent yard track and sidings.

Equipment

There were 61,327 locomotives in service on June 30, 1911, indicating an increase of 2,380 over corresponding returns for the previous year. Of the total number of locomotives, 14,301 were classified as passenger, 36,405 as freight, 9,324 as switching, and 1,297 were unclassified.

The total number of cars of all classes was 2,359,335, or 69,004 more than on June 30, 1910. This equipment was thus assigned: Passenger service, 49,818 cars; freight service, 2,195,511; and company's service, 114,006.

The average number of locomotives per 1,000 miles of line was 249, and the average number of cars per 1,000 miles of line was 9,586. The number of passenger-miles per passenger locomotive was 2,268,067, and the number of ton-miles per freight locomotive was 6,913,246.

Employes

The total number of persons on the pay rolls of the steam roads on June 30, 1911, was 1,669,809, or an average of 678 per 100 miles of line. As compared with returns for June 30, 1910, there was a decrease of 29,611 in the total number of railway employes. There were 63,390 enginemen, 66,376 firemen, 48,200 conductors, 133,221 other trainmen, and 40,005 switch tenders, crossing tenders, and watchmen. The total number of railway employes (omitting 93,718 not distributed) was apportioned among the six general divisions of employment as follows: To maintenance of way and structures, 493,926; to maintenance of equipment, 344,112; to traffic expenses, 22,246; to transportation expenses, 629,654; to general expenses, 52,201; and to outside operations, 33,952. The total amount of wages and salaries paid to railway employes during the year ended June 30, 1911, was $1,208,466,470.

Capitalization of Railway Property

On June 30, 1911, the par value of the amount of railway capital outstanding was $19,208,935,081. Of the capital outstanding, there existed as stock $8,470,717,611, of which $7,074,917,559 was common and $1,395,800,052 was preferred; the remaining part, $10,738,217,470, representing funded debt, consisted of mortgage bonds, $7,825,269,102; collateral trust bonds, $1,183,766,188; plain bonds, debentures and notes, $951,377,816; income bonds, $261,777,220; miscellaneous funded obligations, $195,430,395; and equipment trust obligations, $319,596,749.

Of the total capital stock outstanding, $2,740,467,285, or 32.35 per cent, paid no dividends. The amount of dividends declared during the year (by both operating and lessor companies) was $460,195,376, being equivalent to 8.03 per cent on dividend-paying stock.

Revenues and Expenses

For the year ended June 30, 1911, the operating revenues of the railways (average mileage operated, 243,433.61 miles) were $2,789,761,669; their operating expenses were $1,915,054,005. The corresponding returns for 1910 (average mileage operated 236,986.51 miles) were: Operating revenues, $2,750,667,435; operating expenses, $1,822,630,433. The following figures present a statement of the operating revenues for 1911 in detail:

Freight revenue	$1,925,950,887
Passenger revenue	657,638,291
Mail revenue	50,702,625
Express revenue	70,725,137
Excess baggage revenue and milk revenue (on passenger trains)	15,430,683
Parlor and chair car revenue and other passenger-train revenue	5,274,450
Switching revenue	27,665,997
Special service train revenue and miscellaneous transportation revenue	9,479,809
Total revenue from operations other than transportation	24,707,757
Joint facilities revenue—Dr	647,247
Joint facilities revenue—Cr	2,833,280
Total operating revenues	$2,789,761,669

The operating revenues stated above averaged $11,460 per mile of line.

Operating expenses, as assigned to the five general classes, were:

Maintenance of way and structures	$366,025,262
Maintenance of equipment	428,367,306
Traffic expenses	59,166,364
Transportation expenses	987,382,108
General expenses	73,689,373
Unclassified	423,592
Total operating expenses	$1,915,054,005

The foregoing operating expenses averaged $7,867 per mile of line.

Public Service of Railways

The number of passengers carried during the year was 997,409,882. The corresponding number for the year ended June 30, 1910, was 971,683,199. The increase in the number of passengers carried during the year over 1910 was 25,726,683. The number of passengers carried 1 mile, or the passenger mileage, as compiled for 1911, was 33,201,694,699. The corresponding return for 1910 was 863,198,370 less. The number of passengers carried 1 mile per mile of road was 139,191.

The number of tons of freight carried was 1,781,637,954, while the corresponding figure for the previous year was 1,849,900,101, the decrease being 68,262,147 tons. The ton

mileage, or the number of tons carried 1 mile, as shown for the year ended June 30, 1911, was 253,783,701,839. The decrease in the ton mileage for the year ended June 30, 1911, under the return for 1910, was 1,233,208,612. The number of tons carried 1 mile per mile of road for the year 1911 was 1,053,566. The number of tons per train-mile was 383.10.

The average receipts per passenger per mile were 1.974 cents; the average receipts per ton per mile, 0.757 cent. The ratio of operating expenses to operating revenues was 68.66 per cent.

* * *

METHODS USED IN ERECTING PLANERS

FOUNDATIONS, ALIGNMENT, SQUARING UP, ERECTING COUNTERSHAFTS, ETC.

BY EDWARD K. HAMMOND*

Edward K. Hammond†

DISAPPOINTMENT is sometimes experienced in the performance of new machinery, owing to its failure to produce work of the standard expected. In most cases, however, the machine itself is quite capable of properly doing the work for which it was sold, and an investigation by an expert will usually show the trouble to be due to one of two general causes; the machine is either improperly used, or it has been incorrectly set up. Either error will make production of accurate work impossible, and incorrect methods of setting up a machine will also often cause it to be seriously damaged. It is the purpose of this article to explain the correct methods of setting up a planer, the information presented being based upon methods developed by the Cincinnati Planer Co., Cincinnati, O.

In setting up machines of this type, the following requirements must be fulfilled. A solid foundation must be provided for the planer to rest upon. The bed must be true and set level upon the foundation and square with the lineshaft; it must bear evenly upon the foundation and be adequately supported by it. The cross-rail must be exactly parallel with the table. It will be evident to any machinist that a planer cannot give satisfactory results unless the table runs perfectly true and the cross-rail is parallel with it. The necessity for a solid foundation, upon which the planer bed is evenly supported, is just as important a factor in securing accurate work, although it is not so generally appreciated. Where a planer bed is not given adequate support, its weight will cause it to be sprung out of shape, and the inaccuracy of the ways which is produced in this way will manifest itself in the work produced on the machine.

The best practice is to set planers upon a concrete foundation and the Cincinnati Planer Co., in common with most reliable builders, furnishes foundation plans giving details for the construction which has been found suitable for the size of machine to be installed. Fig. 1 shows one of these foundation plans for a 62-inch x 62-inch x 14-foot Cincinnati planer. This plan calls for the use of leveling blocks between the planer bed and the foundation, one of these being illustrated in Fig. 2. The sliding members of these blocks are lubricated with graphite, to make sure that they will work smoothly, and by means

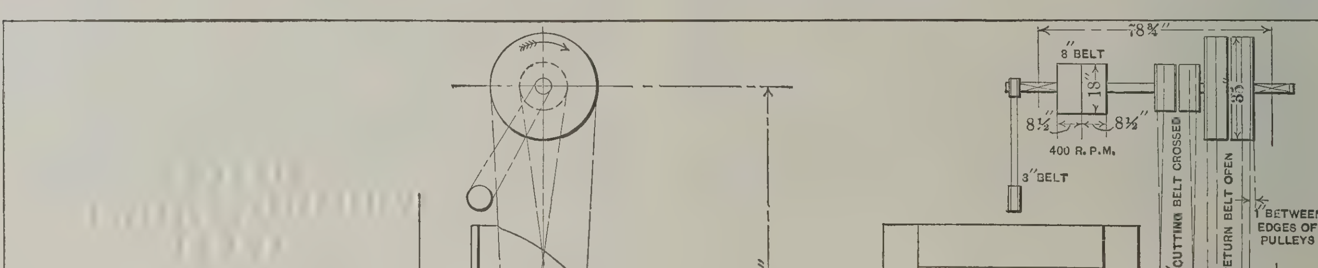


Fig. 1. Foundation Plan for a 62-inch by 62-inch by 14-foot Planer

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of the adjusting screws, each individual block may be set to exactly the required point to bring the planer bed to an accurate level. Where the planer has feet, these rest upon the leveling blocks, but where the bed extends right down to the foundation, the blocks are distributed in the way best suited to carry the weight of the bed and protect it from being strained at any point. Average conditions require leveling blocks in the foundation at intervals of four feet. These blocks not only provide a rapid and accurate method of leveling, but also make it possible to correct a considerable amount of error that may be found in either the planer bed itself or in the foundation, thus bringing the machine back to an accurate level in either case.

In preparing this type of planer foundation, the concrete is filled in to within about eight inches of the floor line. The

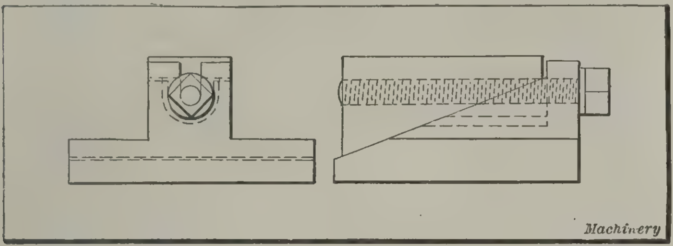

Fig. 2. Leveling Block of the Type used in a Concrete Foundation

leveling blocks are then placed in position and carefully adjusted with a long straightedge so that tissue paper will be held tightly on any block when the straightedge is passed from one position to another. After the blocks have been placed in position with the required degree of accuracy by this adjustment, the concrete is filled in almost to the level of their upper faces, spaces being left to allow access to the adjusting screws. These spaces should be provided with covers to keep chips and dirt away from the screws.

The use of heavy concrete foundations and leveling blocks of this type make the initial cost of installation rather high, but it is possible, in this way, to secure a higher degree of accuracy in planer work than is usually considered practical. This increased accuracy permits the saving of a great deal of time in scraping the work after it has been planed. The time required to keep the planers themselves in proper working condition is also reduced when they stand upon accurate founda-

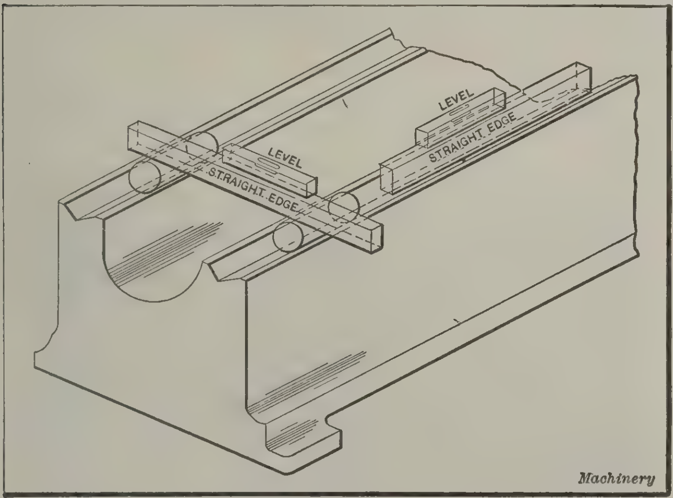

Fig. 3. Method of Testing the Level of a Planer Bed in Two Directions

tions, because all unnecessary strains upon the machines, due to lack of adequate support, are eliminated.

An idea of the efficiency of this form of foundation for a planer may be gathered from tests which have recently been made in the shops of the Norton Grinding Co., Worcester, Mass. After a year of constant use, the table of an 18-inch x36-inch planer with an 18-foot bed was tested with a 15-foot straightedge, and it was found that tissue paper could be held at any three points on the table, with the table in any position on the bed. When a planer is able to meet such a severe test, the claim for a greater accuracy in its output will be readily granted, as very few planers successfully meet such a test when mounted on any other form of foundation.

There has recently been considerable discussion concerning the advisability of bolting down planers to the foundation. The claim is made that a machine which is heavy enough to do its work well will not move at reversal, and the belt pull can never left it from the floor. Experience has shown that the only fastening necessary for a planer standing on a concrete foundation and leveling blocks, is to drill the plates and put in one-half-inch pins on each side of one or more pairs of legs, to prevent endwise sliding. In certain cases where this method of fastening was used, the pins were originally set so that they did not touch the planer feet, and the machine has never moved enough to bring them into contact. The use of foundation bolts was discarded on account of several objectionable features for which they are responsible. Among these the following may be mentioned: When a planer is bolted to a wooden floor and a heavy weight is placed near it, the planer is bound to follow any temporary settling of the floor which occurs; this sets up a strain in the entire planer. The same objection applies when permanent settling occurs in any form of planer foundation, and springing or deformation of the bed is bound to take place if it is bolted to the foundation at the time when the settling takes place. The pres-

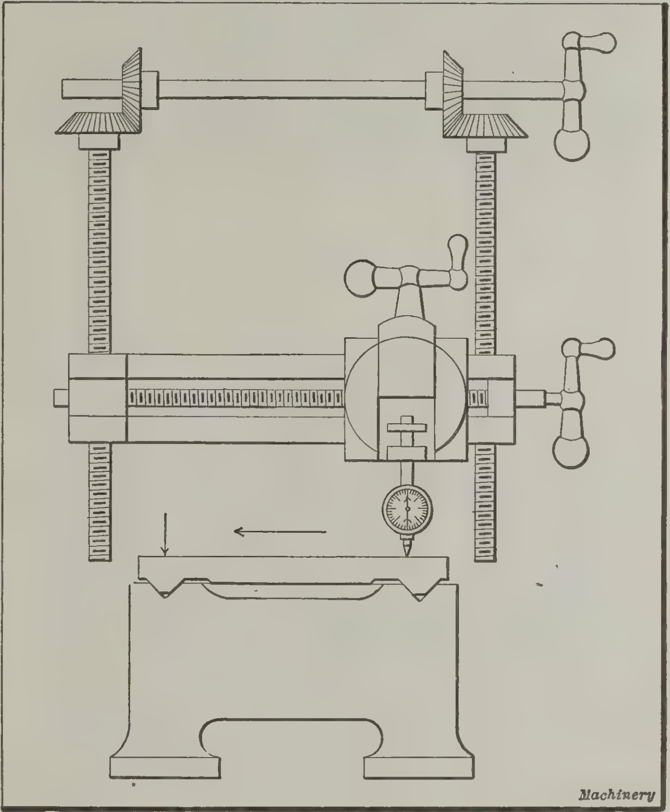

Fig. 4. Testing the Alignment of the Planer Cross-rail with the Table

ence of foundation screws also presents the possibility for careless workmen to attempt to use them to level the bed. This is obviously poor practice, because any leveling that is accomplished through the tightening of foundation screws, is done by springing the bed out of shape.

A More Simple Form of Foundation

A more simple method of supporting a planer consists of preparing a preliminary foundation upon which the machine is placed. Iron wedges or cedar shingles are then used to raise the bed to a height of about one inch above the level of the foundation, and also to bring it to a level position. A mortar is now made, consisting of one part of Portland cement to one part of sand, which is used to raise the foundation to the level of the bottom of the bed. Where this method of constructing a foundation is followed, care must be taken to tamp in the mortar firmly under the bed. A foundation of this kind is less expensive than the one previously described, but it is also far less serviceable in the long run.

Placing the Planer on the Foundation

In placing the planer on the foundation, care must be taken to have the bed set exactly square with the line shaft in order to provide for a proper operation of the driving belts. After this condition has been fulfilled, the bed must be ac-

curately leveled in both the lenghtwise and crosswise directions. This is done by removing the table and using a good spirit level to determine the direction in which the leveling blocks must be adjusted to bring the bed into the required position. If a level, which is long enough to reach across the bed is not available, a shorter instrument may be used on the top of an accurate straightedge which is parallel on both sides.

The beds of the planers built by the Cincinnati Planer Co.

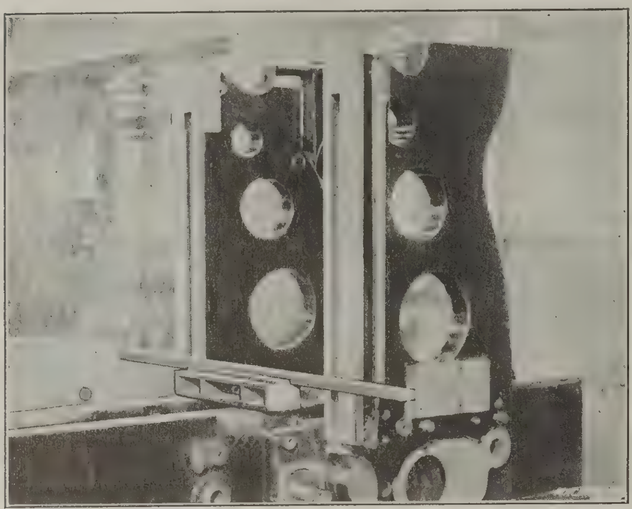

Fig. 5. Method of Bringing the Housings Square with the Ways

and many other firms, have the surfaces at the top of the Vs planed exactly parallel with the ways. If it is known that this method has been followed by the firm which built the planer that is being set up, these surfaces can be used as a support for the spirit level. Fig. 3 shows the proper method of procedure where the top surfaces of the bed have not been accurately lined up with the ways. In this case the ways themselves are used in leveling the bed. For making the crosswise adjustments, two cylindrical bars, of exactly the same diameter and of suitable size to fit in the Vs, are used as supports for the spirit level or straightedge. For the lengthwise adjustments, the level is set directly in the Vs. The bed is left a trifle high at the center, because the pressure of the tool and the weight of the housings come at this point; this causes a little more deflection and a slightly greater tendency for the foundation to settle. By observing the precaution of having the bed a little high at this place, the ways will, in the end, be brought to an accurate level.

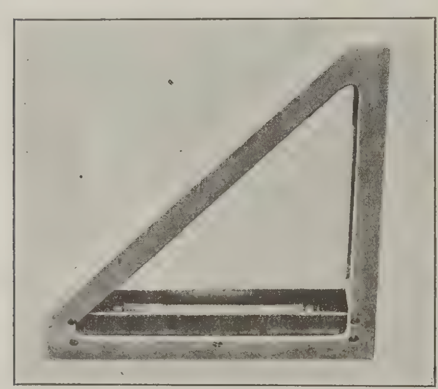

Fig. 6. Special Square used to Determine Vertical Alignment of the Housings

A series of tests should be made along the entire length of the bed to make sure that it is level in both lengthwise and crosswise directions. Such a series of tests should also be repeated at frequent intervals for some time after the planer has been set up, as there is a probability that the foundation will settle, thus disturbing the alignment. Where such settling is detected, the machine is easily brought back into position by means of the screws in the leveling blocks.

It is not necessary to level, in the lengthwise direction, a planer bed which only has legs at the ends, because the distance between the legs is never great enough to cause a deflection in the bed. Consequently, if the bed is a little high at either end, it will still plane straight, because the table will travel in a straight line and there is no tendency for its bearings in the bed to get out of alignment.

Special care, however, ought always to be taken in testing the lengthwise level in all other cases, as all planer beds do not have their ways scraped to a straightedge. Where the bed is merely scraped to fit the table, it insures a bearing, but does not show that the ways are straight, and in such cases, the provision of an absolutely level foundation is required to enable the bed to straighten itself out into proper alignment. When the bed has been brought to a satisfactory level, the Vs of both the bed and the table are thoroughly cleaned to remove grit and dirt, and the oil pockets in the bed are filled with a supply of good machine oil. The table is then replaced upon the bed and the next step is to see that the cross-rail is in proper alignment with the table. For this purpose, a distance rod or some form of surface gage is clamped in the planer tool-post to measure the distance between the rail and opposite sides of the table.

Fig. 4 shows the method of making these measurements with a dial test indicator, which has the advantage of showing the exact amount of any error that may be found in the alignment of the cross-rail. The same general method of procedure is followed with a distance rod; in this case, a piece of hard paper would be used as a feeler. The distance between the table and the cross-rail is measured first at one side of the table and then at the other, as indicated in the illustration. If this test shows the cross-rail to be out of alignment, the error is removed by adjusting the nuts on the elevating screws. These screws are a sliding fit in the bevel gears and carry fine threaded adjusting nuts which rest on the top of the bevel gears. By means of these nuts, the elevating screw at either side of the table can be raised sufficiently to bring the cross-rail parallel with the table. This adjustment should always be made by raising the low side of the rail. If the adjustment was made by lowering the high side of the rail, there would be a little backlash in the adjusting screws. This backlash would allow the rail to work out of the desired alignment with the table.

It was formerly considered necessary for a planer to plane off its own table after having been set up on the floor where it was to be used. Modern practice has discarded this method of procedure. The planers built by leading manufacturers plane their own tables before they leave the shops. Consequently, they require no further finishing, providing the bed has been set up as it ought to be. In fact, the practice of planing off a table is wrong, because if it is necessary to remove any error in the table by planing, it shows that the foundation is not properly leveled, and the trouble should be eliminated by adjusting the leveling blocks.

Additional Operations on Large Planers

Small and moderate-sized planers are usually shipped to the purchaser's plant fully assembled. In such cases the method of setting up which has been outlined puts the planer into condition to be belted to the countershaft; but in assembling large planers which have been taken down to facilitate shipment, or to make repairs on machines that have been damaged in transit, great care must be observed to bring the housings into proper alignment. After the bearings, shafts, and gearing are put into place in the bed, the housings are brought into position and tested to see that their

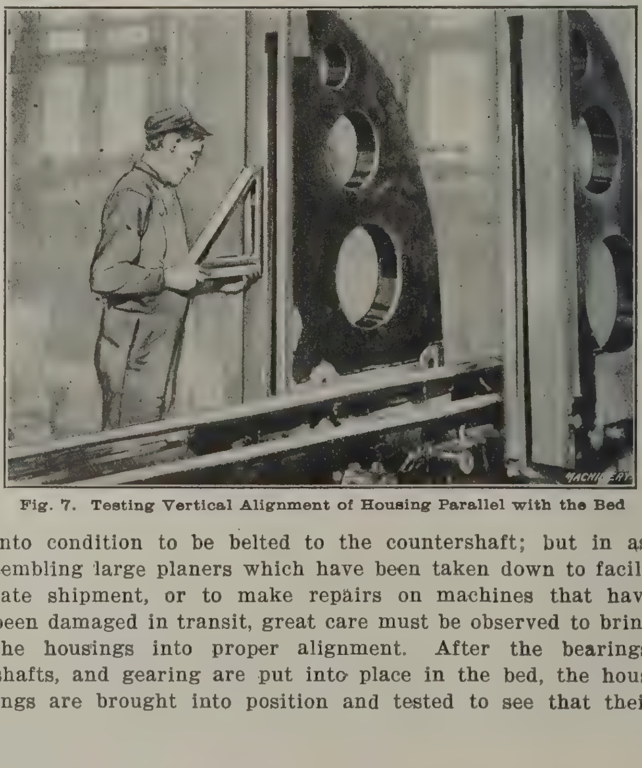

Fig. 7. Testing Vertical Alignment of Housing Parallel with the Bed

faces are square with the ways and that they are in the proper vertical alignment in both the lengthwise and crosswise directions.

The method of bringing the housings square with the ways is shown in Fig. 5. The fixture used for this purpose fits into the Vs and a straightedge is held by a shoulder as shown; the housings are then lined up with the straightedge. A special square shown in Fig. 6 is used to determine the vertical alignment of the housings. This square is fitted with a special spirit level which has been graduated to make each ⅛-inch space correspond to an error of 0.001 inch in 4 feet in the alignment of the housings. The method of using this square is illustrated in Figs. 7 and 8, where the alignment of the housings is being tested in two directions. The square is held against the face of one housing and the position where the bubble stops is noted. The square is then shifted to the corresponding face of the other housing and the position of the bubble is again noted. The same tests are made for the other pair of faces on the housings. If the position of the bubble is found to differ for either set of tests, the square shows the amount of error and the direction in which the adjustment must be made to bring the housings into proper alignment. When necessary adjustment has been made, so that any error which exists is within 0.001 inch in 4 feet, which corresponds to one graduation on the spirit level, the holes in the housings are reamed and they are then doweled into place on the bed. The cross-rail is next mounted in position on the housings and brought exactly parallel with the planer table, by the method previously described. The remaining parts of the planer are now assembled and the machine is then ready to be belted to the countershaft.

Fig. 8. Testing Vertical Alignment of Housing at Right Angles with the Bed

Erecting the Countershaft

In setting up the countershaft, care must be taken to have it perfectly level and parallel with the lineshaft; it must also be accurately located according to the requirements of the foundation plan, as shown in Fig. 1. This plan also gives instructions regarding which is the open and which the crossed belt. The importance of having the countershaft correctly located in relation to the planer lies in the fact that the belts will not shift properly if it is too far in front of or behind the proper position. After the countershaft is placed in position, the loose pulleys and hanger boxes must be given a copious supply of machine oil, and care should be taken to see that the pulleys and shaft turn freely. The collars on the shaft must be set to permit a little end play in the boxes, but not too much.

Some shops are in the habit of overlooking the superior driving and wearing powers of double belting in order to keep the first installation cost as low as possible. Economy in this direction is ill-advised, and double belting of the width specified in the foundation plan ought always to be used. The "cutting" belt, which is the crossed belt in most cases, should be crossed so that the side running back to the countershaft is on the inside next to the housing of the planer. The importance of this arrangement lies in the fact that the side of the belt operated on by the shifter forces the other side with it and enables the reversal to be made in less time than would otherwise be possible.

After all of the belting is in place, all of the pulleys and gearing in the planer should be rotated by hand, to make sure that everything runs freely, before the power is turned on. The gears should be given a good coat of heavy oil, and all of the bearings, loose pulleys, and oil holes must have a liberal supply of the best machine oil two or three times a day for the first week after the planer is placed in service. This precaution will often prevent serious wear while the machine is running itself into smooth running order. In the case of large machines, the further precaution of running them idle for a day or two before starting on heavy work should always be observed.

The time spent in putting new planers into proper operating condition is of little value unless care is taken to protect them from injury while in use. Consequently, some advice concerning the methods of protecting planers from damage will not be out of place in this article. In order to produce accurate work, the ways of a planer must be true, and, owing to their exposed position, special care must be taken to protect them from injury. Several methods are in common use. In planing short work, the ends of the ways may be covered with boards or canvass to keep chips and dirt out of them. A more elaborate method of securing protection for the Vs has been designed and patented by Mr. W. A. Thelin, foreman of the planer department of the Bullard Machine Tool Co., Bridgeport, Conn., where this method has been used for keeping the planers in good operating condition for a number of years.

Fig. 9 shows this device. The two spools at the end of the planer bed have strips of canvass wound on them which are slightly wider than the Vs. These strips are attached to the table, as illustrated, and as the table moves forward, the strips of canvass are unwound from the spools and keep the Vs covered. On the return stroke, the spools rewind the canvass strips through the action of a spring-actuated shaft on which the spools are mounted. Two rollers, carried on counterweighted arms, hold the canvass clear of the ends of the bed, and when the table comes forward to the end of the ways, the arms are swung down by means of blocks on the under side of the guards. An advantage in the use of these guards lies in the fact that they are equally available for all lengths of work and act automatically in protecting the ways from scoring or cutting without hindering the operator in any way.

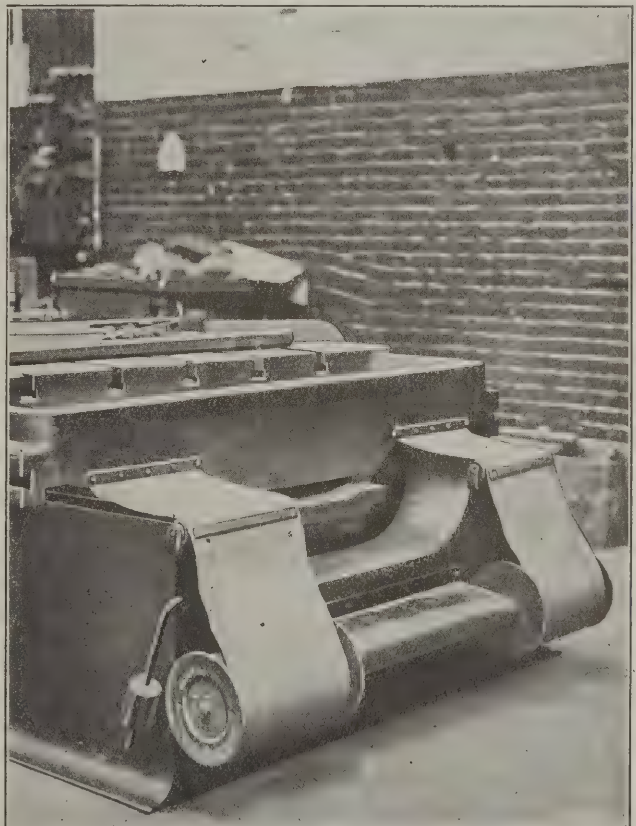

Fig. 9. Automatic Guard for Protecting Planer Ways from Damage

WATCH MOVEMENT MANUFACTURE*—3

METHODS, MACHINES AND SPECIAL TOOLS USED BY THE SOUTH BEND WATCH CO.

BY DOUGLAS T. HAMILTON†

To produce the small parts of a watch such as staffs, pinions, screws and jewel settings, requires the use of specially designed machinery. It is the methods employed in the producing of these parts, and the care taken in their manufacture, that raises or lowers the value of a watch. Automatic machinery has been a great boon to watch manufacture, but if all parts thus made are not carefully inspected and assembled, there is very little gained by producing them automatically. All parts that enter into a South Bend watch, whether made on automatic machines or otherwise, pass through careful inspections, and all are assembled by expert watchmakers. In the following a few of the special machines used will be described.

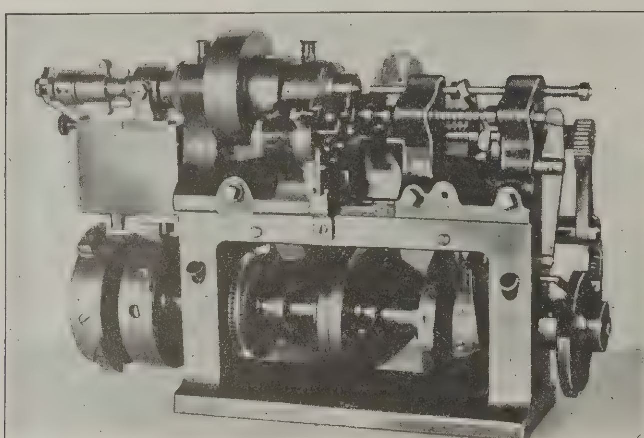

Fig. 26. Automatic Pinning Machine for Bridges

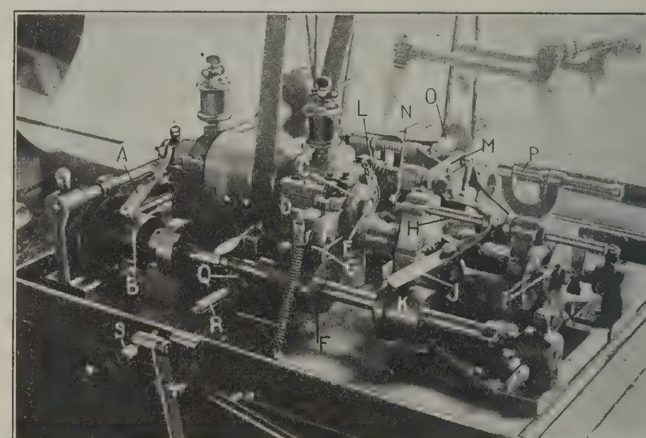

Fig. 27. Automatic Machine for Producing Small Watch Screws

Pinning or Doweling Bridges

The most expensive watches consist of one front plate and several bridges, these forming the bulwarks for the movement. The bridges are pinned and screwed to the front plate and retain the jewels which act as bearings for one end of the staffs. The more important operations on the bridges are: Blanking and shaving in the punch press, facing, stoning, drilling in a jig, counterboring, recessing and pinning or doweling.

The pinning is accomplished in the automatic machine shown in Fig. 26, which is similar, in appearance, to a small automatic screw machine. The construction of this machine is more clearly shown in Fig. 28. The wire from which the pins are made is fed by a feeding tube A by means of a finger which is operated by cam blocks on wheel B. The chuck C is closed by fingers D, operated by a sleeve E and cam blocks on wheel F.

The wire is gaged to the desired length by a spring actuated stop G which is forced forward against the tension of the coil spring H by means of yoked lever I and cam J. The circular cut-off tool K, working at an angle of 45 degrees with the axis of the spindle, is then brought in through the medium of a rack and gear, by lever L and cam M. Before the pin is cut off, stop G drops back, and carrier N held on shaft O is operated or rotated into position by cam P, rack-lever Q, and pinion R. When in line with the work, the carrier is forced forward by cam S and lever T, thus gripping the pin and then dropping back.

The bridge in which the dowel or pin is to be inserted is held in a cage into which it is placed by the operator. Now as the carrier drops back, cam P, rack-lever Q and pinion R rotate the carrier into a position where the pin is in line with the hole in the bridge; then carrier N which is provided with a spring plunger V ejects the pin, inserting it in the work when acted upon by plunger A_1, lever B_1 and cam C_1. The main drive shaft, carrying the various operating cams, is driven by a pulley D_1 through a worm E_1 and worm-wheel F_1. The various cams are so timed that while the pin is being inserted in the work, another pin is being fed out and cut off, these operations being performed automatically.

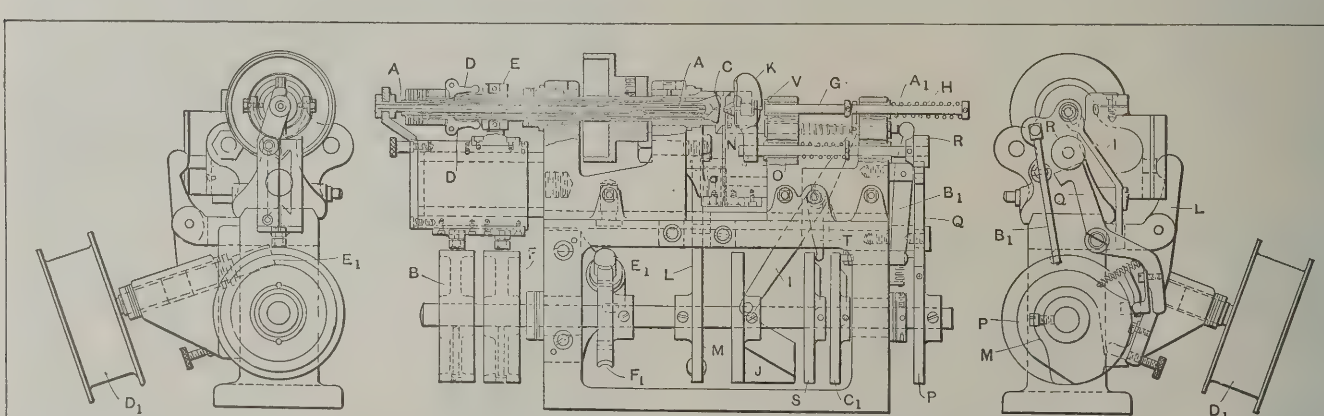

Fig. 28. Construction of the Pinning Machine shown in Fig. 26

Small Automatic Screw Machine

A large number of the cylindrical parts which are used in a watch are produced on the Brown & Sharpe automatic screw machine, but most of the small screws are made on special screw machines, one of which is shown in Fig. 27. The stock—the exact size of the head of the screw—is fed through the spindle by a feed finger operated by lever A and cam B.

The body of the screw, or portion to be threaded, is reduced by a circular form tool C held to a block D, as shown. This block is fulcrumed at E, and is operated by a cam F pressing against the hardened shoe G. It will thus be seen that the cutting edge of the tool, when in operation on the work, passes through an arc. This method of presenting the tool to the work has been found to give better results on

* The second installment of this article was published in the June number of MACHINERY. The fourth and last installment will occur in an early issue.

† Associate Editor of MACHINERY.

small work than feeding the tool in a horizontal plane, as is the usual practice.

The thread is cut by a small mill- or spring-die held in the forward end of spindle H. This spindle is rotated from the rear driving shaft through the change gears I, and is advanced by yoked lever J and cam K. The cams F and K

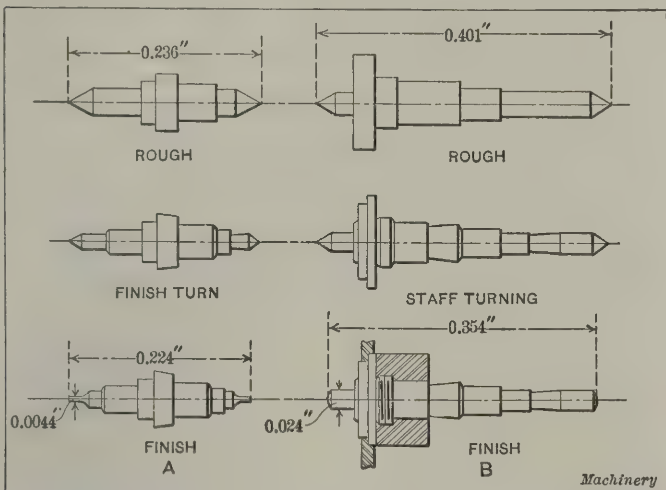

Fig. 29. Various Turning Operations on the Center and Balance Staffs

are so timed that the form tool is raised out of the way to let the die reach the work, the shoe G dropping down onto the cut-away portion of F at the proper moment. The die in traveling onto the work rotates in the same direction as the spindle, the latter reversing to run the die off when the desired length of thread has been cut.

After the thread is completed, the cut-off blade L operated by a cam on the rear shaft comes into action, and severs the screw from the bar. Just as the screw is breaking off, a bushing held in arm M is rotated into position to grip the screw, by

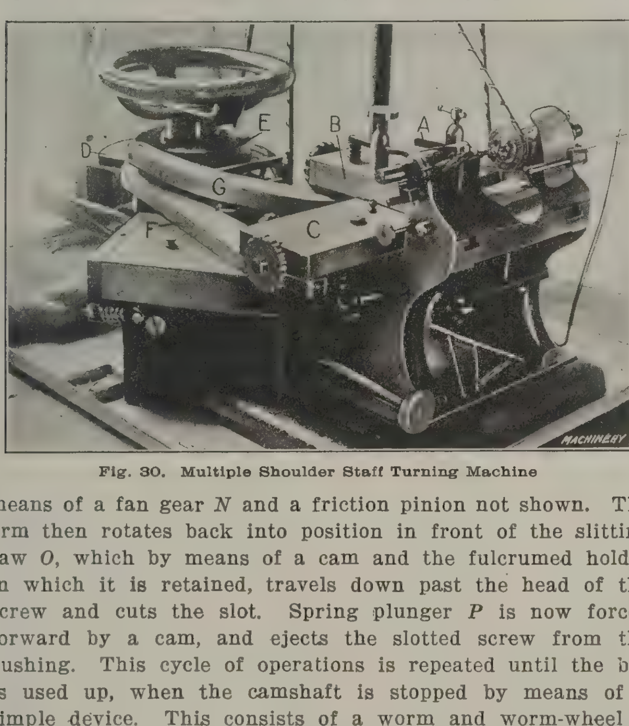

Fig. 30. Multiple Shoulder Staff Turning Machine

means of a fan gear N and a friction pinion not shown. The arm then rotates back into position in front of the slitting saw O, which by means of a cam and the fulcrumed holder in which it is retained, travels down past the head of the screw and cuts the slot. Spring plunger P is now forced forward by a cam, and ejects the slotted screw from the bushing. This cycle of operations is repeated until the bar is used up, when the camshaft is stopped by means of a simple device. This consists of a worm and worm-wheel Q which feed out a shaft R until it comes in contact with an adjustable stopscrew S, thus operating a lever which disconnects the driving clutch.

Staff Turning

The wheels composing the watch train are held on staffs, the ends of the latter running in jewels retained in the lower plate and bridges. Most of these staffs are provided with a number of shoulders of different diameters, as shown in Fig. 29, where A represents the various operations on the balance staff, and B the operations on the center staff. The last operation on the center staff shows the center wheel and pinion assembled.

One of the machines used for multiple shoulder staff turning is shown in Fig. 30. The staff to be turned is held on female centers, and is driven by a small dog. The turning is accomplished by a single turning tool A, held to the tool-slide B, which, in turn, is connected to a longitudinal slide C. Only one-half of the staff is finished at each setting, it being reversed to finish the other end. The movements of the turning tool A are controlled automatically by plate cams D and E. The lower cam D traverses the slide C, and hence moves the turning tool across the work by means of lever F, the ratio of the arms of which is 4 to 1. The top cam E, operating lever G, controls the in-and-out movements of the turning tool, and thus governs the diameter of the staff. The arms on lever G have a ratio of 8 to 1, thus enabling greater accuracy to be obtained on the diameter of the staff. The heights of the lobes on the cams, of course, are made equal to the movements required, multiplied by the ratios of the arms of the levers.

The lobes on cams D and E are so laid out and timed that all shoulders on the staff are faced as well as turned to a given diameter. One girl operates two machines, re-

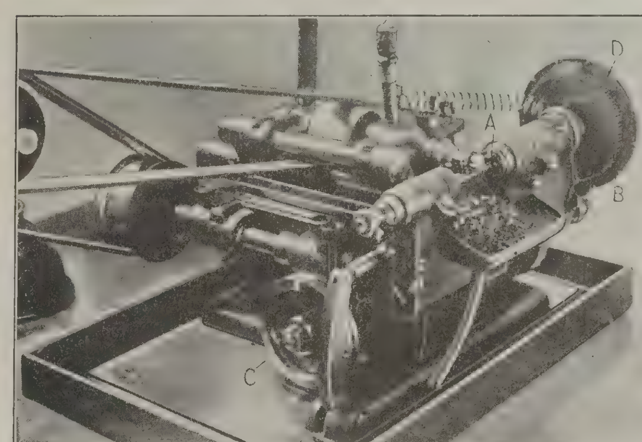

Fig. 31. Automatic Three-cutter Pinion-cutting Machine

moving a staff when finished and inserting a rough one. The machine is stopped automatically by a tripping device, not shown. The operator sits on a chair which is provided with wheels running on a track. This enables her to get from one machine to the other quickly and with very little effort.

Cutting Pinions

Watch pinions, as a rule, are made of steel and are formed-turned and cut off in special automatic staff machines. Then they are placed one at a time on an arbor, the latter being placed between the centers of the machine shown in Fig. 31. The driving center is corrugated, while the dead center is of the female type and is held in a spring-actuated

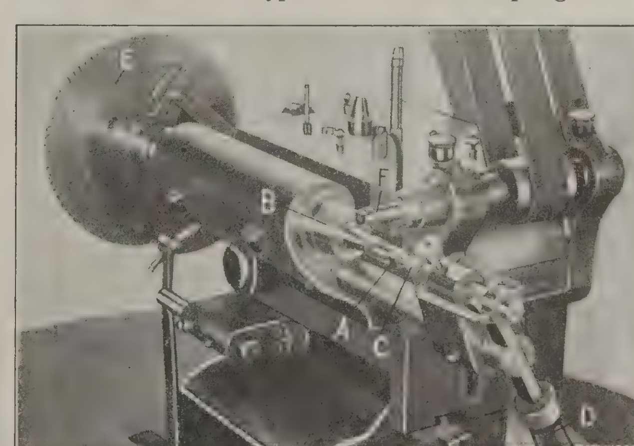

Fig. 32. Machine for cutting the Teeth in the Brass Wheels

spindle or tailstock. As a rule, three cutters are used: The first is a thin saw; the second a roughing cutter; and the third a finishing cutter.

The spindle A carrying the corrugated center is indexed by means of an indexing disk B and a ratchet. After the work has made one complete revolution, a cam held on cam-

shaft C shifts the table, bringing the next cutter into operation. The spindle again makes one complete revolution, when the cam shifts the table, bringing the last or finishing cutter into line. This makes one cut around the pinion, after which the table drops back to the starting position, and the machine is stopped by an automatic tripping device. The index plate D is provided with the same number of notches as there are teeth on the pinion.

Cutting Brass Wheels

The brass wheels, which in connection with the pinions compose the watch train, are blanked out and shaved by sub-

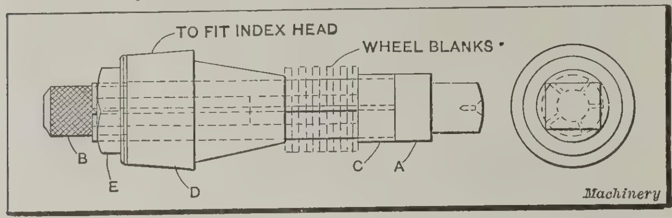

Fig. 33. Arbor used on the Machine shown in Fig. 32 for Holding Brass Wheels

press dies in the punch press. The arms of these wheels are all equally spaced and made of an equal width. The automatic machine used in cutting these wheels is shown in Fig. 32. Eleven of the wheels are held on the arbor A which has a tapered shank fitting in the indexing spindle B. The forward end of the arbor is supported by a spring center C, which is withdrawn from the arbor by pressing on the handle D. The indexing disk E has the same number of teeth as that required in the wheel and is indexed automatically by a ratchet device.

The cutter F is held on an arbor placed in the spindle of the machine. The head carrying the cutter spindle is raised on the return stroke of the cutter by a cam located beneath the head. The table carrying the work is advanced at a uniform speed by a constant-rise cam held on a cam-shaft at the rear, and an automatic arrangement stops the machine when one stack of wheels has been completed.

The arbor on which these wheels are held while the teeth are being cut is shown in Fig. 33. It consists of a central arbor

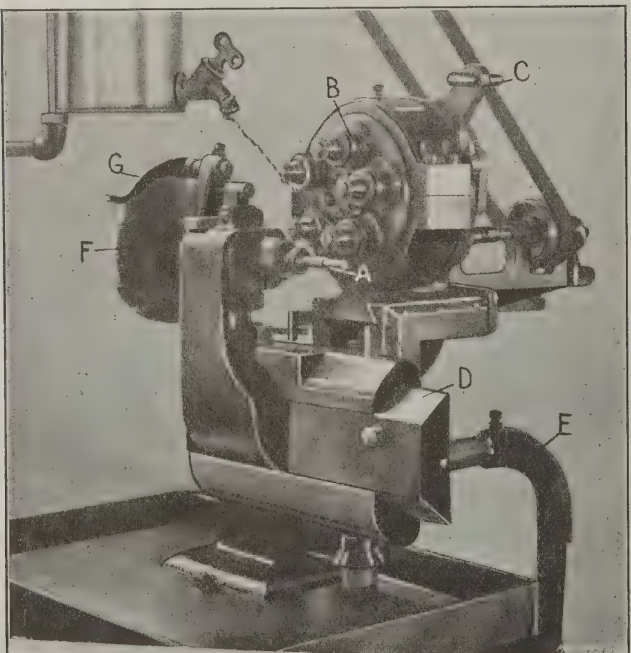

Fig. 34. Machine for Cutting Brass Escape Wheel Teeth

A which has five slots cut in it of the same width as the arms of the wheel. A hole is bored part way through this arbor, and a plug B is inserted to prevent it from collapsing. A washer C of the same diameter as the shoulder on the arbor is put on it as shown; then the wheels are put in place and the tapered sleeve D, which fits the index head, is next slipped over the arbor. Collar-nut E is then screwed onto the threaded end of the arbor, thus clamping washer, wheels and sleeve together.

As these wheels are blanked out and shaved in the punch press, it is evident that the inside of the rim is practically the only place to work from, if a wheel having a rim of an equal width throughout its circumference is desired. By working from this point, and using a milling cutter which will finish the tops of the teeth, it is an easy matter to produce a wheel which will be perfectly balanced.

Cutting Brass Escape Wheels

The escape wheel, so called because of the function it performs in a watch, is made from either steel or brass. The brass wheels are cut by sapphires, seven of which are used as fly-cutters, while the teeth in the steel wheels are produced by hardened steel cutters. Each of these cutters forms one part of the tooth, which differs considerably in shape from an ordinary gear tooth, as can be seen by referring to Fig. 8 in the May number.

The machine used for cutting the teeth in brass escape wheels is shown in Fig. 34. A stack of these wheels is held on arbor A, the latter being retained in the indexing spindle. The teeth are completely formed by five cutters held in the revolving head B, each cutter shaping some part of the tooth. The cutter spindles are driven by gears enclosed in the head. The cutter head itself is indexed by hand to bring the de-

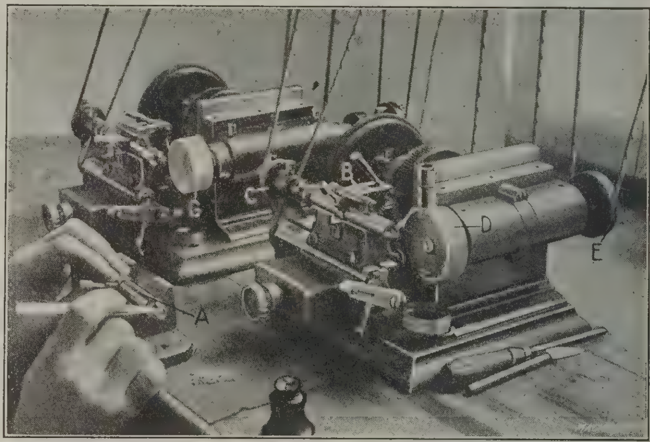

Fig. 35. McGinty Staff Cone Grinding and Polishing Machine

sired cutter into operation, this indexing being effected by means of the handle C. The table or slide D is traversed by hand by means of the lever E. The work is also indexed by hand with the ratchet wheel F, the latter being held in the desired position by pawl G. The teeth in these escape wheels are so delicate that it would be practically impossible to produce them by means of an automatic machine, great care being required on the part of the operator to turn out a perfect wheel.

As it is impossible here to give even a short description of the making of all the parts of a watch movement, only those methods which involve the use of some interesting mechanical device or appliance have been selected. After the steel parts such as pinions, staffs, balance staffs, etc., have been made, they are hardened and tempered. This leaves them in such a state that it is necessary to lap and polish them to the desired size, at the same time improving their appearance.

Grinding and Polishing Machine for Staff Cones

The staffs on which the wheels are held have a coned bearing, which must be of exact size to fit the hole in the balance wheel jewels inserted in the wheel. The staff to be ground is placed in a quill A, the operator using a pair of tweezers for this purpose, as shown in Fig. 35. The quill is then placed, and held by clamp B, in that part of the machine shown to the right in the illustration, which is used for the first operation—grinding. The spindle of the quill A is driven by a grooved pulley C and a small dog, the latter coming against a lug on the quill spindle. The staff is held between pump centers and a faceplate, and the grinding is accomplished by a diamond charged lap D, which is rotated by pulley E.

The spindle carrying the lap is moved back and forth by a cam which, in turn, is operated by a worm and worm-

wheel. This cam is provided with a gradual rise for feeding the lap against the work. When the desired diameter is reached the machine is stopped by means of a trip-stop.

The machine shown to the left is used for polishing the cone on the staff, and is identical in construction with that just described, with the one exception that the lap is given an oscillating movement by means of a crank *F*, shown in Fig. 37. This latter illustration also shows more clearly the construction of this machine. The lap is made of celluloid and

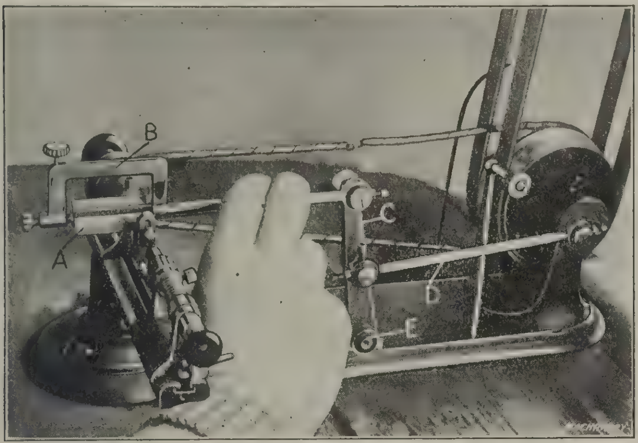

Fig. 36. "Wig-wag" Polishing Machine for Pinions and Staffs

is coated with Vienna lime, obtained in Austria. It is kept in contact with the work by means of a cam that has a cut-away portion, allowing the lap to drop back when the cone has been lapped to the correct diameter.

Before this machine—nicknamed the McGinty cone polishing and grinding machine and known by this name wherever watches are made—was perfected, the grinding of these cones was done by hand by skilled staff makers, who made this a special business. Naturally, when this machine was invented, it was jeered at by these expert cone polishers. About this time the old song "Down went McGinty" was at the height of its popularity, and each time this machine returned to the tool-room for improvements, the polishers would strike up the old refrain. However, after much experimenting the machine was perfected, and at the same time was nicknamed "The McGinty cone and polishing machine." It is now operated by girls who do better work and more of it than was formerly accomplished by expert polishers.

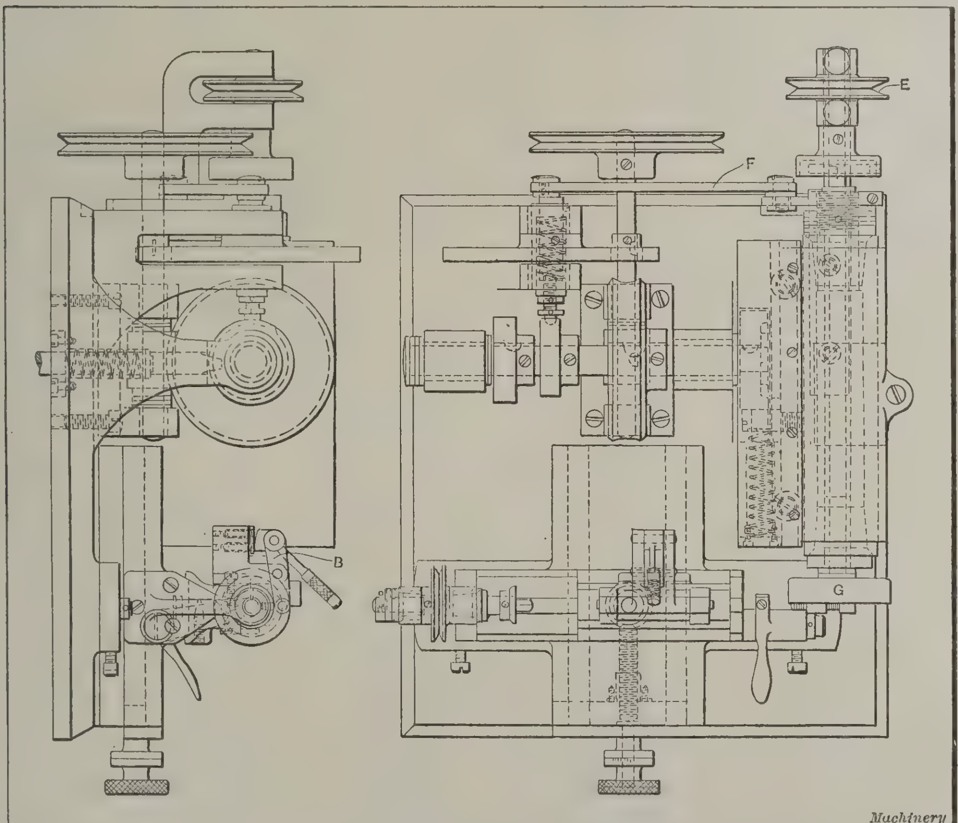

Fig. 37. Construction of the McGinty Staff Cone Grinding and Polishing Machine shown in Fig. 35

Polishing Pinions and Staffs

The pivot ends of pinions and staffs are polished by means of "wig-wag" polishers, one of which is shown in Fig. 36. The pinion is held in a "balloon" chuck provided with a pump center, and the polishing is done with a wing polisher *A* made of machine steel. The wings are ground on a special fixture, to an included angle of 45 degrees, and these lapping

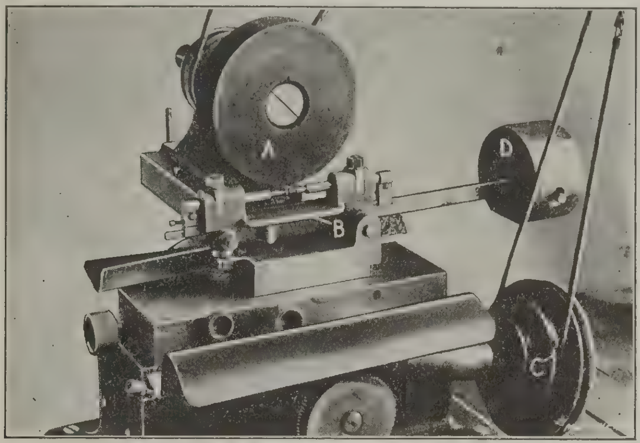

Fig. 38. Pinion Leaf Polishing Machine

edges are charged with rouge mixed with pure lard oil. The wing polisher is held in a bracket *B* which is fastened to a bell-crank *C*, the latter being operated by a connecting-rod fastened on the end of the driving shaft.

In operation, after the part to be polished is placed in the chuck, the frame holding the wing polisher is brought down and the latter kept in contact with the work, as shown in the illustration. As bell-crank *C* is fulcrumed at *E*, the action of the eccentric transmits an oscillating movement to the wing polisher. The machine is furnished with an idler pulley, so that it can be stopped by operating a foot lever, when inserting the work in the chuck.

Polishing and Grinding Pinion Leaves

As previously stated, all steel parts are hardened and tempered, and the pinions are no exception to this rule. After hardening, the leaves or teeth of the pinions are lapped in the machine shown in Fig. 38. The pinion is held between centers, which are retained in a stationary slide *B*. A circular lap *A* made of fiber, and provided with annular grooves, is charged with emery and driven at a high rate of speed. This lap is fed across the work by a cam in one direction and is returned by a coil spring. The cam is operated by a worm and worm-wheel driven from the grooved pulleys *C*.

Traversing the lap across the work rotates the latter on the center, so that all of the leaves are lapped. Weight *D* keeps the adjustable center in contact with the work.

* * *

An article in the *Zeitschrift des Vereines Deutscher Ingenieure* records a number of tests made with belting. These tests indicate that the tension when the flesh side of the belt runs onto the pulley can be 12.5 pounds per inch of width greater than the tension when the belt is run with the hair side in contact. The limiting speed with the hair side of the belt towards the pulley, is about 60 per cent of that with the flesh side towards the pulley.

THE MAKING OF BUSHINGS FOR DRILL JIGS*

PROPORTIONS OF BUSHINGS, MATERIALS USED, TURNING, HARDENING, GRINDING AND LAPPING OPERATIONS

BY F. B. JACOBS†

The making of a set of ten or twenty jig bushings is often looked upon as a long and tiresome operation with something of a degree of uncertainty as to results. This is especially true in some of the smaller shops as very few manufacturing concerns outside of the larger ones have anything like an effective system as applied to this class of work. It is not the intention of the writer to describe anything new but simply to outline the method employed in many of the medium sized shops in the Eastern states for getting out accurate jig bushings with a minimum amount of expense and trouble.

After the jig is bored the holes should be stamped 1, 2, 3, etc., and a chart drawn up as shown in Fig. 1. This need not be an elaborate affair as an ordinary pencil sketch will answer all practical purposes. The value of this chart is apparent, as the toolmaker can at a glance find any dimension for a bushing, thus saving much time that is generally spent in taking repeated measurements. For convenience the bushings are divided into three classes: Liners, shoulder bushings and slip bushings. If there are any solid bushings without shoulders that are used without slip bushings they can be listed with the liners. The letters A, B, C, etc. correpond to the dimensions of the bushings which are filled out in the chart in the spaces reserved for them. Two spaces are reserved under the column C for drill and reamer bushings that are to fit the same liner. The numbers 1, 2, 3, etc. correspond to the figures stamped on the jig to designate the different holes.

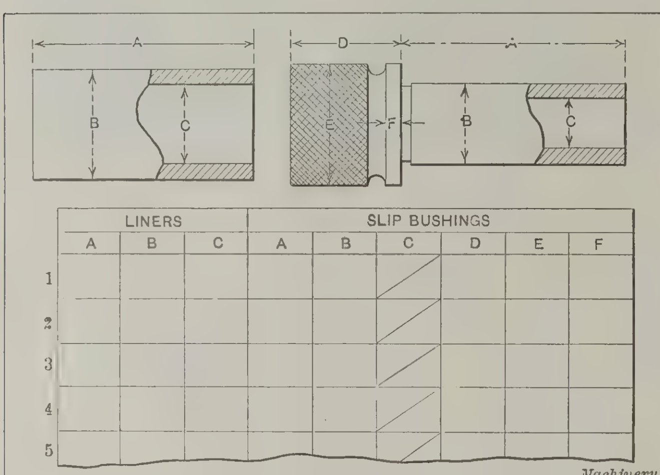

Fig. 1. Arrangement of Table of Jig Bushing Dimensions

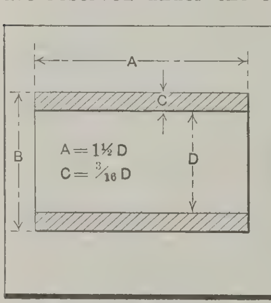

Fig. 2. Proportions of Lining Bushings

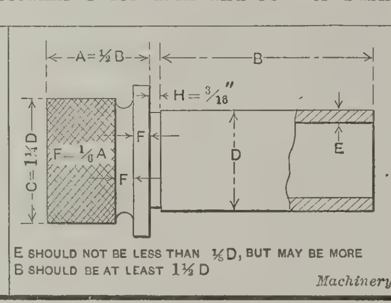

Fig. 3. General Proportions of Slip Bushings

Very few manufacturers agree on a standard for the proportions of jig bushings, each preferring to follow their own ideas. In many cases they are left to the discretion of the toolmaker himself. The proportions shown in Figs. 2 and 3 will generally answer in the majority of cases. When it is necessary to make bushings of unusual length they are often relieved as shown in Fig. 4. Solid bushings should have a shoulder as shown in Fig. 5, when it is intended to have stop collars run against them.

In Fig. 7 are shown three methods of holding bushings to prevent their turning: *A* shows a bushing having a pin inserted which slips in a slot cut in the lining bushing; *B* shows a bushing having a slot milled through the collar, a pin being located in the jig to engage this slot; and *C* illustrates a more elaborate device that is sometimes used. The stop button which is fastened to the jig prevents the bushing from being drawn out of the liner while withdrawing drills or reamers, as well as preventing its turning.

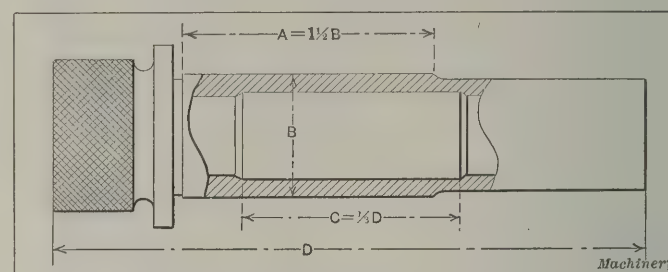

Fig. 4. Proportions of Bushings of Special Length

Bushings are generally made of a good grade of tool steel which insures hardening at a fairly low heat thus avoiding to a great extent the danger of fire cracking. They can be made in much less time from ordinary machinery steel which will answer all practical purposes, provided they are properly casehardened to a depth of 1/16 inch. Where many bushings are to be made a large percentage of the cost of stock can be saved by using machinery steel.

There are several methods followed in turning jig bushings. Some toolmakers prefer to "chuck out" the hole to the desired size and then finish the outside of the bushing by placing it on an arbor; others prefer to turn up the bushings two at a time, end to end, cut them apart and then bore as the final operation. This is an excellent method to follow when making large bushings. The most rapid method, however, is to chuck out the hole and finish up the outside at one setting using bar stock held in the chuck of a rigid engine lathe. This method is not always practicable on large bushings.

ALLOWANCES FOR GRINDING AND LAPPING BUSHINGS

Operation	Diameter of Bushings in Inches					
	½	1	1½	2	2½	3
A	0.008	0.010	0.013	0.016	0.020	0.025
B	0.0005	0.0005	0.0007	0.0008	0.0009	0.001
C	0.008	0.010	0.013	0.016	0.020	0.025
D	0.0003	0.0005	0.0007	0.0008	0.0009	0.001

A—Grind outside; B—Lap outside after grinding; C—Grind inside; D—Lap inside after grinding.

In making allowances for grinding and lapping, many toolmakers neglect to leave enough, which is the cause of many bushings having to be made over again on account of not finishing out. On the other hand many toolmakers leave too liberal an allowance for finishing thereby causing themselves a lot of unnecessary trouble and labor. The allowances given in the accompanying table can be safely used when the bushings are made somewhere near the proportions shown in Figs. 2 and 3, but for extra long bushings more liberal allowances should, of course, be made.

Before hardening the bushings should be plainly stamped with the size and purpose for which they are intended, "15/32 drill," "1/2 ream," etc. They should not be stamped with dull, worn out figures that are used by Tom, Dick and Harry on everything, but with a set of plain sharp figures reserved solely for this purpose. It is poor practice to try to stamp the words "drill," "ream," etc in a straight line,

* For additional matter on jig making and jig design see: "Locating Jig Buttons," June, 1912; "A New System for Locating Holes to be Bored on the Milling Machine," April, 1912; "Some Jig and Fixture Designs," January, 1911, and the articles there referred to. See also MACHINERY'S Reference Books Nos. 41 42 and 43, "Jigs and Fixtures."

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as not one man out of a hundred can do this and turn out a respectable looking job. If, however, the words are laid out on a slight curve the results are more satisfactory as slight irregularities of alignment are not then so noticeable. Anyone can prove this to his own satisfaction by a little experiment with a steel alphabet and a block of cast iron. Sharp clean figures and letters neatly laid out not only improve the appearance of the toolmaker's work, but also save the drilling operator a lot of time as sharp clean-cut figures can be read at a glance.

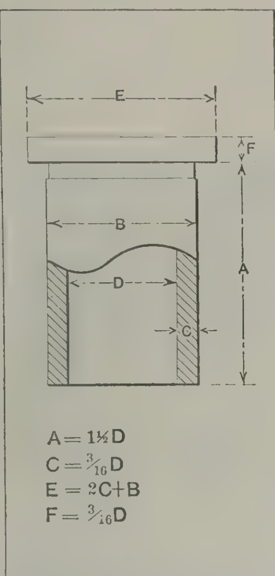

Fig. 5. Proportions of Shoulder Bushings

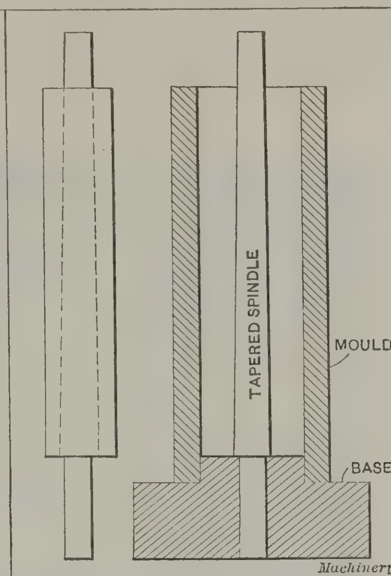

Fig. 6. Lead Lap and Mold used for Casting it

In hardening bushings made of tool steel they should be brought up to an even red heat in a clean fire, and the heating should never be hurried. If heated quickly the bushing is very likely to heat unevenly which invariably results in a warped piece that will not finish out. Gas furnaces are excellent for heating bushings preparatory to hardening. If, however, a gas furnace is not available a good clean charcoal fire in the forge will answer the purpose.

As soon as the bushing has been brought up to an even red heat it should be dipped in water warmed just enough to take off the chill. The bushing should then be brought up to a "sizzling heat" and left to cool in the air. Some toolmakers draw bushings to a medium straw color. This is a mistake as it only tends to shorten their life.

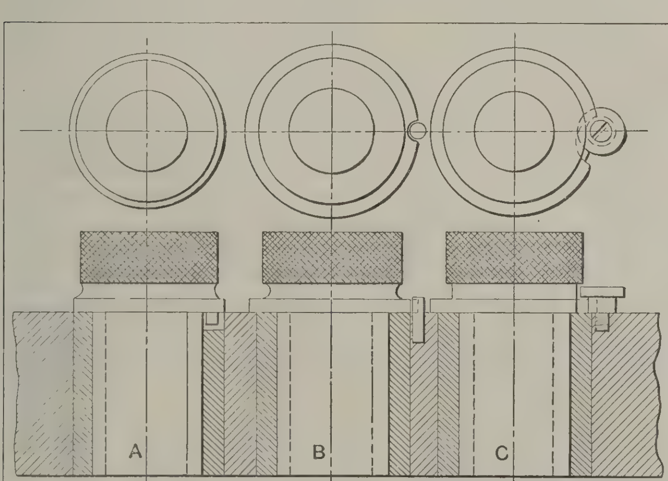

Fig. 7. Methods used for Preventing Jig Bushings from Turning

Grinding and Lapping

There are four methods in common use for finishing holes in jig bushings, *viz:* Lapping with a lead lap, lapping with a lead lap followed by a cast-iron or copper lap, internal grinding, internal grinding followed by a cast-iron or copper lap for removing the last 0.0005 inch. The first method is dead wrong as it invariably results in bell-mouthed holes, especially when the toolmaker charges the lap while in use, which is very poor but at the same time very common practice. The second method is correct for holes too small to be ground conveniently. The third method is wrong as the grinding wheel, no matter how fine, leaves innumerable very fine scores and high spots. These high spots soon wear away leaving the hole oversize. The last method is correct and should be used whenever possible.

In Fig. 6 is shown a lead lap with a steel tapered spindle, and a convenient mold for casting the laps. This mold is provided with a base having a hole to receive the spindle that the lap is cast on. A number of laps can be cast in this mold at one heating of the metal and afterward turned to the size required. Fig. 8 represents a familiar form of cast-iron lap. This lap is split in three places, and provided with a taper-end screw for expanding it to compensate for wear.

Laps should always be charged before—not while they are in use. A good way to charge a lap is to lay it on a cast-iron plate on which some of the abrasive material has been sprinkled. A cast-iron plate small enough to be conveniently handled is then held on the lap and moved back and forth with a regular motion. The lap being rolled between two surfaces picks up a certain amount of the abrasive material. A lead lap can be charged in this manner very rapidly, as the grains of abrasive material readily imbed themselves in the soft metal. A cast-iron lap, being of a harder material, requires more time to properly charge.

Until the last few years emery was the abrasive generally used for lapping. At the present time, however, aloxite, a product of the electric furnace, is displacing emery as it cuts faster, producing excellent results in a comparatively short time as compared to emery. Nos. 90 to 150 are used in connection with lead laps for roughing operations. For the final finishing with cast-iron laps flour aloxite is used. When not in use any abrasive used for lapping should be kept in a covered box to protect it from dirt and other foreign substances. A small chip or piece of grit will often cut a deep score in a piece of work—which neither improves its finish or workmanlike appearance.

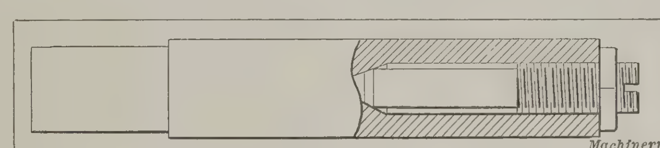

Fig. 8. Usual Form of Cast-iron Lap

Laps should always be run at a fairly low speed. Fifteen to twenty feet surface speed for a lead lap used for roughing, and twenty to twenty-five feet surface speed for a cast-iron lap used for finishing are about right. A high surface speed causes the lap to wear out without cutting as rapidly as it should. Many toolmakers make the mistake of running laps too fast, often causing unsatisfactory work.

For light lapping the work can be held by hand but with a heavy roughing cut it is best to hold the work with an ordinary lathe dog, care being taken to see that the dog is not clamped so tightly as to spring the work out of shape. Lead laps should be split to compensate for wear, and the spindles should have a groove cut along their entire length to prevent the lap from turning.

Before testing with a size plug the work should be washed out with benzine or gasoline to remove all traces of the abrasive material, a few grains of which will wear the size plug below standard size in a surprisingly short time. Washing in benzine or gasoline also brings the work to the same temperature as the size plug, which is important where extreme accuracy is required.

Many toolmakers look on the finishing of jig bushings by internal grinding as a rather uncertain method, whereas it is a comparatively simple process when the following important factors are carefully considered. First, proper selection of grinding wheels; second, correct wheel speeds or at least as near as the design of the machine will permit; third, correct alignment of the headstock in regard to the

travel of the platen; and fourth, proper truing of wheels.

Wheels for internal grinding should be of a medium grit, soft grade and open bond. As a rule the grit should never be finer than 60 grit; in fact a coarser grit can often be used to advantage. Wheels with fine grit cut slowly, fill up readily, glazing and invariably heating the work and causing chattering and other troubles too numerous to mention. In fact the only argument in favor of a fine grit wheel is that it leaves a smooth surface. However, no matter how smooth the surface appears to be, even under a powerful glass, it will have to be lapped to remove the wheel marks for the reason previously stated. When we stop a moment to con-

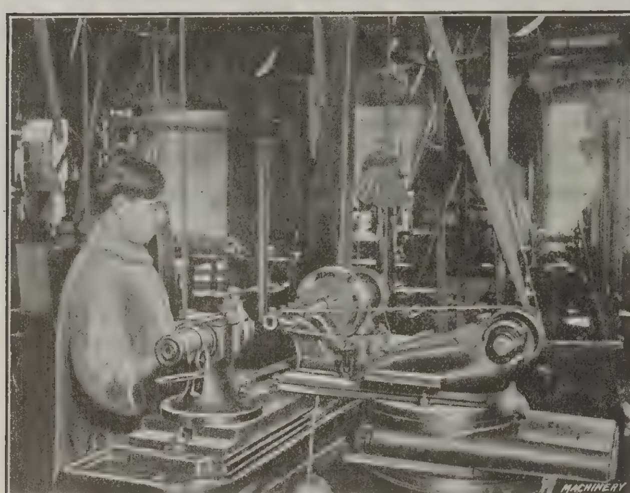

Fig. 9. Grinding the Holes in the Bushings

sider that 0.0005 inch will perfectly lap out the marks left by a 60 grit wheel, there is not much room for an argument in favor of 70, 80, and finer grit wheels.

For the internal grinding of jig bushings on a Brown & Sharpe No. 2 universal grinder, as shown in Fig. 9, the writer has used aloxite wheels, 1½ inch diameter, ⅜ inch face, 60 grit P grade, D-495 bond, with excellent results, the wheel speed being 12,000 R. P. M. The bushings aver-

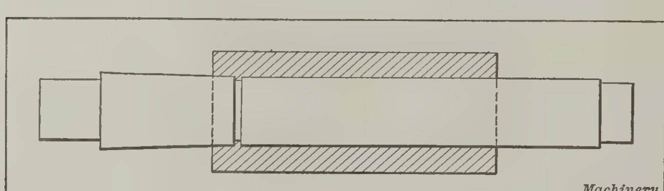

Fig. 11. Arbor for Holding Bushings

aged 2½ inches long, 1¾ inch hole. The holes were rough bored 0.015 inch being left for grinding. The grinding time per bushing, including chucking and truing up, was twelve minutes each and the finish left was good, 0.0005 inch being sufficient to lap out the wheel marks. Reference is made above to the holes being rough bored; this is good practice as the rather rough surface tends to wear the wheel just a little while removing the fire scale thus preventing the wheel from glazing. Once the scale is removed from the hole, the wheel should not glaze readily provided it is of the proper grit and grade.

Wheels for internal grinding should in theory be run at a surface speed of 5000 feet per minute. This, however, is a general rule open to exceptions. A safe practical rule to follow is to speed up the wheel if it wears away too readily, and to reduce the speed where the wheel shows a tendency to glaze. A little attention to this rule will often save much trouble. The toolmaker should bear in mind the fact that it is much easier to adjust the speed to suit the wheel, than it is to try to keep on hand a large variety of wheels to suit all speed conditions.

Assuming that the work in question is to be done on an ordinary universal grinder, the headstock must be set parallel with the travel of the platen to produce straight holes. A practical way to determine parallelism is to clamp a piece of round stock in the headstock chuck, letting it project from the jaws a little farther than the length of the holes to be ground. This piece should have a groove turned in it for the wheel to dwell in during reversal. This test piece is then ground in the regular way with the wheel used for cylindrical work, the headstock being adjusted by means of its swivel base until the test piece is ground parallel. Before calipering, the wheel should be allowed to grind until very few sparks are visible. When once this test piece has been ground straight the setting can be depended on to produce straight holes, provided, of course, that the swivel adjustment of the headstock and the angular adjustment of the platen are not disturbed. To try to straighten up the headstock by calipering the work while the internal grinding is in

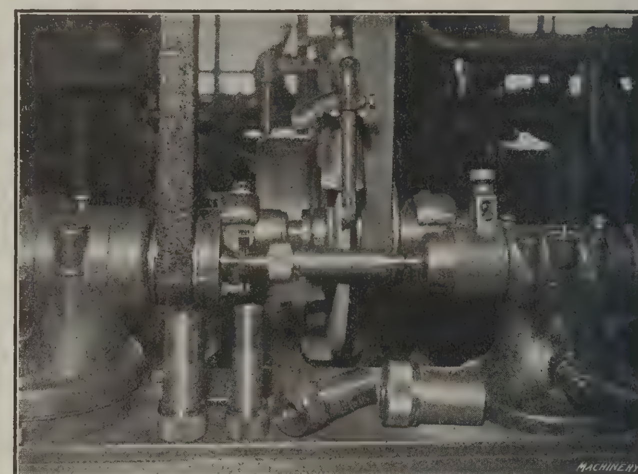

Fig. 10. Grinding the Outside of Slip Bushings

process is at best a difficult job, and the operator is never quite sure of accurate results.

It is common practice to true wheels for internal grinding with a diamond fed by hand, using the eye as a guide. This is poor practice as the wheel is seldom turned parallel, one edge being left to do all the cutting, which, of course, glazes it readily. A more practical way to true these comparatively soft wheels is to feed them past the end of a carborundum rub, in 20 grit H grade. The rub can be held in a suitable holder strapped to the platen of the grinder, or held firmly by hand against the end of the work. As a carborundum rub shows high efficiency when used for this purpose and costs practically nothing as compared to a diamond it is worth considering.

In holding work in the chuck for internal grinding, it is well to exercise due care to see that the work is not clamped hard enough to spring it out of shape. As a rule it does not require much pressure to hold work of this nature as the grinding cut is comparatively light. Attention is again called to Fig. 9 where it is seen that the chuck used in this case is of the variety commonly used on tool lathes. It is my opinion, based on practical experience, that this chuck is an improvement over the chucks commonly supplied with universal grinders, as it is more substantial and has reversible jaws which can be used independently or universally.

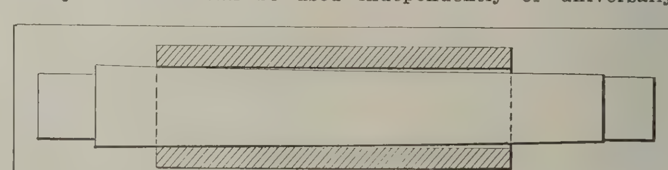

Fig. 12. Improper Fit of Bushing on Ordinary Arbor

As it is general practice to grind internal work dry a certain amount of expansion from frictional heat is always present. For this reason considerable care has to be used in calipering the work with the sizing plug. As the plug is many degrees cooler than the work it is liable, on being inserted, to contract the bushing suddenly, causing bushing and plug to "freeze" together firmly. This can be avoided by cooling the work with a plug that is known to be undersize before calipering with a plug of the desired size. The final calipering should also be done with a plug that is undersize to allow for the final finishing by lapping.

When a wheel of 60 grit is used, a hole one inch or under in diameter should be left approximately 0.0005 inch under size. This amount is sufficient to lap out the wheel marks and leave a dead smooth mirror finish to the hole. This is a general rule based on the fact that a certain amount (in this case 0.00025 inch) is enough allowance to lap out the marks left on a surface by a grinding wheel, and that should suffice for all holes regardless of size. With comparatively large holes, one and one-half inch diameter or over, it is better, however, to make allowance for finishing, owing to the fact that the area of contact of wheel and work is generally not so great and the ground surface is not quite so smooth.

In regard to the external grinding of bushings, there are two important points that should be given consideration,

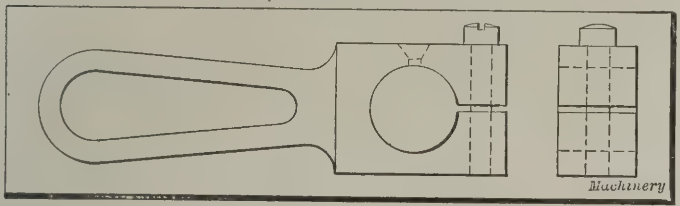

Fig. 13. Lap for Finishing Outside of Slip Bushings

viz: the selection of wheels and method of holding the work. The wheel should be fast cutting and at the same time it should hold its shape and leave a good finish—not the painfully fine finish that delighted grandfather while experimenting with the toolpost grinder, but a good dead finish from which the wheel marks can be readily lapped.

For this work in connection with a Brown & Sharpe No. 2 universal grinder I have obtained excellent results with an aloxite wheel 12 inches diameter, ½ inch face, 5 inch hole, 405 grit, N grade, D-497 bond, the wheel being run at a speed of 1800 R. P. M. In grinding some slip bushings as shown in Fig. 10, the finished surfaces averaging 1½ inch diameter, and 2½ inches long, a work speed of 75 feet per minute was used. The traverse feed of the work was the fastest that this machine was capable of giving in connection with the above work speed, and was approximately an advance of one-fourth the width of the wheel for each revolution of the work.

The finish was excellent and the grinding time for each bushing, removing 0.012 inch, was five minutes. This was accurate work, 0.0004 to 0.0005 inch being left for the final finish by lapping. The above wheel is known as a combination grit, in a medium soft grade and an open bond, and I consider it a great improvement over the hard bonded straight grit wheels used in many toolrooms.

The above work was not done with the idea of establishing a record for this class of grinding, but the object was to show a grinding machine operator what could be done in the line of cutting down production costs by the use of a modern grinding wheel. His time for grinding the same bushings, using a wheel in straight 60 grit, M grade, made by a reliable manufacturer, was fifteen minutes each. He had to use a fine traverse feed, the finest that the machine was capable of giving with a 65 feet per minute work speed to get the desired finish, and to avoid chattering and undue heating of the work.

When a number of bushings are to be ground one after another it is best to mount them on arbors of the same length when practicable to do so, thus saving considerable time generally spent in re-setting the platen, which has to be done whenever the tailstock is moved to accommodate arbors of different lengths. An arbor for holding bushings should be made as shown in Fig. 11. The straight part should be a good fit in the bushing, a slight taper on the remainder of the arbor being sufficient to prevent the bushing from turning on the arbor. When bushings are held on an ordinary arbor or mandrel the operator is never quite sure that the hole and the outside of the bushing are concentric, as one end of the arbor owing to its taper does not quite fill the hole. This is illustrated in Fig. 12. Both Figs. 11 and 12 are somewhat exaggerated to illustrate the principle.

In grinding lining and solid bushings due allowance must be made for a driving fit in the body of the jig. There are three methods in common use for making driving fits on this class of work: First, grinding the bushing until the lower end just enters the hole, the bushing being slightly tapered to bring it to a snug fit when pressed into place; second, grinding the bushing straight for its entire length, leaving it just enough oversize to make a good driving fit; and third, grinding the bushing for nearly its entire length just enough oversize to make a good driving fit, and grinding about one-eighth its length just enough undersize to enter the hole.

The first method is not considered strictly first class practice as the bushing contracts more at the top than elsewhere owing to the taper which leaves the hole in the bushing tapered. The second method is very poor practice as the bushing is very liable to cramp while being forced in place which results in an unsatisfactory job as the hole in the jig is generally sheared by the sharp end of the bushing. The third method is correct as the part that is ground to fit the hole acts as a pilot, thus insuring the proper starting of the bushing, and the body being straight insures even contraction.

In making allowances for driving fits 0.001 inch for each inch diameter of the bushing is considered practical where the holes are one inch or over, and where the holes in the jig are bored smooth. If the holes are rough bored a more liberal allowance is required. After the lining bushings are driven in place they require re-lapping as they always contract a little.

The outside of the slip bushings should be finished by lapping to a dead smooth finish as otherwise they will soon wear loose. This should never under any circumstances be done with emery cloth, but with a cast iron lap as illustrated in Fig. 13. The abrasive used in this case should be of flour grit with lard oil as a lubricant, the abrasive and oil being applied through a hole in the top of the lap. The work should be lapped with a regular even motion to insure its being straight, and should be brought to the temperature of the room by being cooled in benzine or gasoline before testing for a fit. The lapping should be carried to a point where the bushing is a wringing fit in its liner, but not tight enough to stick when left alone for a moment.

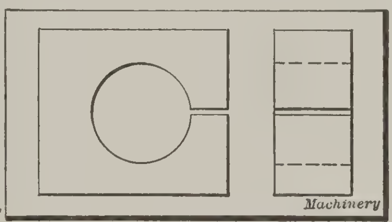

Fig. 14. A Cast-iron Lap which may be used in Emergency Cases

The lap shown in Fig. 14 is often used in an emergency; it is readily made from cast iron and held with an ordinary machinist's clamp. It is practical but not as handy as the lap illustrated in Fig. 13.

After the grinding and lapping of the slip bushings is complete, their tops can be finished by lapping on a carborundum stone, in medium grit, wet with gasoline. A regular motion should be used across the face of the stone without turning or altering the relative position of the bushing. This lapping gives the bushings a workmanlike appearance, and as the dimensions stamped are left black from the action of the fire in hardening, they can be read at a glance.

* * *

In a brief article in *Canadian Machinery*, Mr. Charles T. Main emphasizes a point on which there is a great deal of narrow misunderstanding. Many men possessing technical knowledge seem to believe that they serve their own best interest by keeping it to themselves, whereas, as Mr. Main says, an engineer possessing information, not of a private nature, of benefit to the profession in general, should be broad enough in his outlook to publish it for the benefit of his brother craftsmen. He will find on looking at the matter even from a selfish point of view, that he will not be the loser, for it will bring him into greater prominence and call attention to the fact that he is the man to be employed or consulted in work involving this particular experience. Such men should always be glad to impart to others any information available.

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FINE SCREW THREAD STANDARDS

The Navy, U. S. or Sellers standard screw threads have been widely adopted in America, and are satisfactory for the general run of machine work. They have been used for years in the construction of locomotives, cars, steam and gas engines, mining machinery, farm machinery, etc. But satisfactory as the U. S. standard has been, time has shown that it has limitations of use. The automobile is the most prominent example of a highly developed machine in which the need of finer screw threads was manifested. The jar and vibration incident to high speed and rough roads loosened screws and nuts threaded to the comparatively coarse U. S. system, and finer screw threads were required to prevent loss of parts and rapid deterioration. The French car manufacturers recognized this fact early in the development of the automobile.

In April, 1906, the Association of Licensed Automobile Manufacturers adopted a fine pitch screw standard ranging from ¼ to 1 inch diameters inclusive, and varying by sixteenths to ¾ inch and by eighths to 1 inch. This standard was extended to 1½ inch diameter June, 1911, by the Society of Automobile Engineers, the successor of the A. L. A. M.

The need of a fine pitch screw thread system to supplement the U. S. system is also being felt in the machine trade generally. In order to provide for this need it is proposed to adopt the S. A. E. standard and extend it upward to say 4 inches diameter in harmony with the pitches from ¼ to 1½ inch now existing. Replies to a circular letter sent by MACHINERY to the machine building trade indicate that many concerns have adopted the S. A. E. standard screw threads where fine pitches are required, and would gladly use them for most purposes in larger sizes if they were provided.

The extension and general adoption of the S. A. E. standard would undoubtedly simplify the special thread tool problem for the tap and die makers and relieve them of making many special fine thread taps and dies now demanded. The general adaptability of the two standards is set forth in an extract from a letter from a well-known builder of special machinery:

"The A. S. M. E. and S. A. E. standards for diameters and pitches of screws adequately supply our wants for screws of fine pitches. We rarely find the necessity for any finer pitches in the diversified types of machinery and devices that we are called upon to design or construct, and this occurs only when some peculiar condition of design demands it. From our observation and experience in the design and construction of typewriters, sewing machines, adding machines, tabulating machines, type casting machines, ticket vending machines, auto capsule machinery, knitting machinery, Lanston pneumatic keyboards, etc., we can see no reason why another standard of finer pitches than those obtainable in the A. S. M. E. and S. A. E. standards should be established."

* * *

THE INFLUENCE OF SHOP CONDITIONS

In a comment on the value of well-equipped shops and pleasant working conditions, the *Engineer* (London) remarks that good machine tools mean good workmen to run them. A manufacturer of machinery who had recently reconstructed his machine shop, converting an old-time, dingy shop into one containing the best equipment, arranged and lighted so as to provide for the highest efficiency, stated that he found it much easier to obtain high-class workmen as soon as it became known that they were to operate high-class machine tools.

It is a mistake to believe that all machine operators work for wages only. Many men operating machines in obscure corners of a shop take considerable pride in the work they do, and they enjoy an opportunity to use the best and most accurate machines. Another of the erroneous, old-time ideas which are apparently giving way to a sounder appreciation of the workman's feelings, is that the average machinist, having to perform work in which he cannot possibly keep clean, does not care whether his surroundings are clean and comfortable or not, but is satisfied to work under conditions of any sort. The new plants being erected all over the country show that employers are realizing the value of light, airy and comfortable workshops, and that the additional investment required is money well spent, as it increases the efficiency of the men and lessens discontent, which is the most subtle cause of inefficiency the manager has to deal with. Other conditions being equal, the firm with a clean, light and well-equipped plant will have much less difficulty in getting along with its workmen than one with a dark and dirty shop. It is not without reason that the industries where labor troubles are most frequently encountered are those where the workmen are employed under unsanitary or uncomfortable conditions.

* * *

INVESTMENTS IN UNDEVELOPED INVENTIONS

If the history of "frenzied finance" and dishonest promotion is ever accurately written it will include many cases of patent exploitation wherein inventors and investors were fleeced by smooth-tongued sharpers who promised to develop and market valuable inventions. Some of the most ingenious discoveries and mechanical designs of the times are hopelessly tied up in litigation resulting from the organization of companies and sale of stock before the inventions were developed.

Capital is necessary to place most inventions on the market, and no matter how meritorious a device may be, considerable argument and persuasive ability on the part of some one having faith in it are generally required to obtain the necessary funds from capitalists. The reluctance of capitalists to invest in unknown possibilities is not shared by clerks, bookkeepers, laborers, servant girls and others eager for large returns on small investments, and this fact is shrewdly turned to advantage by promoters who paint in bright colors the probable returns, quoting perhaps the experience of the original investors in telephone stocks as an example of enormous profits yielded by an invention. Inexperienced people who turn over their money for investment in stocks whose value is problematical are too often bitterly disappointed.

A safe rule to follow is to invest nothing in an undeveloped invention unless you have first-hand knowledge of its scope, its novelty, the probable market, and the character of the men who are promoting it. Even when you possess this knowledge the chances for failure are many, and the investment should be made with full appreciation of the possiblity of loss. Widows, orphans and others whose capital is their only resource should steer clear of mechanical promotion schemes generally. Although not usually conceived with the dishonest intent characteristic of mining schemes, they are nevertheless hazardous investments, quite likely to result in loss.

STANDARDIZATION OF MACHINE TOOL PARTS

It is a proper function of the engineer to conserve as well as to produce. Production with waste is abhorrent to the engineer who fully appreciates his economic relation to the manufacturing world. In fact, engineering is the science of producing efficiently, which means the elimination of false movements and waste effort, the utilization of waste products and the substitution of mechanical power for human muscular effort. The elimination of waste carried to the logical end in engineering work would put an end to competition, but that is a condition of society too far removed from present possibilities for serious consideration now. What we can do is to work for those results which in a competitive world may be agreed on as being for the common good.

In the manufacture of machine tools there is little in common as regards sizes and shapes of those parts in the design of engine lathes, planers, shapers, drilling machines and other so-called machine tools made by the various builders for which interchangeability is highly desirable. It is plain to any unprejudiced person acquainted with the conditions of use that certain standards might be adopted by machine tool builders with advantage to themselves and their customers.

For example, take the floor plan of a dozen different makes of sixteen-inch lathes, and it will be found that, although the variation may be little, practically twelve different layouts of foundations will be required. This is a wasteful and undesirable condition, and it would seem that two foundation plans, one for light and the other for heavy designs, should suffice. Surely this is a difference on which it should be comparatively easy to reach common ground for agreement. A similar understanding might be applied to the spacing of bolt holes in countershaft hangers, and any other features affecting the installation.

The more vital matters on which agreement is desirable are standards for lathe spindle noses, dimensions of tee-slots, direction of feed for a given direction of rotation of a feed handle, general position of handles, dimensions and taper of taper shanks and sockets, number of threads per inch of lead-screws, etc.

The matter of agreement of lathe spindle noses is so important that some manufacturers adopted private standards years ago, and specify them when ordering new equipment. One system that has proved satisfactory is the common U. S. standard bolt screw thread sizes. With this system, chuck and faceplates can be sized with standard taps thus simplifying the home making of special lathe attachments.

The Society of Automobile Engineers has worked out several important improvements in manufacturing conditions by which useless duplication of sizes of stock parts have been eliminated. The work of this society is most commendable and constitutes a worthy example for other societies and associations of manufacturers, to imitate.

* * *

THE VALUE OF COST SYSTEMS

In speaking before the American Society of Swedish Engineers recently, Mr. H. L. Gantt, of scientific management fame, pointed out that there are two distinct objects to be accomplished by cost systems and records of factory performances. One purpose of a cost system should be to enable those occupying responsible positions connected with the production to obtain such information as may enable them to devise new and better methods and improve old ones, and to have definite information at hand showing to what extent the new methods actually are more economical than those of former practice. In some shops, however, Mr. Gantt found that the cost system was not kept with this object in view. Very few people connected with the production end of the factory were permitted to make use of the data recorded, and the cost system merely afforded those in charge an opportunity for criticism and fault-finding. No effort was made to devise more economical methods, or to locate the trouble in a systematic way when one month's performance did not come up to that of a preceding month. The executive used the record merely to hold up before his superintendent and foremen, telling them that they did not run their departments as they should.

A cost system run in this way is almost worse than useless; it creates discord and does not serve to increase production. The real purpose of such a system should be to show at any moment if production is falling behind; and a systematic effort should then be made to find the cause, not merely by blaming an individual, but by locating with accuracy the exact conditions which are the cause of the decrease. These conditions may be beyond the control of any of the persons ordinarily blamed. In a machine shop they may be due to hard castings or other defects in the material supplied to the department. They may be due to improper heating and ventilation of the plant. They may be due to unavoidable changes in the personnel. Whatever the cause, it should be ascertained; and unless the cost system accomplishes this, it is of little value because merely blaming a man does not enable him to remedy a defect. He must first find the cause, and the cost system should help him to do that.

Of equal importance is the function of the system which enables foremen, superintendents, designers and others vitally interested in production to determine the value of new ideas; and in order that the cost system may fulfill its purpose in every respect, men in responsible positions within the factory must be given access to the cost data compiled.

* * *

THE PATENT THAT GEORGE DIDN'T TAKE OUT

BY A. P. PRESS

George was a good toolmaker, and when he was not making tools he was playing whist, and although he was an expert at both, I think his abilities in the whist playing line rather lapped over his toolmaking capacity.

Now we have all played whist, and when you have a good sized party in the dining room and parlor, the next morning the floor is covered with the scrap punchings where the score is punched out of the cards.

So as they sat at the breakfast table one morning, with the floor covered with chips, Mrs. George said:

"George, why couldn't you put a pocket on the punch, so as to catch all these little pieces? They are awful hard to sweep out of the carpet."

"Sure thing," said George, and that morning after he got a long chip started, and the boss had gone out for an hour, he turned up a pretty little brass sleeve, and soldered it on to the under side of the punch. He put a threaded cap on the end, so he could unscrew it and empty out the punchings.

He took it home that night, and his wife was enraptured. They used it the next whist night, and his friends all complimented him on the success of his invention.

"Why don't you have it patented? There is a fortune in it if you get hold of somebody to push it for you."

When you get the patent microbe started in a man's brain, it is a pretty hard thing to exterminate it, and George went down to see a patent lawyer the next afternoon.

"Yes," said the lawyer, "that is a pretty good thing, but you ought to have a better looking sample than that. You should get a nicer looking punch, and put it on that."

That night after supper, George got busy. First he sent the oldest boy down to the hardware store and told him to get the nicest ticket punch he could find. The kid came back, and George undid the package, took it out, and there was the cutest little punch you ever saw, with a pocket on it to catch the chips and patented some ten years before!

The microbe was exterminated from George's brain.

* * *

A German contemporary publishes an article in which the writer discusses the theoretical principles of the Tesla steam turbine described in MACHINERY, November, 1911, and also referred to in a note in the July number. The German author points out that the efficiency cannot exceed 50 per cent with the construction employed, and on larger sizes the efficiency would be proportionately less.

INDUSTRIAL ADMINISTRATION AND SCIENTIFIC MANAGEMENT—3

CONSIDERATION OF THE MOST IMPORTANT OBJECTIONS TO SCIENTIFIC MANAGEMENT

BY FORREST E. CARDULLO*

Enough has been said to show that laws and economic conditions have a very great effect upon our industries and the efficiency with which they are conducted. Changes in the law which decrease efficiency are usually objectionable and changes are usually more far-reaching and important than most men believe to be possible. While the engineer usually considers such matters to lie entirely outside his work, yet they affect it so vitally that he will before long be compelled to give them his attention, and to apply to them the same hard-headed and rigorous analysis that he now gives to the design or construction of a piece of machinery. When he does, the lawmaker will regard his efforts skeptically, the financier will regard him as a meddlesome bungler, and most men will regard him as a gross materialist without proper regard for the higher things of life.

In the same way that we have previously classified and examined the sources of industrial inefficiency, let us classify and examine the objections which may be raised against scientific management. These objections come from three sources, the employer, the employe and the public.

Objections of Employers to Scientific Management

Taking first the objections raised by the employer, they usually arise either from a misunderstanding of what scientific management is or from a misconception of the fundamental principles of industrial administration. The objection most often raised is that scientific management very greatly increases what some men term the "expense burden" and what others term the "overhead charges." This is true and yet it is not an objection to scientific management if it can be shown that the total cost of manufacturing a given product is reduced by thus increasing the overhead charges. The introduction of a drafting-room or of a pattern-shop into an establishment which has previously purchased such work outside, will increase the overhead charges, but most plants find it cheaper to maintain drafting-rooms and pattern-shops in spite of this fact. If four men are employed, it is just as well to have one of them constantly engaged in planning the work of the other three, and keeping them supplied with tools and material, as it is to have each one plan his own work and run his own errands.

The question of whether scientific management unduly increases the expense burden is one which can only be answered by experience and in the terms of dollars and cents. If the cost of doing a given piece of work is reduced by scientific management, the question of the ratio of the overhead to the direct charges is of no consequence. If, on the other hand, the cost is increased by scientific management no other argument is necessary in order to condemn the system, and the ratio of the direct and indirect expenses is a matter of purely academic interest.

While some employers are willing to admit that the cost of manufacture is reduced when scientific management is employed, they advance the argument that while direct labor may be discharged when it is not employed, the men in the planning department cannot be discharged without destroying the efficiency of their organization, and so must be retained at considerable expense during periods of industrial depression. Similarly, while the wage cost is cut off entirely when men are discharged, the extra fixed charges upon the larger plant usually called for by scientific management, do not cease when times are slack, and that, therefore, in those industries which are particularly subject to periods of depression, scientific management will be a failure, although during periods of prosperity, it may show a reasonable saving in costs of manufacture. To this objection two answers may be made. First, when scientific management shows a gain after taking account of the periods of depression, it ought to be adopted. Second, if scientific management enables a firm to manufacture more cheaply than competitors, that firm will be able to accumulate a surplus so that it can continue to manufacture and store its product when it would otherwise have to be sold at a loss. Furthermore, it will be able to undersell its competitors, will do a fairly large business in dull times, and will therefore be able to operate its business with less attention to industrial conditions than is given by other firms. If scientific management is able to show a saving at any time, the chances are that it will be able to show a saving all of the time.

A third objection often raised to scientific management is that when a shop is run as systematically as this method of management requires, a sudden change in plans is impossible without seriously disarranging the work, so that the rush order or the special job does not receive the attention which it should. The answer to this objection is that scientific management should contemplate all of the conditions likely to arise in the plant and should provide special means for expediting certain work when that is necessary. If such special means are not provided, the system is imperfect and is not scientific management since it is not adapted to the needs of the particular plant.

A great many objections raised against scientific management come from men who have seen shops in which scientific management has been attempted by managers, superintendents or others, who did not understand what it was. Such men have often attempted to combine scientific management with conventional systems, and while they have sometimes developed improvements, they have often fallen into ludicrous blunders. Such blunders cannot be charged to scientific management, and when it is claimed that scientific management has failed in specific instances, it is well to investigate the case, and see whether the failure is one of scientific management or of unscientific management.

Objections of Workmen to Scientific Management—Wearing Out Men

On the part of workmen there is considerable objection to scientific management. I believe that it usually arises from an idea that efficiency lowers wages and throws men out of employment. This objection, however, is rarely if ever alleged, but others are sought to take its place. The first one, and the one worthy of most serious consideration, is the objection that under scientific management men are urged and compelled to work at such a pace that their health and vitality suffers. Now it is doubtless true that men can be overworked in certain industries, but it is equally true that it is very difficult to overwork men in most industries unless the hours are unusually long. What is termed overwork is usually a matter of unsanitary laboring or housing conditions or insufficient nourishment. For instance, a man may be compelled to work in a cramped position or exposed to great heat or poisonous vapors, he may be compelled to eat and sleep in a hot and dirty tenement, or his wages may be too small to buy nourishing food. If the adoption of scientific management lengthens the time during which he is exposed to unsanitary conditions, his health will suffer, but this is not a matter of overwork but a matter of industrial sanitation. Scientific management recognizes the fact that workmen are often exposed to unsanitary conditions, but the scientific method is to change the conditions and not to reduce the amount of work required.

When we come to discuss the trades usually carried out under sanitary conditions, and requiring a considerable expenditure of muscular effort, we will find that the amount of effort required to accomplish a given task may be reasonable for some men but unreasonable for others. Whether a task is too severe or not, depends on the strength and endurance of the individual workman. Tasks possible for a vigorous man are impossible to one who is ill or weak. Men lacking in strength or vigor are not fitted to engage in certain occupations and they should be transferred to other occupations for

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which their physical defects do not unfit them. For instance, a man whose strength is unequal to the tasks demanded of a hod carrier or blacksmith helper may be very well fitted to become storekeeper's assistant or to operate a punch press.

In this connection it must be noted that a man is not like a machine, but that the wear and tear of the body are repaired by periods of rest. So long as the degree of exertion required of a man is not such as to produce discomfort when continued for several minutes, and so long as proper rest periods occur at suitable intervals throughout the day, the man will not be overworked, but after becoming accustomed to his task will be able to continue his work week after week without any diminution of vigor. If he is properly nourished and works and lives under sanitary conditions, such a man will be just as vigorous and long-lived as though he were engaged in some less laborious occupation.

As a matter of fact it does not pay to wear men out. If men are caused to work at such a rate that their vigor diminishes, they will in their lifetime do less work than they would had they worked at a slower and less exhausting pace, and both the industry which employs them and the community in which they live will suffer accordingly. On that account we need have no fear that scientific management intends to overwork men, although in isolated instances men may be overworked under scientific management either because they are not fitted to the task to which they are assigned or because the one assigning the task was not experienced enough or careful enough to assign a proper task.

One of Mr. Taylor's early successes was to increase the amount of pig iron carried by laborers by properly training them for the task. The amount of pig iron carried after proper training and selection was about forty tons against a previous record of ten tons per day. The first laborer trained for this task was a man named Schmidt, and one of Mr. Taylor's critics thinking the task excessive and severe, very justly inquires, "What became of Schmidt?" Mr. Taylor informs me that Schmidt is at the present time well and hearty and still capable of strenuous tasks and financially much better off than he would be had he not been helped by scientific management.

Harder Work without Corresponding Pay

The second objection raised by workmen against scientific management is that the men are expected to "work very much harder" without receiving a corresponding increase in pay. Often by the introduction of scientific management, a man's output will be increased three or four fold while his wages will be increased not more than from thirty to sixty per cent. The average workman feels that under such circumstances his wages should be increased in the same proportion as his output. When, however, we come to analyze the matter, we find that the workman's contention is not true and that he ought not to expect his wages to be increased in that proportion.

When a man receives his wages, he is paid for several things. In the first place he is paid for his time. In order to get a grown man of potential value as a workman to come and sit in an office and do nothing for eight hours a day, or even to amuse himself in some manner, it would be necessary to pay him something, and probably it would be hard to find men willing to undertake such work, if it may be called work, for a dollar a day. In the second place he is paid for his physical effort. Work requiring no knowledge or experience and which merely requires physical effort does not usually command very good pay. Of course it commands more pay than does the mere expenditure of time, but certainly the effort which an ordinary laborer puts forth, cannot be estimated to command more than 75 cents to $1 a day, and I doubt if the average laborer who receives $2 per day would be willing to take a job at $1.50 per day which did not require any expenditure of effort. A third element for which a man is paid is the ability to receive and understand instructions. A fourth element is skill or dexterity, which enables him to perform a task quickly and well. A fifth element is a knowledge of the details of a trade, which is usually attained by experience and observation.

Let us suppose that a man is engaged in the turning of heavy pieces of steel and that by means of scientific management (*i.e.* by furnishing him proper tools, by standardizing the material, and by informing him of the proper speeds and feeds to use) his output is increased three fold. The time required is the same as before. That portion of his wages which he receives for time expended should therefore be the same as before. The effort required is three times as great as it was before. Since, however, the most of his time is expended in watching his machine and only a small portion of it in changing tools and work, the pay which he receives for the effort expended is very small, and the increase in pay due to the increased effort is proportionately small, certainly not more than 25 to 30 cents per day. The dexterity which he has, and the knowledge of the details of his trade, are no greater than before, and these elements do not call for any inccrease in his wages. A larger measure of ability to follow instructions is required, and this element of his pay should be increased. Of the five elements of his pay two require an increase, and three should remain unchanged. Altogether the increase in pay required by the extra effort and by the increased ability to follow instructions is quite modest, and if the man receives thirty or forty per cent increase in wages, he has received all that he can in fairness ask for. The only way in which we can fix a fair rate of pay is by reference to the rates received by other men engaged in substantially similar occupations. The application of scientific management in different industries will result in different increases in efficiency. In some lines a workman's efficiency will be increased only 20 or 30 per cent, while in other lines it may be increased five hundred or even one thousand per cent. If the work done in the two lines is similar, the pay of the workmen is probably nearly equal before the introduction of scientific management, and ought to be equal when they have attained their best efficiency.

Let us take as an example a foundry in which two different molders are engaged, one on light brass molding and the other on heavy iron molding. Let us suppose that each is paid at the rate of forty cents per hour, that the brass molder puts up twenty flasks a day, and that the iron molder puts up two. Let us suppose that as a result of a careful time study it is found that the brass molder can, without tiring himself unduly, put up thirty flasks a day, while the iron molder can put up six. Each man is then working at his best rate, and while it might be possible for him to do a trifle more work, it can only be done at the expense of his physical welfare. If now, the pay of each is increased in proportion to this increased output, it will be seen that the brass molder will get a fifty per cent increase and the iron molder a 200 per cent increase, the brass molder receiving 60 cents per hour, while the iron molder receives twice as much, or $1.20 per hour.

Now, when you come to think over the results of the application of time study in these two cases, it will be plain that if the work of the brass molder was formerly worth 40 cents an hour, that of the iron molder was worth only 20 cents an hour, and it would be highly unjust after the change in conditions had taken place, to pay the iron molder twice as much as the brass molder. In other words, for work requiring substantially the same intelligence, the same effort, and the same training, workmen should receive substantially similar pay, and this pay should be based upon what constitutes a fair wage under the best conditions, and when they have reached their best efficiency.

The same thing which applies in the case of two molders will apply in the case of two different trades in the same industry, or for that matter, in different industries. If the efficiencies of the workmen engaged in two different trades were unequal before the introduction of scientific management, it follows that injustice will be committed if the increase in wages in each trade is made proportional to the increase in output after, in each case, the workmen have attained their best efficiency.

Another way to look at the matter is to treat it as though the workman were selling his labor under the same conditions as any other commodity. Whenever there is a great reduction in the cost of manufacturing a given product, we expect that there will be a corresponding drop in the price, and usually this is true. The cost to the workmen of doing a given piece

of work is the cost of living. The fact that he does a much larger amount of work than he did before does not increase his cost of living, and consequently the cost to him of doing a given amount of the work is materially reduced, being in the case we have chosen, only one-third of what it was before. Under such conditions the employer may reasonably expect that there will be a decrease in the labor cost, and while the workmen should expect to get higher wages, the employer expects with reason, to pay a lower price per piece. When the workman has an opportunity to do a larger amount of work without any increase in the cost of living, and to receive for his work a larger wage, he is in exactly the same position as the merchant, who by reducing his price is enabled to sell a larger quantity of goods in a given time, to turn over his capital oftener, and to make a larger profit in the course of a year, although he makes a much smaller profit on each article sold.

Finally, we must consider that when a man's efficiency is increased as a result of the application of scientific management, only a small part of this increase in efficiency is due to his own effort and that the most of it is due to the study and effort of the employer. Accordingly any gain which is realized must be divided between the employer and the employe, and usually with the public in the form of lower prices, in order that the public may absorb the larger output resulting. If the employe is to receive all the benefit resulting from scientific management, which would be the case if wages were increased in proportion to output, then it would be no object for the employer to utilize scientific management and its adoption would be of no advantage to the community. If the employe realizes a third of the gain due to scientific management, he has had his share, and must recognize that the other two-thirds belong respectively to the employer and to the community.

On being not required to think, but to carry out Instructions

A third objection often urged by workmen against scientific management is that they are not required to think, but merely to carry out instructions. They feel that when they receive complete instructions as to the method of performing work, it places their work upon a lower plane, transforming them from intelligent workmen into automatons. As one man has expressed it, "I like to think I think, even if I don't think." The answer to this is that Americans have in the past laid undue stress on originality and not enough on ability to follow instructions. If ten men are given explicit instructions as to exactly what to do and how to do it, very seldom will it be that one out of the ten will do exactly as he is told. On the other hand, if ten men are given a puzzle to solve, most of them will succeed within a reasonable time in solving the puzzle. The solution of a puzzle or the origination of a method of work really does not require any higher order of intellect than the exact following of a described method, and is, in the majority of cases, a gift of considerably lower social value.

I have had considerable experience in writing out exact directions informing men in the junior and senior classes of an engineering school, how to perform certain experiments—for instance, how to calibrate a gage. Three men out of five when given the directions for calibrating a gage will read them over and then go to work to calibrate the gage by a method of their own, which is usually incorrect. In the same way, it will be found that when a workman is given a piece of work to do, he will perform the work by a method of his own which is usually incorrect, in that it is not the most efficient method. This brings up the question of whether, for his own amusement, a workman ought to be permitted to adopt inefficient methods of work. When it is put in this blunt manner, every workman will admit that he ought to adopt the most efficient methods of work, and when he realizes that his wages are reduced and his employment endangered if he follows inefficient methods, he will usually be perfectly willing to follow instructions.

The use of instruction cards does not, however, take away from a workman the power of initiative. When a workman succeeds in devising a better method of doing a piece of work than that devised by the planning department, his method will be adopted, and he will receive a reward for devising it. If a workman shows himself capable of devising good methods of work, a place will soon be found for him in the planning department in which he can use his superior ingenuity to his heart's content. Because he has been accustomed to the use of the best methods, he will have a very much better fund of experience to draw upon than a man who has always worked in shops in which the workmen devise their own methods, and on that account his work will be of a superior character.

The use of instruction cards does not prevent a workman from thinking about his work, or from striving to originate new methods, in case he has any originality. Instead, when working from instruction cards, he has constantly before him examples of the best methods of doing work, and his experience is very much superior to that of a man who works in a shop where the workmen devise their own methods.

A man who is minded to do so can advance very much faster in a shop under scientific management, provided he is willing to study and learn. To the intelligent workman such a shop is a trade school, which will help him to a better understanding of his trade, and a chance for larger usefulness.

The argument that scientific management destroys the workman's power of thinking is a fallacy, because it assumes that the only thinking which the workman does is in regard to his work. The higher wages which scientific management involves will bring to the workman opportunities outside of his work which he cannot get otherwise. It will give him money for the purchase of books, for the building of his home, for the education of his children and for increasing the refinements of life. Even if it were true that scientific management curtailed the workman's opportunity to exercise real originality in his work, his intellectual life would still be the gainer from its introduction.

The workman's principal objection to scientific management is that he likes to do things his own way, to work as he pleases and when he pleases. Scientific management is objectionable to him because it compels him to change his habits, which is an uncomfortable process. If a workman were trained under scientific management from the beginning of his apprenticeship, and after several years were put to work in an ordinary shop, the change in habit would be just as disagreeable to him. He would object strenuously to being saddled with additional responsibilities while at the same time his pay was substantially reduced. The slipshod methods of his fellow workmen and the general inefficiency of the shop would grate on his nerves, and be ten times more disagreeable to him than the change in habits which scientific management usually introduces.

We must recognize that men are prone to complain and that anything new, especially if it involves a change in habit, will be the butt of the complaint. If they could not complain about scientific management, they would complain about the length of hours or the temper of the boss or the tools furnished for their work.

Scientific Management involves a Change of Habit

The fact that scientific management involves a change in habit which is disagreeable to many men is not a serious argument against it. People who become accustomed to living in disorderly and dirty surroundings find themselves uncomfortable when obliged to clean up and put things in order. Habits of labor which are inefficient are just as objectionable from the standpoint of the social welfare as habits of life which are unsanitary. Coming generations will look scornfully upon those who are inefficient, just as the present generation looks scornfully upon those who are dirty.

The change of habits involved in the adoption of scientific management is, from the practical standpoint, the strongest objection that there is. The minute you can show a workman that it is to his financial advantage to adopt the methods of scientific management, that minute all objections but this will disappear, but this one is ingrained in his temperament and nervous system, and cannot be reached by logic. Habit is one of the easiest things to form and one of the hardest things to eradicate, but even habits and prejudices must disappear at the demand of social welfare.

A great many misguided souls will urge against scientific

management the same arguments which are urged against all other advances of civilization, namely that it impoverishes the imagination, takes the poetry out of life, puts men to work at machine-like tasks, etc. The same arguments are leveled against all improvements. The sanitary dwelling is less picturesque than the thatched cottage; the mowing machine is not so poetical as the scythe; the division of labor which enables ten little minds in combination to accomplish ten times the task that was formerly done by the ten master craftsmen is said to deaden men's souls and to limit their horizon. It is the eternal battle of common sense and the good of the community against selfish sentiment which regards only its own mental pleasure and takes no account of the good of the swarming many that are benefited by industrial advancement.

No Provision for Unions or "Collective Bargaining"

Another and very valid objection which workmen urge against scientific management is that it makes no provision for unions or "collective bargaining" as our friends the sociologists prefer to term it. It is undeniable that unions are necessary for the welfare of workmen and that without organized effort it would be difficult for them to maintain satisfactory wages and conditions of employment in the face of the tendency of capital to combine into trusts and associations. If scientific management is incompatible with labor unions, workmen cannot afford to accept it, because when scientific management has been adopted and unions have been destroyed, the whole of the benefits will be appropriated by capital, and labor will receive nothing for its increased efficiency.

Notwithstanding that many of the leading exponents of scientific management are opposed to labor unions, and believe that individual bargaining is one of the essentials of scientific management, this is not true. We can still have agreements in regard to minimum wages, hours of labor, conditions of employment, and many other things which affect the welfare of the workmen. The unions, however, must stop short of making any requirements in regard to methods of work or quantity of output or maximum wages paid or premiums given, because such things are not proper subjects of discussion between the unions and the employer, and because any effort on the part of the unions to interfere in such matters will harm workmen even more than employers.

I believe that the reasons that the advocates of scientific management feel their work to be incompatible with unionism is that many of the unions have in times past interfered in matters which were not properly their concern, and by doing so have harmed the cause of labor. Whether scientific management is largely adopted or not, unions will some day cease to interfere in these matters, because it is contrary to their own interests to do so. Since proper demands on the part of unions do not interfere with the operation of scientific management, and since those demands which would interfere with its operation are contrary to the interests of labor, I cannot see that there is anything incompatible in having scientific management in a union shop, and I believe that any effort to destroy unions when introducing scientific management can only serve to delay the date of its introduction.

Even the most serious objections to scientific management on the part of workmen, however, fall to the ground in the face of the fact that when scientific management is adopted workmen receive from thirty to sixty per cent in increase in wages. Not only will there be an immediate increase in wages as a result of scientific management, but with the extensive introduction of scientific management, there will be a substantial decrease in the prices of all those commodities in the manufacture of which it is generally applied. It is usually found that it is impossible to combat the self-interest of a community for a considerable period of time, and as soon as it becomes apparent that the working class, in common with all members of society, receives substantial benefit from scientific management, the objections to it will disappear and those things which at first were regarded as serious drawbacks, will eventually be deemed to be mere trifles and in some cases be regarded as positive benefits.

Objections of the Public to Scientific Management

From the standpoint of the general public, objection can be made to scientific management if it can be shown that it is inefficient, that it injures the health of the workmen, that it lowers the quality of the product, or that it brings about undesirable social or economic changes. The public does not, however, need to worry about the question of efficiency, because if scientific management is not efficient, it will not be used by manufacturers. Scientific management will for a long time be under very severe scrutiny by workmen themselves and it is unlikely that any harm will come to the physical welfare of the workmen unless in very exceptional cases.

Scientific management does not usually lower the quality of the product. In certain cases quality may suffer, but in most cases quality will improve as a result of scientific management. Sometimes a decrease in the quality of the product is not a serious matter, while at other times it is. If it is, scientific management is prepared by proper inspection to insist on such quality as may be commercially desirable. Whenever the public is disposed to require a certain standard of quality, and is willing to pay for that quality, there need be no fear that the quality of output will suffer from the introduction of scientific management.

The principal objection to scientific management is that it will bring about very important social and economic changes with which our present laws are not capable of dealing. One of the effects of scientific management will undoubtedly be the destruction of the small manufacturer. Scientific management achieves its greatest success in comparatively large plants. Those firms which adopt scientific management and are able to secure successful administrators, will crowd their competitors to the wall, eventually absorbing their business and becoming monopolies. Since our present laws are obviously inadequate to deal with such a situation, it follows that we must have a little scientific management in the lawmaking department of our government if we are to avoid social and political evils from the growth of scientific management.

It may be pointed out in this connection however, that men of the "public-be-damned" class do not take kindly to scientific management. Men who are successful in introducing scientific management are those who recognize their duties, and are prepared to act for the welfare of the community as well as of their workmen and themselves. And aside from this fact those monopolies which will be the outgrowth of scientific management will be less oppressive and objectionable than those which are the outgrowth of high finance, legislative favors, or the cornering of natural resources.

Another economic evil which may result from the adoption of scientific management is the mis-direction of effort which will mark the transitory period while conditions are becoming settled. The cause of this is that by the use of scientific management the output of an industry will be very greatly increased. Sometimes the increase will be so great that the community cannot absorb the entire output at the cost of manufacture. The result will be that certain lines of work will be overdone and we will be some time in finding a rational and proper outlet for the extra productive capacity made possible by improved management.

Social and Economic Effects of Scientific Management

Upon surveying the social effects of scientific management, one is impressed with the idea that scientific management will improve social conditions very greatly and that there are only two economic evils prevalent at the present time that will not be materially diminished by the direct or indirect effect of scientific management. The first of these is the misdirected application of capital which results in potential overproduction in certain lines of industry. The second is the diversion of capital from industry for private pleasure. As an example of the first evil, I may cite the textile industry where capital is invested to such an extent that the mills are capable of filling all demands for textile goods when working at only a fraction of their capacity. Examples of the

second evil are unnecessary since they will suggest themselves to most of my readers.

Scientific management must, in the long run, depend for its success upon the habit of mind of those who administer it. We think of the scientist as being a man who is, above all things, intelligently honest, who is without passion or prejudice; who is open-minded and determined to arrive at the truth. The scientific habit of mind is the only one compatible with the administration of scientific management. The man in authority must divorce himself from prejudice, from preconceived notions and snap judgments, and from everything which will turn him aside from the truth. In adopting scientific management, he must recognize certain great principles; some of which are economic, some of which are psychological, some of which are ethical, and some of which are merely physical.

An industrial establishment is merely a part of a great economic system. Recognizing this, the employer will see that if the establishment does not minister to the needs of the community, it is useless. Not only must its product be valuable, but is work must be carried on in such a way as not to harm the community. Work which is carried on at the expense of a part of the community, in order to benefit the remainder, cannot be justified. By such work I mean work carried out under dangerous or unsanitary conditions, or where the wages paid are insufficient to maintain the community standard of living. It may be cheaper to carry on work in that manner, but the moral sense of the community will not in the long run permit of it, and scientific management recognizes the fact.

The interests of all men engaged in a given industry are identical. A certain school of thought is accustomed to regard the labor situation as a war, in which employer and employe are striving to obtain an advantage over each other, each striving to secure from the other the largest possible proportion of the total returns of the industry. Scientific management recognizes this to be an error, and knows that cooperation between employer and employe is essential. It recognizes not only that the employer must purchase the cooperation of the employe by high wages and fair treatment, but also that he must cooperate with the employe by assising him in every way to become as efficient and valuable as possible. Each must cooperate with and assist the other, and must purchase by fair dealing and generous attitude the cooperation of the other.

The greater the productivity of a community, the more prosperous the community will be. High wages and restricted production are incompatible, and only by achieving the highest efficiency can the greatest prosperity be reached. There may be, however, overproduction in certain lines of work, because too much capital or too many men may be engaged in that line. This does not mean that too many men are employed or too much capital is available. It merely means that men are employed in the wrong industries and that capital is invested in the wrong lines. Consequently, the application of scientific management to all establishments engaged in one particular industry, may result in throwing the industrial system out of balance by producing more of one kind of goods than is necessary.

Conclusion

Work well done under proper conditions is interesting and healthful when the worker is healthy and well nourished. Work under unsanitary conditions is unhealthful. A poorly-nourished workman is always overtaxed by relatively small tasks. Unsatisfactory surroundings and slovenly work results in nervous strain which breaks down the workman's health. Men differ mentally and physically in innumerable ways, and each workman must be studied in order to discover the most useful place in which to put him. He must be put in that place where his abilities will be utilized to the utmost.

A careful study of a piece of work by a man of scientific habit of mind, having at his command the knowledge of a large number of expert workmen, will result in the development of methods of doing work which are far superior to the methods usually employed. Workmen naturally perform their tasks in improper ways as a result of habit. In order to have them perform the tasks in a proper way they must have supervisors to see that they form correct habits of work, and they must be encouraged by extra pay to continue in these habits.

The cooperation of workmen must be secured by persuading them that the employer has abandoned the attitude of war and that he is willing to divide the results of his improvements with the men whose cooperation makes these improvements possible.

Finally, the benefits of scientific management are so many and so varied that not only employers and workmen but the community generally will participate in them. It is therefore proper not to object to scientific management but rather to study the ways in which we can eliminate the evils which may possibly come from its use, and take advantage of the benefits just as we take advantage of the benefits of railroads, printing presses and steam power, in spite of the manifold evils which some men thought they foresaw as a result of their introduction.

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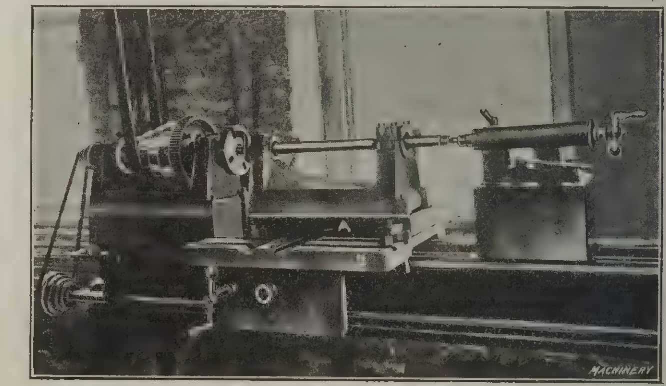
BORING AND FACING THE SPINDLE BEARINGS OF LATHE HEADSTOCKS

There are various methods used for boring and facing the spindle bearings of lathe headstocks. Some lathe manufacturers use boring machines, while others equip lathes with special fixtures for this purpose. The accompanying illustration shows the method used by the Rahn-Larmon Co., Cincinnati, Ohio, in boring and facing the bronze spindle bearings for a 20-inch engine lathe.

After the V-guides have been planed, the caps fitted, and the bearing boxes faced on the planer, the headstock is bolted



Fixture used by the Rahn-Larmon Co., for boring and facing the Spindle Bearings of Lathe Headstocks

to a special table *A* provided with ways to fit the V-guides in the headstock. This table, in turn, is clamped to a special carriage *B*, fitting the lathe shears and provided with a slot in its top face, which by means of a tongue on table *A* locates the bearings in the headstock in perfect alignment with the lathe centers.

The boring is accomplished with a boring bar held on the centers, and driven by a dog. Both front and rear bearings are bored at one setting, two cutters being used. The front bearing is 3¼, and the rear, 2½ inches in diameter. The bronze bearings are next faced with a broad-faced fly-cutter, after which operation the bosses of the bearing caps are reduced to the same diameter as the bronze bearings with an L-shaped fly-cutter. All the operations enumerated, as well as clamping, etc., take about 40 minutes for each headstock.

D. T. H.

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Statistics relating to the automobile industry in the United States indicate that, at the present time, this industry is the third in importance of the various industries of the country. There were in April, 1912, 652,500 automobiles registered in the United States. The daily production of pleasure cars alone, during 1911, reached 700 a day. There are more than 25,000 commercial cars and trucks in use and it is estimated that 30,000 of these cars will be manufactured during 1912.

THE MOTOR TRUCK IN MANUFACTURING

ITS UTILITY, ADAPTABILITY, CAPACITY AND ECONOMY UNDER SUITABLE CONDITIONS

BY HAROLD WHITING SLAUSON*

There is probably no place where the motor truck is surrounded by more favorable conditions for efficient operation than in the average manufacturing business. Machines are used throughout for the production of the goods; why should not mechanical power be employed for the transportation of the raw and finished material? No matter how large or how small the plant may be, and regardless of the size, nature, or quantity of the product, a motor truck transportation, delivery, and hauling service *must* show a marked saving in time and money over the horse type, if the former is properly installed and operated under efficient conditions. As power-driven machines have reduced the cost of manufacturing goods, so will motor-propelled trucks lessen the hauling charges for those goods.

These may seem like sweeping statements, but they are attested to by thousands of successful truck installations in hundreds of different kinds of manufacturing businesses. The success of these proves the adaptability of the motor vehicle, for each of these manufacturing lines may require its trucks to operate under conditions absolutely different from any of the others. By means of special bodies and a wide selection of types and sizes of power plant, a variety of combinations can be obtained, the proper selection of which will allow almost any operating condition to be fulfilled. A few years ago the motor truck cost more to install and to operate than the horses and wagons required to perform the same amount of work, and this excess expenditure was charged to advertising; but the modern motor truck has been brought to the point where it can show an actual dollar-and-cents saving, and even on this one merit alone can the mechanical means of transportation compete with the horse. Figuring interest on the investment at 6 per cent, depreciation at 10 per cent, chauffeurs' wages higher than those paid to horse drivers, and insurance premiums and repairs at a larger amount than would ordinarily be required in practice, the properly-organized truck installation will show a saving of from ten to thirty per cent over the maintenance expenditure required by a horse system.

From an investigation of many installations made by one company, it was found that interest, insurance, garage expenses, and driver's wages constituted a daily fixed charge of $5.32 for a 5-ton truck. This charge, of course, continues whether the truck is in use or not, and remains constant regardless of the mileage covered. Operating expenses, such as those for tires, gasoline, lubricating oil, and allowance for repairs, overhauling, and depreciation amounted to 15½ cents a mile. For a 50-mile day, the total expense would amount to the fixed charge of $5.32, plus 50 times the 15½ cent per mile operating cost, or $13.07 per day.

This strikes the keynote of the secret of a successful truck installation. Inasmuch as the $5.32 represents a fixed charge that is not affected by the distance that the truck travels, it is evident that the cost per ton-mile will be reduced as the daily mileage is increased. A 5-ton truck traveling 50 miles a day has a ton-mile capacity of 250. Inasmuch as there is but little difference between the operating cost of a loaded truck and one running empty, it will be seen that the hauling expense per ton mile may be reduced to slightly over $0.05. This is on the assumption, however, that the truck will be run at full load at all times—a condition which, obviously, cannot be attained in the average installation. If the truck is run loaded in one direction and returns empty, the hauling cost per ton-mile will be doubled.

There are, consequently, four broad, general conditions to be met in order to secure the most efficient installation. The truck must be selected with due regard to its capacity; its work must be so laid out and routes so arranged that but a minimum amount of time will be spent in idleness, and its active hours must be employed in hauling loads approaching as nearly as possible to its rated capacity; its construction must be such that the necessity for repairs will be infrequent; and its design must be so simple that it may be handled and overhauled by the ordinary intelligent driver or machinist, thereby eliminating the expenses of high-priced help. The fulfillment of the first two of these conditions rests with the purchaser, with the co-operation of the manufacturer of the truck, while the last two depend upon the truck builder and designer—but with the necessary co-operation of the purchaser.

The selection of a truck with regard to its capacity is an important consideration, but one too often overlooked. A 5-ton truck should not be purchased to conduct a 2-ton hauling business, unless expansion in the near future is to be provided for. To haul two tons in this case will cost nearly as much as to haul five, and such an installation would probably show a loss. Of course, it rests with the purchaser as to whether the expansion of this end of his business will, in the future, call for larger trucks, or a greater number of small vehicles, but the installation departments of the truck factories will help him with this problem.

While it is necessary that the trucks should be run fully

Fig. 1. Pierce-Arrow Auto Truck carrying Machinery to the Freight Depot

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loaded as much of the time as possible, the fact must not be overlooked that loads in excess of the capacity of the machine will cause the ton-mile hauling cost to increase rapidly. In fact, it is probable that to this tendency on the part of owners and drivers may be attributed the majority of the failures of commercial vehicle installations. By a constant 25 per cent overload, the life of the tires may be reduced by two-thirds.

Inasmuch as a high mileage is essential to efficient motor truck operation there should be as little delay as possible in loading and unloading, and trips and routes should be so arranged that the truck may be given an opportunity to take advantage of its speed and large territory-covering ability. But even though the area to be covered by the truck might, of necessity, be restricted to the factory yard, the use of special loading and unloading devices may easily overcome what would otherwise be serious obstacles to an efficient installation. If the factory is situated some distance from the freight yards, and the truck can be utilized to carry the finished products to the point of shipment and to bring back raw material on the return trip, conditions are nearly ideal, and such an installation should show a marked saving over any other arrangement. In fact, an installation that will allow the truck to travel loaded in both directions is so obviously destined to be successful that the only question to be considered is as to which of the many trucks on the market would be best adapted for the particular requirements of the business. Many manufacturing businesses employ one or more trucks to do "odd jobs" around the yard. As work of this type will consist, probably, in moving heavy machinery or other material, and in traveling under load from one building to another, trucks used for this purpose should show good returns on their investment.

The very multitude of chassis sizes and types and body designs from which the purchaser may choose is striking evidence of the variety of purposes to which the motor truck may be put. Special bodies may be obtained to meet certain requirements, and these may be mounted on any size or type of chassis. It is probable that the average manufacturer will find the conventional stake body the type best suited to his needs. This may be mounted on a chassis of the ordinary length when heavy loads are to be carried, or on a chassis of extra-long wheelbase if its regular load is to be bulky or long.

It is not, however, only because of the unusual opportunity to run loaded a large part of the time that a truck will appear to unusually good advantage when used in a manufacturing business. The fact that a motor truck is a *machine* indicates that it will be well cared for, and that unusual

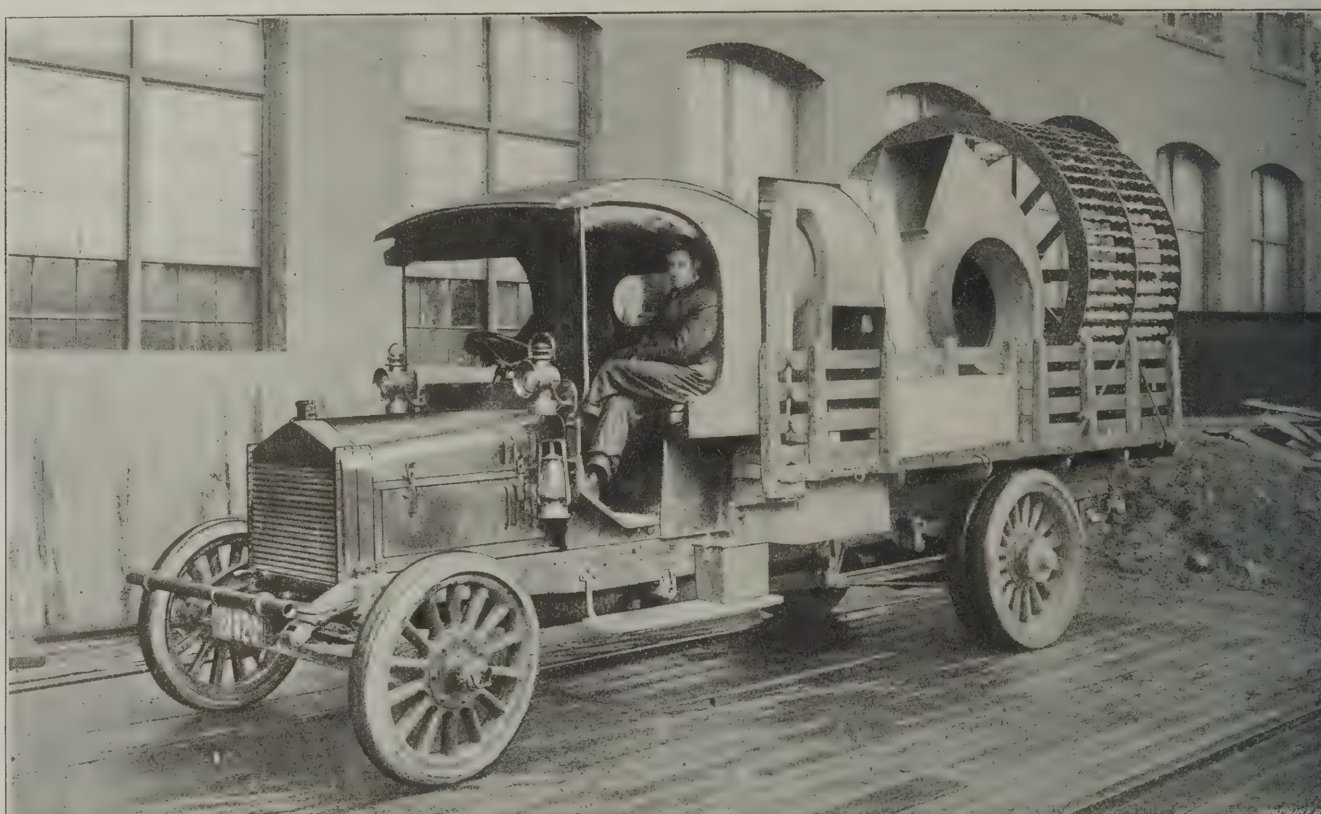

Fig. 2. Pierce-Arrow Five-ton Worm-driven Truck used by a Large Manufacturing Concern for carrying Heavy Castings and Large Parts of Machinery

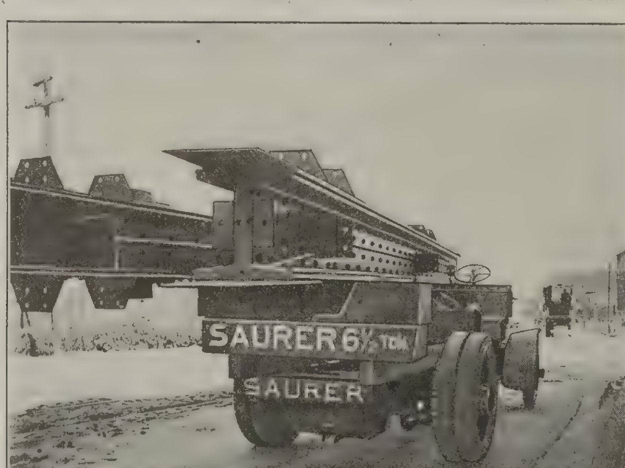

Fig. 3. A Six and One-half-ton Saurer Truck hauling Steel Girders for an Office Building Construction

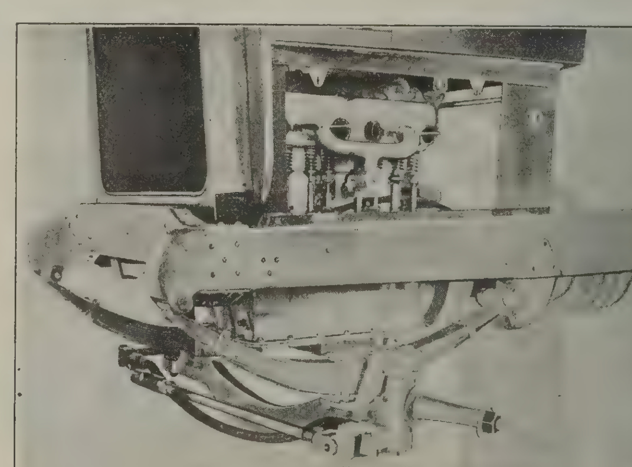

Fig. 4. The Front of a 5-ton Lozier Truck Chassis. All the Vital Parts are properly protected in Case of Collision

facilities will be already at hand for its overhauling and repair. Probably every tool that would be used in a complete garage and repair shop will be found in the average large factory. There will probably be a large force of men familiar with all kinds of machinery, and consequently the motor truck will not be the "strange creature" that would be the case were it replacing the horse transportation system of many another line of business. This enables the factory to retain its old drivers. Thus a complete garage and repair shop may be installed and equipped in the factory yard at but little additional expense, and the attendant saving in storage and overhauling charges will represent a large item. If the truck installation consists of but one vehicle, it may be advisable for a time, at least, to store the machine in a public garage, but even this will not bring the expense above that figured for a 5-ton truck in a preceeding paragraph, as this charge was included in the estimate.

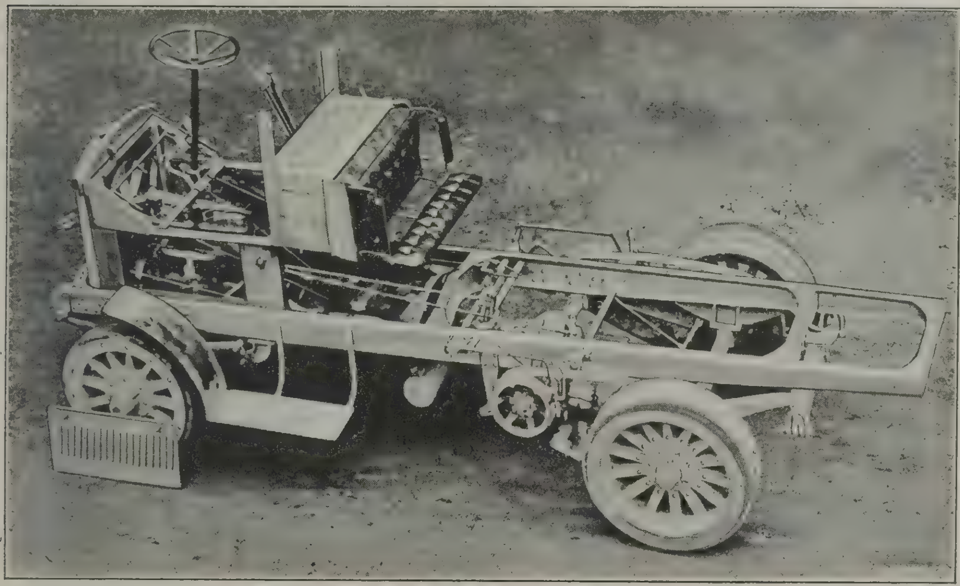

Fig. 5. Chassis of a Five-ton Lozier Truck showing the Accessibility of the Motor located under the Driver's Seat, which can be folded back

If the equipment consists of three or more trucks, it will undoubtedly prove advisable to equip a private garage and employ an expert whose sole duty shall consist in overhauling the vehicles and keeping them in perfect repair. In this case the drivers need only understand the control of the car, and are not required to be experts themselves. Consequently, a considerable saving may be made in chauffeurs' wages, and this forms the third advantage to be found in a motor truck installation in a manufacturing business.

The question of service is naturally an important consideration. No matter how well constructed a motor truck may be, it will require a certain amount of care and attention, and the engine must be overhauled occasionally. If several trucks are used, much of this work may be done at night, and if the power plants are thus kept continually in the top-notch of condition, there need be but little fear of interference with their work during the day. It was not long ago that, in large installations, one truck in every ten was used as a reserve machine. In other words, it was assumed that only 90 per cent of the trucks would be available for service. To-day, through better management of the installation, as well as through improved design, the average percentage of idle trucks has been reduced to about two. Some builders have provided removable power plants that can be used to replace the engine that requires overhauling. These power plants are of the "unit" type and include, besides the motor, the clutch, transmission, and, in some cases, the radiator and all electrical equipment. These parts are all attached to the motor or its base and the entire power plant may be lifted out after the removal of two or three bolts. Thus, by the use of but one extra removable power plant, nine or ten trucks may be kept in practically continuous service, and yet each motor may be thoroughly overhauled as often as necessary.

The unit power plant, which includes the transmission mounted on an extension of the motor base, is not used on the majority of heavy trucks—although some of two, three, and even five-ton capacity will be found so designed. The average five-ton truck is chain-driven from two sprockets mounted at each end of a jack-shaft extending from the transmission case and located about in the middle of the frame. There is at least one notable exception to this design, however, in the form of a shaft-driven five-ton truck that employs a worm and gear for transferring the power from the propeller shaft to the floating rear axle. Practically all of the trucks having a capacity of over three tons use the twin, or dual, solid tires on the rear wheels. Such a wheel is provided with one set of spokes, but possesses two rims, thus giving the effect of an exceedingly wide tire. Instead of using one wide tire on each wheel, however, two narrower tires are mounted on the single felly.

The power plants of the larger trucks are similar to many of those used on the high-power touring cars. The ordinary 5- or 10-ton truck is generally driven by a 30- or 40-horsepower motor located in the forward portion of the chassis, either under a conventional bonnet or under the driver's seat. In the latter design, the seat tips back or to the side in order to render the motor easily accessible. The gear ratios of the truck are much higher than are those of the pleasure car employing a power plant of equal size, for the speed of a 5-ton truck should not exceed 12 miles an hour, while that of one of 10 tons capacity should be restricted to 7 or 8 miles an hour. Some 3-ton trucks are designed to attain a maximum speed of 15 miles an hour—and even higher—but the governors used on the majority of the motors restrict their speed to about 1200 revolutions per minute, and consequently the maximum speed of the truck will depend upon the gear ratios employed. On one truck, the governor is attached to the driving shaft, so that the speed of the car itself, rather than that of the motor, will be restricted.

Fig. 6. Six and One-half ton Saurer Truck hauling Long Steel Girders

It is evident that many designers have kept in mind the desire of truck owners to employ former horse drivers—or other men unskilled in handling a power vehicle—instead of

expert chauffeurs, for the modern motor truck is of exceedingly "foolproof" construction. In fact, continued overloading constitutes about the only means—aside from downright vandalism—by which the average motor truck can be injured. By means of heat-treated and other special steels in the motor, transmission, and other parts of the frame and running gear subject to unusual strain or wear, the present-day truck can successfully withstand a remarkable amount of abuse; but there are right and wrong ways of handling even the most invulnerable truck, and many designers have bent their efforts toward eliminating all possible sources of abuse. In some, the spark control lever has been removed and a fixed point of ignition used in its stead, so that the driver cannot run the motor at slow speeds and with closed throttle when the spark is advanced. On other trucks, an automatic spark advance and retard has been installed by means of which the speed at which the motor is operated regulates the point of ignition. In still another design, a spark lever has been used, but instead of placing this on the steering wheel—as is usually the case—it has been located on the dash where it cannot be reached as easily by the driver as can the throttle. It is assumed that there will be less temptation to "monkey" with the spark if the lever is not so conveniently located.

Fig. 7. Packard Truck with Long Overhanging Body at the Rear, facilitating Loading at a Platform. This Truck does the Work of Four Teams of Horses at an Average Cost of $9.92 per Day, or at a Saving of about $10.00

Fig. 8. A Good Example of the Load that can be put on a 5-ton Truck

Although some of the heavy trucks are provided with planetary transmission, the majority employ the sliding type with either the selective or progressive method of shifting—the latter being in the majority. Modern transmission gears are so accurately cut and are made of special steels of so high a grade that it seems well-nigh impossible to "strip" them. As an added precaution, however, some trucks are provided with special devices which render abuse in this direction impossible. On one such device, the gears are in mesh at all times and each is provided with an individual clutch. The gear control lever is used to engage the various clutches, and thus the different speeds are obtained without any actual sliding or clashing of the gears, and the changes may be made without releasing the main clutch. Other designs employ a notched quadrant which prevents the movement of the gear-shifting lever until the main clutch is disengaged. Still a third system allows the gear-shifting lever to be moved, but the gears themselves are not slid into position until the clutch is released. This action is obtained by means of a bar cam which brings the tension of a spring into play against the gear to be moved. A back-cut on the jaws of the positive clutch with which each gear is provided, however, prevents the movement of any of them while the jack-shaft is revolving, and as this jack-shaft will continue to turn as long as the main driving clutch is engaged, the gears cannot be changed until conditions are proper for the shifting.

Fig. 9. Alco Tank Truck used for Spraying Dust-laying Oil on Roads

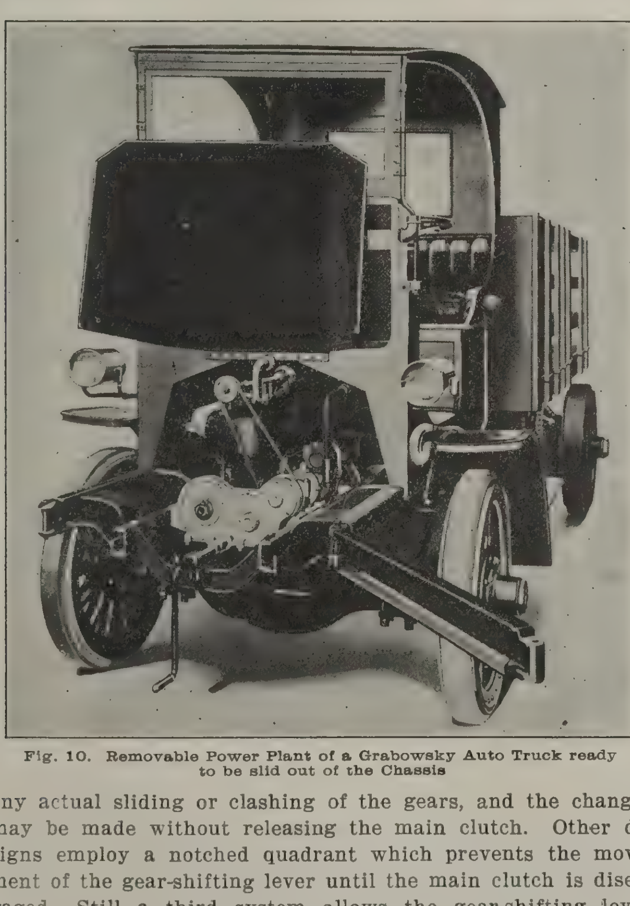

Fig. 10. Removable Power Plant of a Grabowsky Auto Truck ready to be slid out of the Chassis

From 60 to 80 per cent of the load on the modern motor truck is carried over the rear wheels. This insures effective traction and enables the truck to negotiate slippery roads and steep hills with comparative ease. Designers are realizing that, because of its surroundings and the nature of its work, the average motor truck will be subjected to many a hard knock from exterior sources, in addition to those it may receive at the hands of a careless driver. Consequently all vulnerable parts are protected as far as possible from contact with any obstacle which the heavier portions of the truck might strike. For example, a heavy cross-member may be riveted to the forward portion of the frame to serve as a guard for the more delicate radiator, and all of the motor, transmission, and protruding shafts or studs may rest within the confines of the frame proper. On some trucks, the motor sub-frame and radiator are mounted on separate springs to relieve these parts of the shocks and jars of travel that will not be absorbed by the heaviest body springs.

In fact, the modern truck is so well designed and constructed, and there is such a variety of body and chassis types and sizes from which to choose, that the blame for an unsuccessful installation may generally be laid to the purchaser of the truck and his system, rather than to the builder. There are, of course, many problems to be met and changes to consider, but each problem can be solved and all difficulties overcome especially well in a manufacturing business.

* * *

The corrosion of nickel, chromium, and nickel-chromium steels has been investigated by Messrs. J. Newton Friend, J. Lloyd Bentley, and Walter West, of Darlington, England, and the results of the investigation have been placed on record in a paper read before the Iron and Steel Institute of Great Britain. One of the interesting conclusions arrived at is that in certain neutral corroding media, such as salt water, the resistance to corrosion rises with the percentage of chromium. Hence, the employment of chromium steels in the construction of ships seems to be fully justified on this ground alone. Nickel steels appear to be resistant both to acid and neutral corroding media, in proportion to the percentage of nickel.

DESIGN OF A HYDRAULIC INTENSIFIER

A SYSTEMATIC METHOD OF CALCULATING THE DIMENSIONS OF THE DIFFERENT DETAILS

BY J. B. VARELA*

The object of this article is to explain in a simple and direct manner the calculations necessary for designing a hydraulic intensifier that shall fulfill certain specified requirements, and be of correct design, as nearly as possible, from the view-point of the engineer. The specifications that will govern the design may be briefly stated as follows: Required, a hydraulic intensifier to raise the pressure from 1500 pounds per square inch to 4500 pounds per square inch, having a capacity of 10 cubic feet on the low-pressure side. The choice of the materials, as well as of the proper working unit stresses, is left to the judgment of the designer.

In order to ascertain the diameters of the rams and the corresponding lengths of the stroke, it is advisable to tabulate the various possible diameters together with their corresponding lengths of stroke, and then select the most suitable dimensions as dictated by practical considerations.

Large Ram			Small Ram	
Diameter	Area	Stroke	Diameter	Area
21	346.36	49.8	12	113.1
17	226.98	76.1	10	78.54
16	201.06	86.0	9	63.62

The high-pressure cylinder acts as the low-pressure ram, as shown in Fig. 1. This arrangement is the most economical in the use of materials, as well as in the space occupied by the apparatus.

The sizes tabulated indicate fairly good proportions. We will select the third set of possible dimensions and calculate how they balance. The area of the low-pressure ram multiplied by the pressure acting on it must equal the product of the area of the high-pressure ram by the pressure acting upon it plus the excess load required to overcome the friction of the machine. Thus:

$201.06 \times 1500 = 301{,}590$ pounds, the load on the low-pressure ram,
$63.62 \times 4500 = 286{,}290$ pounds, the load on the high-pressure ram.

15,300 pounds, the excess load on the low-pressure ram. This difference is necessary, as noted above, in order to overcome the frictional forces that oppose the motion of the rams.

The volume of the low-pressure cylinder is assumed to be equal to the volume displaced by the low-pressure ram, that is $201.06 \times 86 = 17{,}291$ cubic inches, which is slightly in excess of the required volume. The actual volume of the low-pressure cylinder greatly exceeds this figure, as will be seen from Fig. 1. The length of the stroke is 86 inches, which is not abnormal.

The friction of the packing may be calculated by the following formula:

$$F = \mu P D$$

in which F represents the force of friction; P, the internal pressure in pounds per square inch; D, the diameter of ram in inches; and μ a coefficient, the value of which depends on the kind of packing used. (Although U-leather packing offers the least frictional resistance, we will use hemp packing in our design owing to the fact that it is easy to replace, cheap to maintain, and that leakage can be readily avoided.) The value of μ for hemp packing may be taken as 0.20. Hence the force of friction against the stationary ram is: $F = 0.2 \times 4500 \times 9 = 8100$ pounds; and for the movable ram: $F = 0.2 \times 1500 \times 16 = 4800$ pounds; making a total of about 12,900 pounds.

The inside diameter of the low-pressure cylinder is 18½ inches and the internal pressure 1500 pounds per square inch. Using Lamé's formula, we have:

$$D = d\sqrt{\frac{S+P}{S-P}}$$

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in which D represents the outside diameter of the cylinder; d, the inside diameter; S, the working unit tensile stress, taken as 8000 pounds per square inch; and P, the internal pressure, also in pounds per square inch. Hence:

$$D = 18.5\sqrt{\frac{8000+1500}{8000-1500}} = 22.37, \text{ say } 22\tfrac{3}{8} \text{ inches.}$$

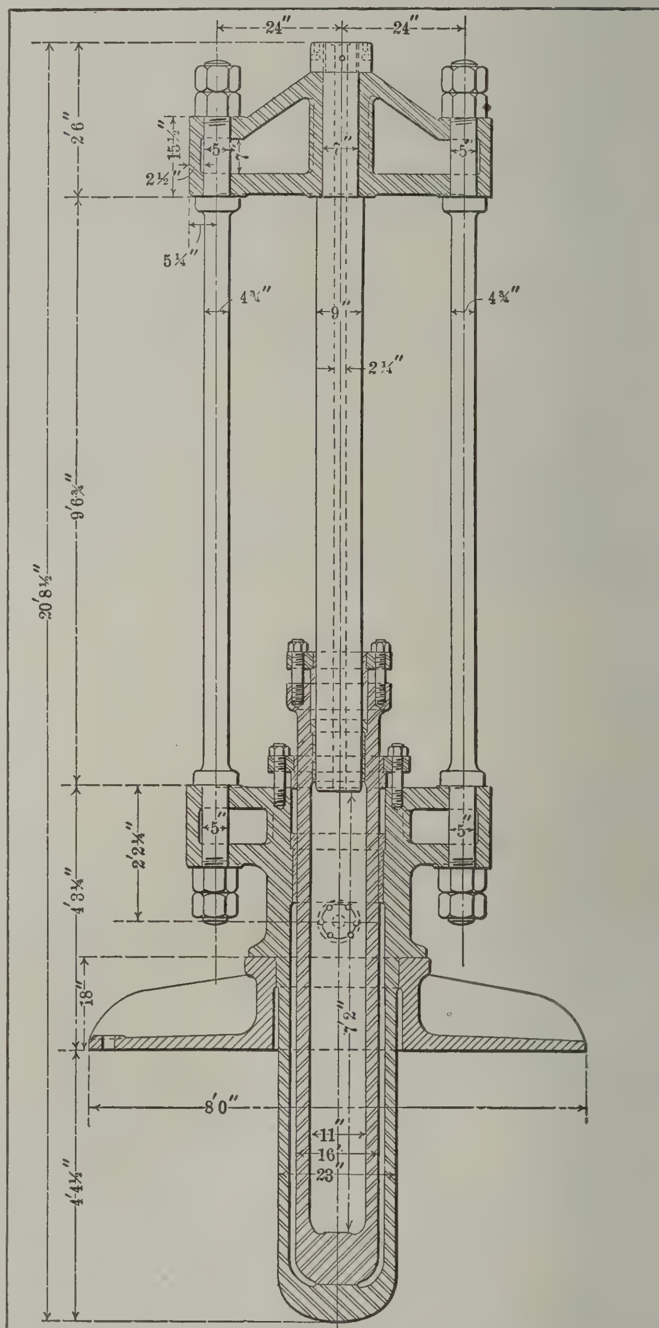

Fig. 1. General Assembly View of Hydraulic Intensifier

Therefore, the thickness of the cylinder wall is:

$$\frac{22.375 - 18.5}{2} = 1\ 15/16 \text{ inch.}$$

Using Peterson's formula as a check on the above calculations, we have:

$$t = \frac{p\,r}{S - 2/3\,p}$$

in which t represents the required thickness; p, the internal pressure in pounds per square inch; r, the internal radius of the cylinder in inches; and S, the working unit tensile stress in pounds per square inch. Therefore:

$$t = \frac{1500 \times 9.25}{8000 - 2/3 \times 1500} = 1.98, \text{ say 2 inches.}$$

These results are in close agreement with each other. Owing to the fact that the water under pressure percolates somewhat into the pores of the casting, thereby reducing the actual effective thickness of the cylinder walls to resist the pressure, and because of the difficulties that may arise when casting the cylinder if its walls are made too thin, it is advisable to make the thickness of the walls slightly in excess of the calculated value. Another reason for increasing the thickness of the walls is on account of the fact that the cylinder will be subjected to a test pressure double the normal working pressure, while the maximum tangential unit stress S should not exceed, under the test, 15,000 pounds per square inch.

Substituting these new values in Peterson's formula:

$$t = \frac{3000 \times 9.25}{15{,}000 - \frac{2 \times 3000}{3}} = 2.135, \text{ say } 2\tfrac{1}{4} \text{ inches,}$$

which makes the outside diameter of the cylinder 23 inches.

The outside diameter of the movable ram is fixed at 16 inches, and from Fig. 1 it can be seen that the inside diameter is made 11 inches. This ram is subjected to an internal pressure of 4500 pounds per square inch, and also to an external pressure of 1500 pounds per square inch. We may, therefore, assume for simplicity that the actual pressure is the difference between the two, and since the thickness is fixed, we can determine the value of the tangential unit stress S acting upon the inner surface of the bore.

From Lamé's formula we have:

$$S = \frac{(D^2 + d^2)\, P}{D^2 - d^2}$$

$$S = \frac{(16^2 + 11^2)\ (4500 - 1500)}{16^2 - 11^2} = 8377, \text{ say 8400 pounds per}$$

square inch, which is a safe stress.

The test pressure will be applied simultaneously to the inner and outer surfaces of the ram. The tangential unit stress S then becomes, according to Lamé's formula, 16,750 pounds per square inch, exceeding the maximum value previously fixed. Strictly speaking, however, these stresses are the apparent tangential unit stresses acting at the inner surface of the bore. If we take into account the longitudinal elongation of the cylinder, the true tangential unit stress T, upon the inner surface of the bore, is found by the following formula:

$$T = \frac{(r_1^2 + 4\, r_2^2)\, p_1 - 6\, r_2^2\, p_2}{3\, (r_2^2 - r_1^2)} \qquad (1)$$

in which r_1 and r_2 are the inner and outer radii of the ram, respectively; and p_1 and p_2, the corresponding inner and outer pressures. Substituting the known values in this formula, we have:

$$T = \frac{(30.25 + 4 \times 64)\, 4500 - 6 \times 64 \times 1500}{3\, (64 - 30.25)} = 7030 \text{ pounds}$$

per square inch.

When the test pressures are applied, the values of p_1 and p_2 become 9000 pounds and 3000 pounds per square inch, respectively, and the corresponding value of T found by Formula (1) is about 14,060 pounds per square inch, which is well within the maximum value assigned for S.

A possible, but not probable, contingency may arise when the movable ram is subjected to the full internal pressure of 4500 pounds per square inch, while the external pressure is zero. In this case the value of S as obtained from Lamé's formula is:

$$S = \frac{(256 + 121)\, 4500}{256 - 121} = 12{,}565 \text{ pounds per square inch, which}$$

is a safe stress.

The total pressure acting on the small or stationary ram is $63.62 \times 4500 = 286{,}300$ pounds, nearly. Let us assume that this load is carried by two tie-rods placed as shown in Fig. 1. Let A represent the area at the root of the thread of one of the tie-rods, and assume the working unit tensile stress to be 10,000 pounds per square inch for mild steel. Then:

$$2\,A \times 10{,}000 = 286{,}300, \text{ whence } A = \frac{286{,}300}{2 \times 10{,}000} = 14.32 \text{ square}$$

inches.

From a table of bolts it is seen that the diameter of bolt having the area at the root of its threads next larger in value to 14.32 square inches is a 5-inch bolt. We, therefore, make the diameter of that portion of the tie-rod that fits in the casting 5 inches. Since the diameter at the root of thread is 4.48 inches, we will make the diameter of the body of the tie-rod $4\tfrac{3}{4}$ inches.

The next step is to design the top casting. This piece is a simple beam carrying a concentrated load at the center. It is a rather difficult matter to calculate the required dimensions directly from the formula, and consequently we will assume the most suitable dimensions and check them for strength. For a simple beam with a concentrated load at the center of the span the maximum bending moment occurs at the point of application of the load, and its value is:

$$M = Pl \div 4$$

in which M represents the bending moment, P the load, and l the length of the span.

The load P equals 286,300 pounds, or 143.15 tons; the length of the span is 48 inches. Consequently

$$M = \frac{143.15 \times 48}{4} = 1718 \text{ ton-inches.}$$

The unit tensile stress acting on the outer fiber at the center of the beam is found by the formula:

$$\frac{M}{S} = \frac{I}{c}$$

in which M represents the bending moment found above; I, the rectangular moment of inertia of this section; and c the distance from the neutral axis to the outer fiber. The cross-section of the top casting at the center is as shown in Fig. 2, which is equivalent, as far as the rectangular moment of inertia is concerned, to that shown in Fig. 3. The moment of inertia about the neutral axis A-A is:

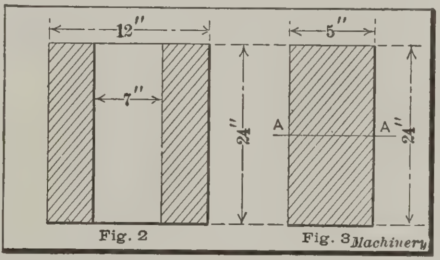

Fig. 2. Section of Top Casting at Center. Fig. 3. Equivalent Section of Top Casting

$$I = \frac{5 \times 24^3}{12} = 5760, \text{ and } c = 12 \text{ inches.}$$

$$\text{Hence, } S = \frac{1718 \times 12}{5760} = 3.58 \text{ tons per square inch,}$$

which for a steel casting is well within the limits of safety. When the test load is applied, this unit stress becomes equal to about 14,200 pounds per square inch, which is also well within the maximum value previously fixed.

The ends of the casting are in shear, the value of which is $286{,}300 \div 2$ pounds. The area resisting this shearing stress is 81.75 square inches. Hence the shearing unit stress is:

$$286{,}300 \div (2 \times 81.75) = 1750 \text{ pounds per square inch, about.}$$

Practical considerations, in addition to the stresses produced by the external forces, were the controlling factors in proportioning this piece.

The next step is to check the studs that compress the glands. We will assume the extreme case of the glands being subjected to the full pressure on their lower surface. For the low-pressure gland, the total pressure acting on its lower surface is about 42,500 pounds. This load is borne by ten 2-inch studs. The area at the root of the thread of a 2-inch bolt having 6 threads per inch is approximately 2.5 square inches, thus giving a working unit stress of about 1700 pounds per square inch. This is a very low value, but it must be borne in mind that the gland may be unevenly

screwed down, due to the comparatively large diameter of the bolt circle, thus inducing greater stresses in some bolts than in others.

The total pressure acting on the lower surface of the high-pressure gland is about 74,200 pounds. This load is carried by eight 2-inch studs having 6 threads per inch, and consequently the working unit stress is about 3700 pounds per square inch. Owing to the fact that the bolt circle is smaller in diameter than in the previous case, the danger of an unevenly screwed down gland is not so great, and for that reason we are stressing these bolts twice as much as those in the low-pressure gland.

* * *

BAR TURNER FOR "LIBBY" TURRET LATHE

A box-type of turning tool having some interesting mechanical features embodied in its construction is shown in Figs. 1 and 2. This turning tool is used on the "Libby" turret lathe, manufactured by the International Machine Tool Co., Indianapolis, Ind., and is used for turning bar stock. It has a capacity for turning bars from 3/4 inch up to and including 3 1/4 inches in diameter. It is clamped by four bolts to the face of the turret, the boss or shoulder *A*, Fig. 2, fitting in the bored hole in the turret, and thus aligning the tool. It carries a single high-speed turning tool *B* of 1 by 5/8 inch section. A cut 1 inch deep—the full width of the tool—can be taken in machine steel without any perceptible chatter.

The main frame or body *C* is a steel casting, cored to clear the largest bar—3 1/4 inches—and provided with openings to allow the chips to drop out. The front face of the frame is machined to receive two blocks *D* which carry the hardened and ground roller supports *E*, the latter being free to rotate on hardened and ground studs held in the blocks. These blocks *D* are provided with T-bases which fit in corresponding grooves in the frame and in the two blocks *F*, the latter being held to the frame by two bolts as shown. The roller supports are adjusted by collar screws *G*, which are screwed

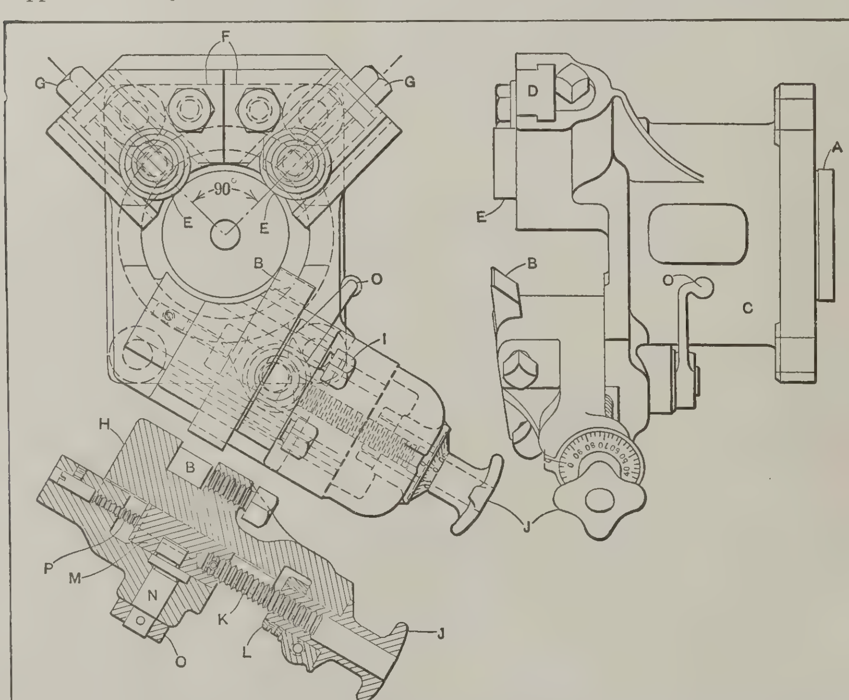

Fig. 2. Construction of the Bar Turner shown in Fig. 1, showing how the Turning Tool is withdrawn from the Work when retreating

into the frame, the collar fitting in a slot cut in the base of the block. The studs on which rollers *E* rotate are provided with oil grooves and proper means for lubrication.

The tool-slide *H* fits over a dovetailed guide machined on the front face of the frame, and is provided with an adjustable gib. A groove is cut in the tool-slide to receive the turning tool *B*, the latter being clamped rigidly in position by two set-screws. The 2 1/2-inch adjustment of the slide *H* for the diameter of the work is effected by means of a knob *J* and screw *K*. The knob is provided with a collar having 100 graduations, and as screw *K* has 10 threads per inch, each graduation equals a movement of the slide *H* of 0.001 inch. The overhanging arm of the slide is bored to receive the reduced end of the knob and is split and provided with an adjusting screw to compensate for wear. A collar *L* screwed onto the end of the knob and locked by a headless screw is used to take up the end play resulting from the frequent adjusting and the thrust of the tool.

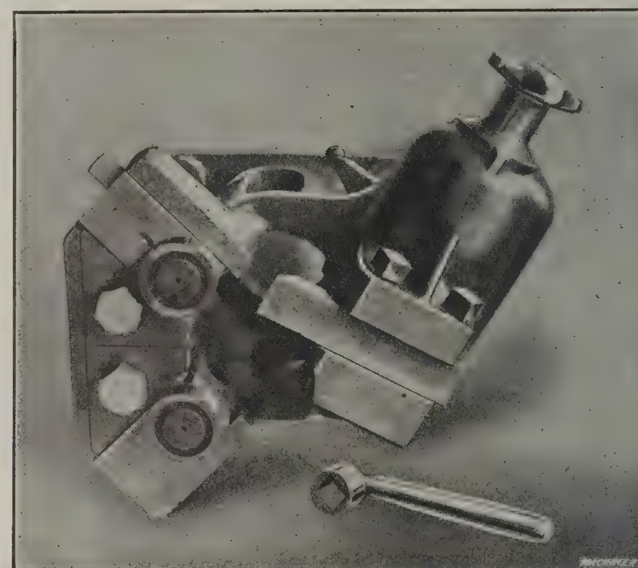

Fig. 1. Box-type of Turning Tool for the "Libby" Turret Lathe

The ordinary box-tool commonly used on turret lathes and screw machines is drawn straight back over the work after taking a cut; consequently, if a heavy cut has been taken—causing the tool to spring away from the work—the tool will make a spiral mark when returning. This objectionable feature is obviated in the particular tool illustrated in an interesting manner. The forward end of screw *K* is pinned to a block *M* which fits in a slot cut in the frame *C*. This block is actuated by an eccentric stud *N*, the latter being operated by a handle *O* held on it by a pin. When the cut has been finished, the operator pulls out handle *O*, rotating the eccentric, which, in turn, withdraws block *M* from stop *P*. Then as screw *K* is fastened to block *M*, thus connecting it with slide *H*, it follows that the slide carrying the turning tool must also recede. When handle *O* is pushed in, block *M* is located in the exact position by stop-screw *P*, which is locked with a headless screw, thus setting the turning tool again to the correct diameter.

Another commendable feature in the construction of this tool is the location of the turning tool relative to the supports and the body of the holder. The turning tool is set tangentially to the work and is also so placed that it can be located in advance of the supports or face of the holder. This construction allows the tool to cut close to a large shoulder—much larger than the width of the frame—without any portion of the holder coming in contact with the work. This feature makes this turret tool especially valuable for turning large work. The wrench shown in the foreground in Fig. 1 is used for tightening the set-screws on the turning tool.

D. T. H.

* * *

On January 1, 1912, there were 70,000 power driven vehicles in use in Germany, about 63,000 of which were passenger cars and about 7000 trucks. Of the passenger cars about 23,000 were private pleasure cars and 30,000 were used for business purposes. There were also 5200 motor cabs and omnibuses in use.

MUSEUMS OF SAFETY AND THEIR ACTIVITIES*

A BRIEF HISTORY OF THE MOVEMENT FOR THE PREVENTION OF INDUSTRIAL ACCIDENTS

BY MANCIUS S. HUTTON†‡

It is not so many years ago that labor was considered one of the cheapest of commodities and the employer of labor simply hired a new man in place of one incapacitated through injury at his work. He did not take the time to study how accidents could be prevented, nor did he spend money in placing safeguards about the works; but he was willing to spend the same or more money in fighting, in the courts, the claims for damages which the injured employe tried to obtain. The old common law liability of employers was very lenient at first towards the firms in whose shops accidents happened, but latterly the juries have been awarding larger sums to the sufferer. Within the last four years, however, the relations between the employer and his workmen have been changing in many places by the former's recognition of his responsibility for his work people, and he has been trying to safeguard the dangerous places around his factory. He has also been forced somewhat to do this by the casualty insurance companies in order to obtain a lower premium from these companies.

Present Activity in Passing Laws to safeguard the Industrial Worker

In nearly all the states, at the present time, laws in regard to safeguards have been made more stringent. In some of the states, commissions have been appointed to investigate and report to the legislature on the whole question of accident and sickness prevention, with the object of enacting laws which would tend to reduce the number of industrial accidents by compelling the introduction and use of safeguards. These laws, however, should not be made so exacting as to bankrupt the small employer.

When enacting workmen's compensation laws in the various states, which in no case were made compulsory, the law makers so changed the common liability law that it became to the advantage of the employer to accept the terms of the compensation law rather than to go to the courts under the liability law. This was done by taking away from the law the two defences under which the employer had the best chance of winning the suit. These defences are known as the "assumption of risk" and the "fellow servant rule." The former of these is that an employe who contracts to work for an employer assumes the hazard of the occupation. The latter one is that an employer cannot be held responsible for an injury to the workman which was caused by another employe engaged in the same work.

The recognition on the part of the employer of his responsibility toward his work people, the passing of more stringent factory laws, and the enacting of compensation laws, all have brought the employer to the realization that the question of safety and sanitation in his factory is a very vital one. He is now, therefore, studying these questions and others which are related to them. It is obvious that it would be to the employer's advantage to find all the material and information on safety devices brought together in one place for study. This is the genesis of the idea of museums of safety.

Foreign Museums of Safety

The first museum of safety was opened to the public at Amsterdam, Holland, in 1893. This museum, at the start, was a very small affair and was entirely supported by private subscriptions, but it soon outgrew its first quarters. In 1910 the city gave a site for a new and larger building, while the parliament appropriated $22,500 for the building. The running expenses will, as hitherto, be borne by private subscriptions. This museum was opened eight years before the country passed a workmen's compensation law.

There are at present sixteen museums of safety, of which fourteen are in Europe, one in the United States, and one in Canada. In the following table is given the location of these, together with the year of their opening and the year in which the compensation law in that country was first enacted.

City	Country	Year of Museum Opening	Year of Enactment of Compensation Law
Amsterdam	Netherlands	1893	1901
Berlin	Germany	1903	1884
Budapest	Hungary	1908	1907
Copenhagen	Denmark	1910	1898
Dresden	Germany	1911	1884
Gratz	Austria	1911	1887
Helsingfors	Finland	1910	1895
Milan	Italy	1906	1898
Montreal	Canada	1909	1909
Moscow	Russia	1908	1903
Munich	Germany	1906	1884
New York	United States	1907	1906
Paris	France	1905	1898
Stockholm	Sweden	1908	1901
Vienna	Austria	1909	1887
Zürich	Switzerland	1902	has none

The year given for the New York museum is that of the first exhibition of safety devices. It was not until three years later that a permanent museum was opened. The year given in the fourth column is that of the first Federal Compensation Law in the United States.

The following countries which have passed compensation laws have no public museum of safety:

Country	Year of Enactment of Compensation Law
Norway	1894
Spain	1900
Belgium	1903
Great Britain	1907

From the table it will be seen that Germany has three museums at the present time and Austria two. It is an interesting commentary on this movement that while Switzerland has never passed a compensation law, yet it was the second country to have a public museum of safety and sanitation located at Zürich; and Germany, which was the first country to have such a law, did not open its first museum at Berlin until nineteen years after the law went into effect. This latter museum is one of the largest and most up-to-date in the world. Its actual location is at Charlottenburg, a suburb of the city. The building occupies one-sixth of an acre and contains, besides the exhibition hall, the administration offices and a lecture hall which can accommodate two hundred people. The exhibition hall covers an area of 64,000 square feet.

In the summer of 1911 there was held in Dresden the first International Exhibition of Hygiene. This exhibition was opened to the public in April and closed in October. From the time of its opening to the first of September it has been estimated that four million people visited it. Nearly every country was represented, even those of South America, by either a pavilion or a section in a building. The United States was the only large country which was not officially represented. It was an educational campaign put in practical form by means of models and charts, so that the lesson could be easily understood and would not easily be forgotten. The preparations for the exhibition required over four years. After it had been closed there was a popular demand on the part of the German people that the models and charts which had taken so long and so much painstaking care to prepare should not be destroyed, but should be kept in a museum. Thus it was that Dresden's name was added to those cities which have a permanent museum.

One reason why the German museums are ahead of others in regard to their buildings and exhibits is the encouragement and financial backing which the government gives them. In the case of all the foreign museums, with the exception of that in Vienna, the government or the city in which they are located have given some financial help. Some of the foreign

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* The following articles on this and kindred subjects have previously been published in MACHINERY: "American Museum of Safety Award of Medals," February, 1912; "The Prevention of Industrial Accidents," November, 1911, engineering edition, and the articles there referred to.

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museums occupy only part of a building, as is the case of the one in Paris, which is located in the Vaucasson Gallery of the National Conservatory of Arts and Trades.

To the average American these foreign museums are of no practical benefit, as few can visit them and the literature which they publish is not within the reach of everyone unless translated. The reason for mentioning them has been to show the large number located in the principal centers of Europe.

The American Museum of Safety

The idea of having a museum of safety devices in America was conceived by the present director of the Museum in 1900, on his return from abroad where he had seen, in Paris, a partial exhibit from the Amsterdam museum. The next seven years were spent in educational work by means of lectures throughout nearly all the states. The next step forward was the holding of an International Exhibition of Safety Devices in New York City which lasted two weeks. This was held at the Museum of Natural History in February, 1907. It exhibited practical safeguards in the way of models, photographs and actual devices manufactured by American firms; it also had actual devices, photographs and charts of methods which were in use abroad. These latter were obtained from the foreign museums. After this exhibit was over it was decided to hold another the next year, which should be open for a longer period. The exhibition of 1908 was held at 231-241 West 39th St., New York City, and extended over a period of two months (April-May); it contained exhibits from eighty different American firms, while the foreign museums were again represented by documents, photographs and charts. There were only a few models of foreign devices shown at this exhibition. The next year was spent in lecture work and in visiting factories in which safety devices were being used. In November, 1910, the first permanent Museum of Safety and Sanitation in America opened its doors and invited the public to come and visit it. It is located on the sixth floor of the United Engineering Building, 29 West 39th St., New York City, and occupies two rooms. It is open every day, except Sundays and holidays, between the hours of 9 A. M. and 5 P. M.

There are four methods in which a museum of this kind can have its work brought to the attention of the public:

1. By the collecting and displaying in a museum of the actual safety devices themselves, or, if too large or cumbersome, of models of them. The devices should be constructed so that they can be operated in the same way as in actual practice. If either the device or model cannot be shown, then the device should be illustrated by photographs, blueprints or charts.
2. By the assembling of a library of all the literature pertaining to the subjects which have to do with the question of improving the workmen's condition. The library should be fully catalogued and contain foreign books and pamphlets as well as American literature.
3. By means of lectures illustrated with lantern slides of the best safety devices. These lectures are delivered at the principal industrial centers and before employers, workmen, societies, associations, state and city officials, and others interested.
4. By the publication of literature on various subjects relating to the workmen's welfare, such as illustrated books, pamphlets and leaflets; besides promoting the movement through articles published in the daily papers and the technical press; and the making of special reports and publishing of same.

The first and second methods are by far the most advantageous as regards the studying of safety devices and industrial hygiene, but they are limited to those persons who live in or near the city in which the museum is located. Those outside this narrow area would not gain any advantage from it. The third method has a larger scope, but is limited by the fact that it is only possible to lecture a limited number of times in any year in any one large industrial center. The publication of illustrated books, pamphlets and leaflets which can be mailed to anyone, places the last method far ahead, as regards the number of persons which it reaches, of all the other methods combined.

It may be of interest to those not familiar with the service which such a museum can render, to make some extended references to the activities of the American Museum of Safety. It applies all four methods given above. In its exhibition hall it now has over two hundred full-sized apparatus and models, besides having at least three thousand mounted photographs from both foreign and American practice. The exhibits, including the photographs, are divided into three sections, each of which is under the jurisdiction of a committee; more sections will be added from time to time, as space and exhibits warrant. The three sections at present are: iron and steel; fire prevention; and industrial hygiene and sanitation. There is also a general section which includes exhibits which do not come properly under the other three. The chairmen of these section committees are men who are authorities on their special subject.

The exhibits are put in the museum by the manufacturer or inventor himself. Among the conditions for exhibiting are the following:

1. No exhibit is allowed to be displayed which has not been approved of by the Board of Approval of Exhibits.
2. There will be no charge for space in the exhibit hall.
3. The installation of an exhibit is at the exhibitor's expense.
4. Exhibits are accepted with the understanding that they are not to be removed within twelve months except with the consent of both the Director and the Chairman of the Board of Approval.
5. Exhibits are not accepted which are not purchasable in any market or commercially available in the industries as a means to prevent accidents.
6. Untried inventions are not accepted.
7. The museum assumes no responsibility for any damage by fire or loss by theft.

These conditions are nearly the same in all the museums.

A few of the more important firms which are exhibiting in this museum at the present time are: The United States Steel Corporation, and several independent steel companies, Brown & Sharpe Mfg. Co., Mergenthaler Linotype Co., National Cash Register Co., Norton Co., Patent Scaffolding Co., Pennsylvania Railroad Co., Prudential Insurance Co., Standard Oil Co., Travelers Insurance Co. and many others.

The American Museum has been visited since its opening by the presidents, general managers and committees of safety of different companies, state factory inspectors, casualty insurance inspectors, engineers, workmen and students. The museum provides a demonstrator who shows and explains all the devices.

The library of the museum contains bulletins, reports, catalogues, books, charts and articles taken from different publications. When this library was started there was very little literature on these subjects in the English language, while the foreign publications were more numerous, especially those in German. Accident prevention is now a very live subject in America, the result of which is that special articles and books are increasing in numbers. Many of the foreign publications are not easily obtainable anywhere else in the United States for reference or study. This library is growing very fast and is an important adjunct to the museum.

In lecturing before associations, workmen, superintendents, foremen, inspectors and others, the museum has had a splendid chance to do educational work. At the present time there are four members of the museum who are doing this lecture work. Each of them has from one to two hundred colored slides of practical safety devices. During the last year the director of the museum has had the opportunity of lecturing before the superintendents, foremen, and workmen of several of the large steel companies, the New Jersey Zinc Co. and the Pennsylvania Railroad Co. The number of people who have been reached by these lectures averaged between three to twenty-one hundred at each lecture. The total number of lectures delivered during the year has been in the neighborhood of fifty.

From the time of the museum's first inception to the present time, there have been published a number of pamphlets and books to promote the work of the museum, as well as to educate the public to the waste of life in the industries. The museum has had the cordial cooperation of the daily papers and the technical press in the work which it is carrying on. The museum, at the present time, is engaged in publishing

"Safety Manuals" and leaflets, of which two manuals and three leaflets have already been published. Other manuals and leaflets are in preparation and will be issued from time to time during the course of the year. The museum has embarked on a new method of valuable help to the employer which is the inspection of plants and the reporting of the kind of safeguards recommended. The museum is always glad to answer any legitimate question in regard to accident prevention.

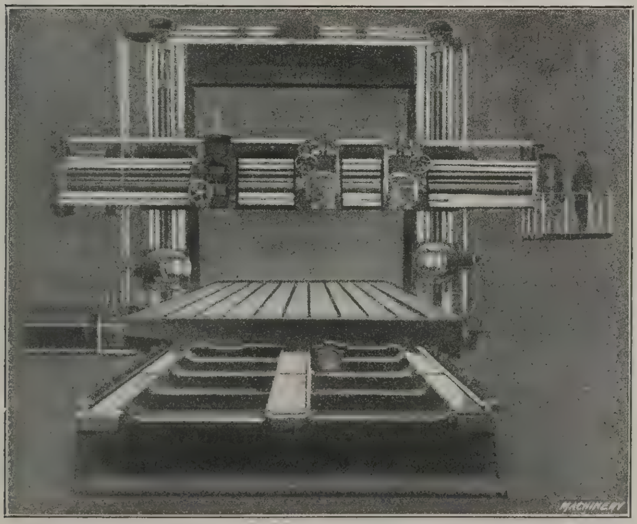
The museum awards annually three gold medals, the first of which is known as the "Scientific American Medal of the American Museum of Safety," and is given to "such individual or corporation as has produced and exhibited in the American Museum of Safety within a recent period of years any perfected device of utility which in the judgment of the Jury of Award of said museum best conserves human life and limb in the processes of productive industry." This medal has been awarded three times. The second medal is the "Travelers Insurance Company Medal of the American Museum of Safety," which is awarded to the "American employer or other corporation which in the judgment of the Jury of Awards of the museum has done most or achieved greatly, during a recent period of years, in the conservation of the lives and limbs of their workmen by means of safety devices for machines and processes." This medal has been awarded twice. The last medal is the Louis Livingston Seaman Medal of the museum to be given for progress and achievement in the promotion of hygiene and sanitation and the mitigation of the evils of occupational disease. This was awarded for the first time in 1911.

The Legislature of the State of New York passed in May, 1911, a bill incorporating the American Museum of Safety. The museum is a non-commercial enterprise, and it does not take orders for any of the devices it happens to exhibit. It has so far received no financial support from city, state or national government, but is maintained entirely through membership subscriptions. In this respect it differs from the foreign museums, which, as explained before, obtain at least some governmental support. It is to be hoped that the industrial community will realize the public service which the museum is rendering and will seek to cooperate in its work as a public duty.

* * *

A LARGE GERMAN PLANER

The accompanying illustration shows a planer built by the firm of Wagner & Co., Dortmund, Germany. This machine is intended for work on turbine housings and is built for F. Schichau in Elbing. The extreme length of work that can be



A Large Planer which takes in Work approximately 34 by 16 by 13 feet

done is about 34 feet 5 inches, and the extreme width, 16 feet 5 inches, the limit in height being 13 feet 1 inch. The main drive is from a 60-horsepower motor. The machine is provided with a milling head in addition to the four planer heads. Auxiliary motors are used for the various feeds.

PLANING STEEL RACKS FOR FROG AND SWITCH PLANERS

The rack used on the frog and switch planers manufactured by the Cincinnati Planer Co., Cincinnati, Ohio, is made of a steel forging instead of from cast iron, on account of the heavy duty that this type of planer is called upon to perform. The rack is made in sections, these being fastened securely by bolts and dowels to the under side of the planer table. To cut the rack teeth, the sections of the rack are clamped to the planer table, as shown in Fig. 1, the rack teeth being formed with cutting tools held in the tool-head.

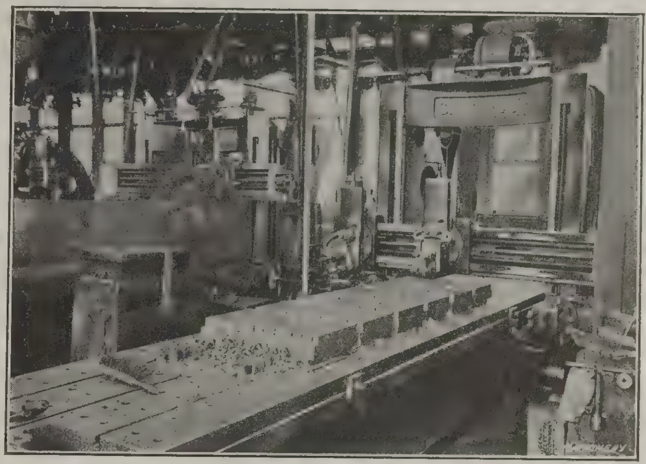


Fig. 1. Planing Teeth in Steel Racks for Frog and Switch Planers

The rack sections shown clamped to the planer table in Fig. 1 are made from 40-point carbon steel forgings, and the teeth, which are 1½ diametral pitch, are cut from the solid block. Naturally, this operation requires considerable time, and calls for a special type of planer tool equipment. The successive tools used are shown in Fig. 2. Here *A* is the first roughing tool—similar in shape to a wide parting tool—with a nose ⅝ inch wide. This tool is used to rough out the teeth, taking a cut 0.040 inch deep per stroke, at a cutting speed of 40 feet per minute. After all of the teeth have been roughed out to within about ⅛ inch of the proper depth, tool *B*, having a stepped face is used to rough out the angular

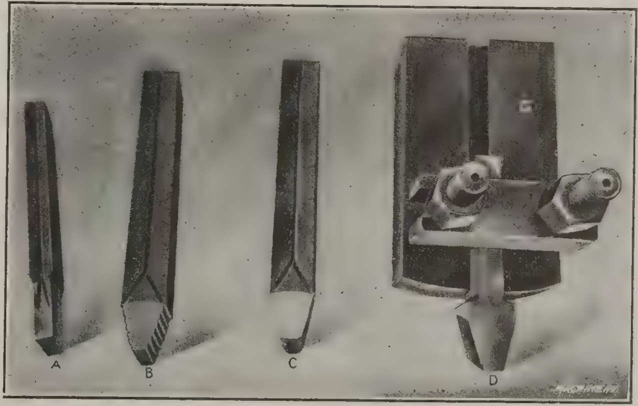


Fig. 2. Successive Tools used in Cutting the Steel Rack Teeth in the Rack for a Cincinnati Frog and Switch Planer

sides of the teeth. Next, tool *C* is put in the tool-holder, and all the teeth are finished to within about 1/64 inch of the proper depth.

The final shape is given to the teeth by the rack-tooth cutter *D*. This is held by a strap, bolts and nuts in a slot in the special block *G*, the latter fitting snugly in the clapper-box. Holding the finishing tool in this manner insures that the teeth will be accurately formed on the sides, and also maintains the proper face angle. The spacing of the teeth, of course, is accomplished by means of the micrometer collar on the rail-screw.

D. T. H.

* * *

The total steam power used in the United States is about 27,000,000 horsepower. It is estimated that 35,000,000 horsepower could be made available from the waterfalls. Of this about 5,000,000 horsepower has been developed.

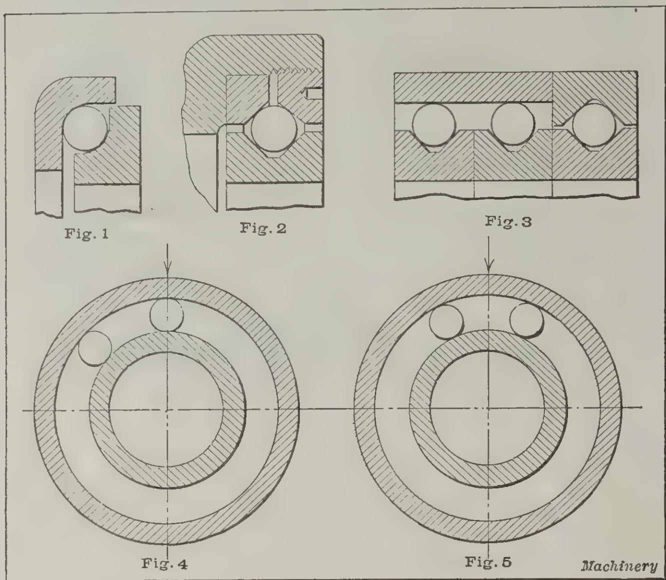
BALL AND ROLLER JOURNAL BEARINGS*

THEIR DEVELOPMENT FROM EARLY TYPES AND CONSIDERATIONS IN THEIR DESIGN

BY ROBERT H. GRANT†

In a previous article, appearing in the August number of MACHINERY, the writer reviewed the history and development of ball and roller thrust bearings. In this article ball and roller journal bearings will be treated.

The first type of ball bearing used was that known as the cup and cone type, a section of which is shown in Fig. 1. The design of these bearings has been varied considerably, some designers having advocated a two-point bearing, and others a three-point bearing; some have believed in the use of large balls, and others in balls of a smaller size, etc. At the present time it is of little importance, however, as later types of bearings have taken its place.



Figs. 1, 2 and 3. Early Types of Ball Thrust Bearings. Figs. 4 and 5. Action of Ball Journal Bearings when Distance between Bearing Points is too Great

The next type of bearing was the grooved ball shaft bearing, a section of which is shown in Fig. 2. This bearing had three hardened steel races, and was fitted to a housing or hub. The plain outer race was driven into place and the threaded race was a good fit in the housing, so that the two would be in alignment with each other. The inner race or cone was a sliding fit on the shaft, so as to allow it to adjust itself to the outer races. This bearing was satisfactory for light loads and high speeds, but had to be very accurately ground and fitted; otherwise there would be a three-point bearing instead of a four-point, which would soon cause wear. On account of the expense of manufacture and mounting, this bearing has been very little used. The adjustable feature also caused a great deal of trouble due to the fact that inexperienced users would adjust the bearings improperly; hence, types were developed in the early years of bicycle manufacture which could not be adjusted.

The next bearing developed was a modification of the grooved ball shaft bearing, as shown in Fig. 3. The first bearing in the series is a regular grooved ball thrust bearing which takes the end thrust, while the other ball bearings take the journal load, thus distributing it over the whole length of the journal bearing. This bearing was applied to a railway car as early as 1888 and is now quite extensively used on electric cars.

While many other bearings have been developed and tried, the regular annular ball bearing has been adopted by nearly all manufacturers as the standard. These bearings are now being made of the same inside and outside diameters and thicknesses by all makers. The various makes differ only in the material, workmanship, size of ball, and design of cage. The material mostly used for the ball races is an alloy steel made in the form of tubing. One steel much used for this purpose, as made by the Becker Steel Co., of New York, is composed of carbon, 1 per cent; chromium, 1.25 per cent; manganese, 0.35 per cent; phosphorus and sulphur, not to exceed 0.025 per cent; and silicon, 0.25 per cent. In German bearings a chromium content between 1.50 to 1.60 per cent is used. It is claimed that this alloy steel gives still better results. Alloy steels of this type will stand a high surface pressure, which is necessary on account of the fact that the ball has practically only a point bearing in the race.

The cage, the design of which varies considerably with different manufacturers, should be made of a light, strong material and should prevent the balls from coming in contact with each other, and at the same time give them perfect freedom of action. The diameter of the balls to be used must, of course, be determined largely by the load that is to be carried; the ball must have sufficient diameter to stand the strain. It is evident that the closer the points of contact are to each other when the load comes onto the balls, the better will the bearing run. If the balls are small there will be a greater number of points of contact, and the bearing will work more freely, but the size of the ball must be kept within safe limits to prevent it from breaking.

The ball cage is of vital importance, as it reduces the friction between the balls, preventing them from rubbing against each other, but it should be so made that the bearings can be almost entirely filled with balls. In Figs. 4 and 5 are shown two diagrammatical sketches to illustrate the importance of having the bearing nearly filled with balls and the bearing points as close to each other as possible. When the load is directly over one ball, as shown in Fig. 4, this ball will carry the greater part of the load. When the load comes between the balls, as in Fig. 5, the ball just coming into action will necessarily take more of the load than the ball which is leaving the line of action. It will carry this increased load until it reaches the center and for some distance beyond. Thus it can be seen that if three or four balls are at the same time near the line of action, the load of the bearing is more evenly distributed over the balls. This condition can only be obtained by making the cage so that the balls practically fill the annular space of the bearing.

Types of Ball Bearing Cages

The first cages used were designed with so great a distance between the balls that the bearing could carry only a very light load. In recent constructions it has been found possible to make ball bearings with a cage where 96 per cent of the space between the races is filled with the balls. The balls are introduced through filling slots, the size of which is a little less than the diameter of the ball, so that the latter are forced in between the two races under pressure. The shallow filling slots are not as deep as the ball races and are inclined at an angle to these. The early cages, such as shown in Fig. 6, were made from brass castings and were very clumsy and heavy. Later sheet-steel cages came into use, but the best cages, at the present time, are pressed up from sheet bronze or brass, in two parts, and are then riveted or fastened together after the bearing has been assembled.

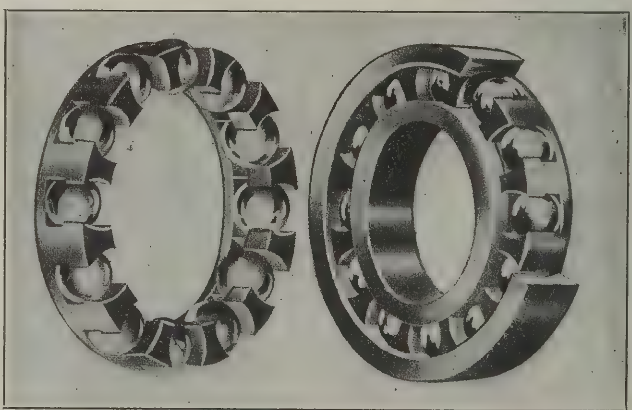
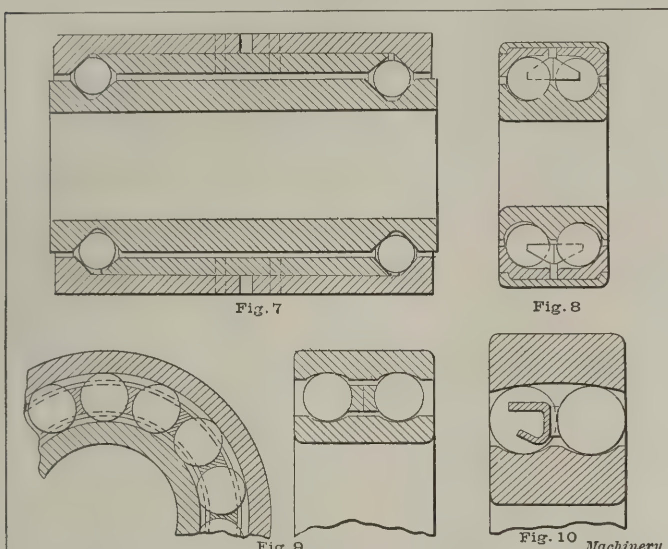


Fig. 6. Early Type of Ball Cage for Journal Bearings

*See "Ball and Roller Thrust Bearings," MACHINERY, August, 1912.
†Address: 912 Oakland Ave., Ann Arbor, Mich.

Double Row Annular Bearings

On account of the thrust to which annular bearings are sometimes subjected, the regular type was found unsatisfactory for certain work, and the double-row annular bearing was introduced. The first double-row annular bearing made in this country was designed and put on the market by the writer in 1890. The first design of this bearing is shown in Fig. 7. This bearing was not ground, but simply polished, and proved very satisfactory in a great many cases. It was, however, somewhat ahead of its time, and did not become as popular as the single-row bearing. The first double-row bearings of this type were made from soft steel and casehardened. Later they were made from regular tool steel and finally from an alloy steel.



Figs. 7 to 10. Various Types of Double Row Ball Journal Bearings

A type of double-row annular bearing made by the New Departure Mfg. Co., Bristol, Conn., is shown in Fig. 8. This bearing is composed of a cone with two grooves, two cups, and a shell. One cup is first forced into the shell, then the bearing is assembled and the second cup forced into place, after which the shell is spun over at the ends. When this bearing was first made, the cage was solid, and, therefore, caused considerable trouble, as it was practically impossible to get both races of exactly the same diameter. This caused the balls on one side to run at a different speed from those on the other, resulting in damage to the cage. This difficulty was overcome by making the separator in two parts, thus allowing each row of balls to run independently of the other.

Another type of double-row annular ball bearing is that brought out by Fichtel & Sachs, as illustrated in Fig. 9; this is practically composed of two single-row annular bearings. The cage used in this case is especially advantageous, as it permits the balls to occupy about 96 per cent of the annular space. The balls are introduced after the cage has been put into the bearing.

The double-row annular ball bearings manufactured by the S. K. F. Ball Bearing Co., Fig. 10, have a distinctive feature of self-alignment. Although this bearing has a retainer made of one piece, it is so constructed that both rows of balls take an equal amount of the load at all times.

Review of Manufacturing Methods

In the manufacture of annular ball bearings the methods have changed very rapidly. The bearings were first made by turning the races from a solid bar, which was a very expensive process, as about 75 per cent of the stock was wasted. In Fig. 11 is shown the method wh ch the writer adopted in the early stages of the ball bearing manufacture, in order to economize on material as well as to cheapen the cost of production. The operations were performed on a Cleveland automatic screw machine and consisted in first drilling and reaming the central hole; then, with a hollow mill having a pilot to guide it, the space between the races was cut out. A grooving tool formed the recesses for the balls, after which the pieces were cut off. As the larger sizes of bearings came into use, forgings were adopted for the races for these sizes. The method first employed for finishing these forgings was to use a hand screw machine; later the semi-automatic machine was adopted for this work.

The latest and best method for making the ball races is to make them from tubing. On account of the processes through which the tubing has passed, the metal is very dense and close grained, so that the bearings made from this material have an excellent bearing surface.

After the races have been machined it is necessary that they should be heat-treated. The treatment consists in heating the bearing very slowly to or near the recalescent point and then allowing it to cool slowly. This treatment is given to the ball races in order to prevent them from warping out of shape in the hardening process. After being hardened they are subjected to an artificial seasoning; without this operation they would not keep their shape.

The simplest method employed for the seasoning is to use a wheel about 6 feet in diameter, mounted on the top of a tank containing boiling water. The wheel is slowly revolved, and to it are attached wire baskets which hold the races. These come into contact with the boiling water for a short time, after which they cool off slowly during the remainder of the revolution of the wheel. The races are subjected to this treatment for about twelve hours, and in this way a result which ordinarily requires two months for its accomplishment is rapidly obtained.

The next operation is to rough-grind the bearing, after which it is allowed to rest for several days before being finish-ground. When finish-grinding the bearing, it is completely finished all over except on the outside diameter, which is left until after the bearing has been assembled, in order to insure perfect concentricity. The machines and methods used in the manufacture of ball bearings will be taken up in detail in a future article.

Roller Journal Bearings

In the making of roller journal bearings, the most difficult problems are to insure the alignment of rollers and to take care of the thrust at the end of the roller. Most of the improvements on these bearings have been to provide rings or collars to hold the rollers in position, as well as to take the thrust. One of the first roller bearings to be manufactured was made by the Ball Bearing Co. of Boston, Mass. This bearing had thin annular disks or washers at the ends, with flat brass stay-rods connecting them. The sides of these stay-rods were concave and held the rollers in place. The rollers were made in short lengths with nothing to prevent them from wearing out through the end of the cage, which they very often

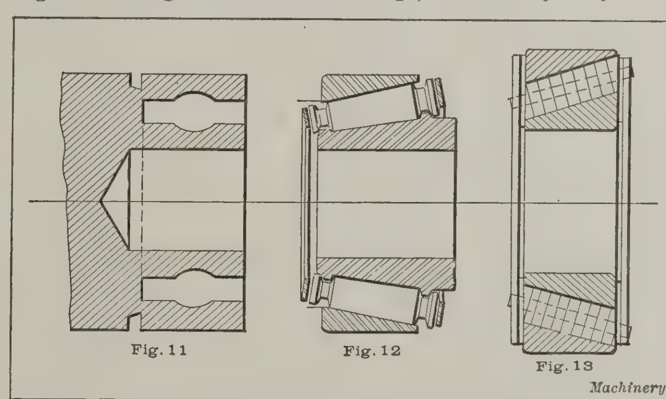


Fig. 11. Method of Turning Ball Races from Bar Stock. Figs. 12 and 13. Taper Roller Journal and Thrust Bearings

did when the sleeve, casing or roller was not ground perfectly straight.

The Standard Roller Bearing Co. of Philadelphia, Pa., then brought out another roller bearing in which the cage was made by drilling holes into the ends of sleeves, the metal in which was thinner than the diameter of the roller to be used. Two such sleeves were used for each bearing (one at each end), the two sleeves being held together by stay-rods. A ball was placed at the bottom of the drilled hole, against the end of the roller, in order to minimize the friction. This construction, of course, overcame the difficulty of having the roller wear through the cage end, but the rollers were not kept in perfect alignment, as the holes in the cages had to have some play in order to have the bearing run smoothly.

Other bearings have been developed which overcome the difficulties mentioned. Among these are the Zahn bearing where the roller is provided with a groove around it which fits either a projecting ring solidly held in the bearing, or shoulders on the races which are supposed to keep the roller in perfect alignment, and, at the same time, take the thrust. Another bearing known as the Johnson bearing, which is shown in Fig. 14, is provided to take the end thrust as well as the annular load and to overcome the difficulties due to lack of alignment in the rollers. In this bearing the stay-rods which hold the cage together are provided with two balls inserted in them which hold the rollers in alignment. The ends of the cage are grooved and a hardened steel washer is inserted. The balls which take the end thrust bear upon this washer. The roller is also provided with a ball at each end to eliminate friction. This bearing has some good features, but it is very intricate and must be made with great care. It is also rather expensive unless used where the end thrust, as well as the radial load, is to be carried.

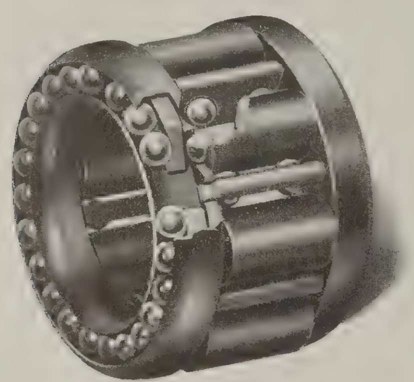


Fig. 14. The Johnson Bearing for taking Both Radial Load and End Thrust

Taper Roller Journal Bearings

Taper roller journal bearings have certain advantages, but they also introduce certain conditions which are difficult to overcome, the same as do taper roller thrust bearings. The first bearings of this kind were made by the Grant Axle & Wheel Co., of Springfield, Ohio. This bearing took the thrust on the cone and had holes in the rollers with stay-rods through them to form the cage. This style of bearing is supposed to take the thrust as well as the radial load. When taking the thrust on the ends of the roller, however, there is a tendency to twist the roller and to get it out of alignment with the axis of the shaft, and if the rollers are not all of exactly the same size, the larger rollers that take the thrust will soon chip off and wear out.

The Timkin Roller Bearing Co., of Canton, Ohio, soon followed the Grant Axle & Wheel Co. in making a bearing in which the thrust was taken exactly as in the Zahn bearing previously mentioned, where the roller is grooved and fits ridges in the race. To still further develop this bearing, two grooves were provided in the roller and two ridges on the inner ball race, as shown in Fig. 12. The latest type of straight roller taper bearing is that shown in Fig. 13. Here the rollers are made up of short straight sections, the same as in a plain roller thrust bearing. The use of straight rollers in this bearing causes slippage of the rollers. On account of the difference between the surface speed at the large and small diameters of the cone, there is a great deal of slippage which, although it increases the friction, at the same time takes the thrust of the bearing.

* * *

WORM AND HELICAL GEARS AS APPLIED TO REAR AXLE DRIVES*

European practice extending over a period of fifteen years has given ample evidence of the eminent success of the worm and helical type of gearing, and the author feels confident in saying that in the near future a large percentage of the cars in the United States will be equipped with this drive. The principal reason for the adoption of the helical form of tooth appears to be its peculiar quality of silence, regardless of speed or load. With the best methods of design and assembly, great durability, strength and efficiency are obtained.

It is impracticable in an article of this character to cover all the details satisfactorily. However, the author believes that on all styles of cars in the United States to-day the worm gear could be used successfully for rear axle purposes.

* Abstract of paper by Mr. Frank Burgess, read before the Society of Automobile Engineers at the Detroit meeting, June 27-29, 1912.

The successful worm gear should embody the following qualifications:

1. Cheapness of construction.
2. Strength for resisting shocks.
3. Hardened and smooth surfaces for durability.
4. Material of a suitable composition to reduce friction.
5. Simplicity of construction and mounting.
6. Perfect bearing conditions.
7. Noiselessness at any speed or load.
8. Reversibility.
9. Lightness in weight.
10. High efficiency in power transmission.

Granting that there is some argument against the worm in regard to trucks as to the dead axle proposition, this could be overcome by using a worm gear on each end of the axle, the same as sprocket wheels, having a double worm gear drive in place of the cumbersome chain drive. If at first slightly more expensive than the chain and sprocket drive, less repairs will more than make up the difference. Care should be taken to have accurate bearings, both radial and end-thrust.

RESULTS OF EFFICIENCY TESTS ON ORDINARY TYPE WORM-GEAR FOR AUTOMOBILE REAR AXLE DRIVE FOR ELECTRIC VEHICLES AND LIGHT POWER CARS

Number of Test	Temperature of Worm-gear, Degrees F.	Twist of Shaft in Degrees	R. P. M. of Worm	R. P. M. of Worm-gear	Input, Transmission Dynamometer, Horsepower	Output, Brake Horsepower	Efficiency, Per Cent
1	74	$1\frac{1}{4}$	1393	143	1.64	1.01	61.6
2	82	2	1423	146	2.65	2.11	79.6
3	86	$2\frac{3}{4}$	1416	145	3.41	3.11	91.3
4	86	$3\frac{9}{16}$	1416	145	4.46	4.15	93
5	90	$4\frac{7}{16}$	1370	140.5	5.48	5.03	92
6	94	$5\frac{7}{16}$	1389	142.5	6.72	6.12	91.2

Worm-gear: Phosphor-bronze, 39 teeth.
Worm: Casehardened steel worm, solid on shaft, quadruple thread.

Considerable discussion has arisen in regard to the relative merits of the straight and Hindley types of worm gearing. In my opinion both can be used successfully, although each has its own advantages and disadvantages. For most purposes, particularly where considerable power is to be transmitted, the Hindley type has the advantage, but with ordinary machinery it is somewhat more difficult to obtain the same degree of accuracy as can be obtained in the case of the straight type.

From tests made there is no question but that there is a larger bearing surface on the Hindley type of worm than on the straight. Therefore this type of gearing will for the same pitch present a bearing of greater durability, and heat less than the straight type, particularly under heavy load. The straight type may have less trouble with end-thrust bearings. The worm can move in its position longitudinally with the worm axis and therefore does not require as close an adjustment of the end-thrust bearings. With first-class bearings the Hindley type has the advantage, as a smaller and lighter gear can be used, thus reducing the expense.

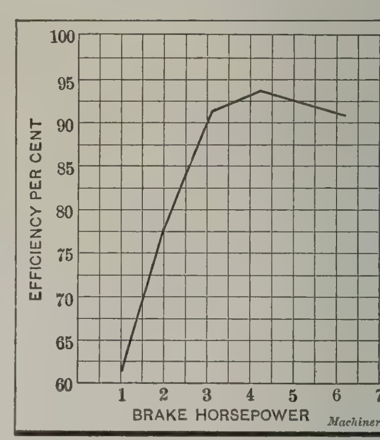


Diagram showing Relation between Brake Horsepower and Efficiency, based on Results of Tests

Some efficiency tests on an ordinary type worm and worm-gear for automobile rear axle drive, for electrical vehicles and light-power cars, were undertaken by the author. A transmission dynamometer, similar in some respects to the apparatus used at the Massachusetts Institute of Technology by Prof. Riley, was constructed. The prony brake was adopted for an absorption dynamometer, and a long shaft of small diameter was arranged to obtain the torsion of the shaft in degrees by an electrical indicator apparatus for a transmission dynamometer. The results of the tests are given in the accompanying table. The diagram shown gives a curve plotted from the results obtained in the tests and recorded in the table.

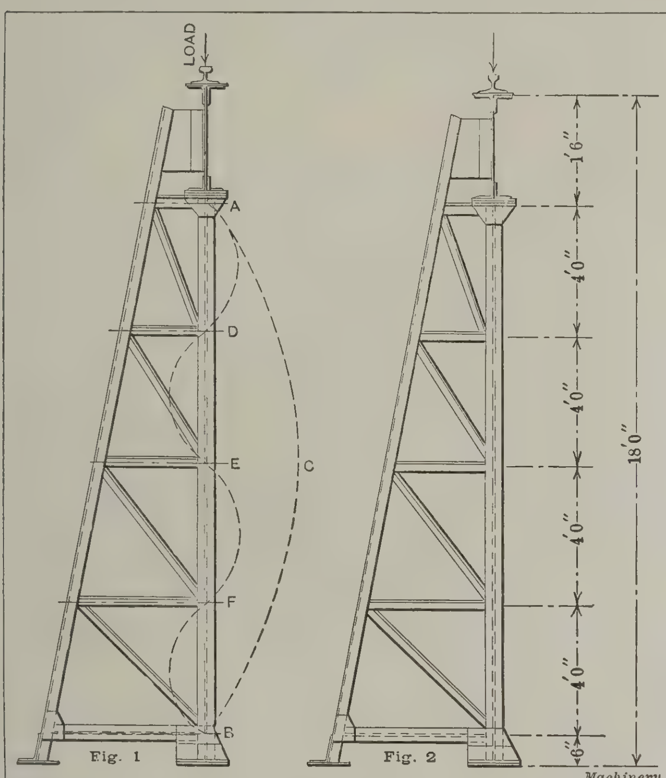
STRESSES IN AN A-FRAME FOR A CRANE RUNWAY

AN ANALYSIS OF THE PRIMARY STRESSES AND A DISCUSSION OF THE STRESSES IN THE LATTICE BARS

BY HARRY GWINNER*

Fig. 1 is an outline of an A-frame or trussed column for a crane runway. The following information has been requested in connection with it: "A discussion of the stresses in the members; a graphical analysis of the stresses; and an investigation into the influence that the other members have upon the perpendicular main member when choosing a section, as in the case of a column."

This frame will be treated as being subjected at different times to a different set of forces, which actually occurs in practice. In Fig. 1 the frame is shown as being subjected to a direct load along the axis of the main member *AB*. Under this load there is no tendency for the frame to rotate about the foot of the column *AB* (provided there is no eccentric stress in the column), and while the trussing does not receive any primary or direct stresses from this load, it does receive secondary stresses when the column begins to deflect under the load, or when the inevitable shortening begins to take place—that is, when the points *A* and *B* approach each other.



Figs. 1 and 2. Analysis of Stresses in A-frame for Crane Runways

The object of the trussing is to prevent buckling in the column at the points of attachment of the trussing, and will compel the member *AB* to assume the compound curve line, threading in and out of the column through the points of attachment *ADEFB* instead of bending along the single curve *ACB*, when deflection begins to take place. Thus the member *AB* may be treated as a column or strut of one-quarter of the length of *AB* (since the trussing as shown in the figure divides the length into four portions), so far as bending in the plane of the trussing is concerned.

To test the column to note the effect of the trussing or bracing, assume in Fig. 2 a direct load of 150,000 pounds, and the dimensions as shown. Assume a 15-inch by 42-pound I-beam for the column, and use the straight line column formula:

$$P = 16{,}000 - 70\frac{l}{r}$$

where

P = permissible unit stress,

l = length of column,

r = radius of gyration.

Then we have for the permissible unit stress per square inch for the four-foot sections:

$$16{,}000 - 70\frac{4 \times 12}{1.08} = 12{,}890 \text{ pounds,}$$

1.08 being the least radius of gyration about the line 1—1, Fig. 3.

The permissible unit stress for the full length portion, taking the radius of gyration about axis 2—2, is:

$$16{,}000 - 70\frac{18 \times 12}{5.95} = 13{,}460 \text{ pounds}$$

Thus it will be seen that the trussing breaks the continuity of the column on the weaker side, and, hence, strengthens it materially.

Stresses in Truss Members

The stresses in the truss members are secondary ones, similar to those induced in the lattice bars of a built-up column. Some years ago the writer took up the matter of stresses in lattice bars with Prof. Mansfield Merriman—the author of the well-known work on "Mechanics of Materials" —who, at that time gave the information that no rational formula had been deduced for accurately computing the stresses. In an article on "Tests of Built-up Steel and Iron Compression Pieces," in the *Transactions of the American Society of Civil Engineers*, Vol. LXV, 1909, the results of the experiments undertaken showed that there is no simple mathematical law governing the distribution of the stresses in a latticed column, and in Bulletin No. 44, issued by the University of Illinois Engineering Experiment Station, on "An Investigation of Built-up Columns Under Load," a portion of the summary of the tests says: "It seems futile to attempt to determine the stresses which may be expected in column lacing for central loading by analysis based on theoretical consideration or on data now available."

Hence, it is theoretically impossible to assign any definite values to the horizontal reactions, or the tendency to buckle at the connections of the trussing to the column. However, the following method is sufficiently accurate to determine the stresses for the purpose of proportioning the trussing. Using the formula $16{,}000 - 70\frac{l}{r}$ to get the permissible unit stress on the column, and with the assumption that the column is very short, 16,000 pounds per square inch will be used. The expression $70\frac{l}{r}$ may, therefore, be taken as the measure of the stress per square inch due to bending in the column under a direct load.

If l is in feet, this expression becomes $70 \times 12\frac{l}{r} = 840\frac{l}{r}$. Designating this stress per square inch as S, we have $S = 840\frac{l}{r}$. Then, by assuming a load put on the side of the column to produce this stress, we can more easily ascertain the stresses. Hence, place the column as shown in Fig. 4, loading it with a uniform load of w pounds per linear foot, and treat it as a beam. Then the beam will tend to deflect as shown by the dotted curve *xzy*. If the column is treated as being pin-connected at *A* and *B* in Fig. 1, it will have a tendency to assume the curve *ACB* shown in Fig. 1, which is very similar to he curve *xzy* in Fig. 4. Under his assumption, we may treat the bending in the column as if it were caused by the uniform load in Fig. 4.

Now, $\frac{wl^2}{8}$ is the bending moment in foot-pounds, or $\frac{12wl^2}{8}$ is the bending moment in inch-pounds. Then,

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$$\frac{\text{Bending moment}}{\text{Section modulus}} = \frac{M}{Z} = S_1$$

Therefore, $\frac{12}{8} \times \frac{wl^2}{Z} = S_1.$

Let I = moment of inertia,
C = distance from center of gravity to extreme fiber,
A = area of section,
r = radius of gyration.

Then,

$Z = \frac{I}{C} = \frac{Ar^2}{C}$, and, from the previous equation,

$$S_1 = \frac{12wl^2}{8} \times \frac{C}{Ar^2} = \frac{3wl^2C}{2Ar^2}$$

Therefore, as S and S_1 are approximately the same, $\frac{840l}{r} = \frac{3wl^2C}{2Ar^2}$ and solving for w, we have:

$$w = \frac{560Ar}{lC}, \text{ or total load} = \frac{560Ar}{C}$$

Therefore, R in Fig. 4 is $= \frac{560Ar}{Cl} \times \frac{l}{2} = \frac{280}{C}Ar.$

Having found R, treat the frame as for finding the stresses in a latticed truss, and as indicated in Fig. 5.

The writer recently requested sme information on trussed columns from two expert detailers and designers on columns employed by a bridge company with whom he was at one time employed. They both agreed that the most suitable way to handle such problems was to assume a deflection of two or three inches at the center of the column (after designing the column to take care of the direct load), and then to ascertain the amount of load which, when the column was treated as a beam, would produce this amount of deflection. The stresses at the different points along the beam (column), are proportional to the ordinates of the curve as shown in Fig. 4.

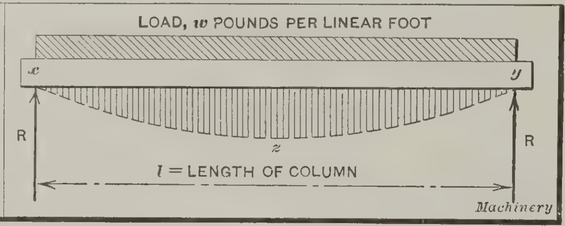


Fig. 3 Fig. 4. Column treated as Beam

Under this assumed deflection, the lengths of these ordinates can be measured on the supposition that this deflection, or elastic line, is a sinusoid, the equation of which is

$$Y = \triangle \sin x \sqrt{\frac{P}{EI}}$$

as given in Johnson's "Modern Framed Structures" under column formulas. This method is rather crude, but it has the advantage of giving something upon which to work.

The New Jersey Steel and Iron Co. has incorporated in its specifications the following clause: "The lattice bars shall be so spaced that each channel between the lattice connections shall be stronger than the column considered as a whole, and their size shall not be less than would be obtained by treating the column as a lattice girder supported at the ends and loaded at the middle with a load equal to 3 per cent of the total compression on the column. Mr. Pritchard, who was the engineer of this firm at one time, says the 3 per cent rule was first published in 1891 in the *Lehigh Quarterly*, and that it was adopted as a result of experience.

It is the opinion of the writer that the secondary stresses due to the direct load, as mentioned in the foregoing paragraphs, are very small, and that the theoretical sections required to take care of them are so small that these sections are impracticable, and that any structural shapes which are large enough for the rivets will be greatly in excess of any theoretical sections required.

In general, the practice is to entirely neglect these secondary stresses in crane frames and to design the trussing of such frames for horizontal loads. These horizontal loads are produced when the brakes are applied to the trolley traveling at right angles to the crane girders. The coefficient of sliding friction of the wheels on the rails is found to be about 0.2, and the maximum horizontal load possible, therefore, will occur when the brakes are so suddenly applied to the moving trolley carrying its maximum load, as to cause it to slide on the rails. Therefore, to proportion the trussing, assume 0.2 of the maximum vertical load plus 0.2 of the weight of the trolley applied horizontally at the rails of the runway girders, and design the A-frame as a cantilever for half this load, as it is assumed that the bridge girders of the crane

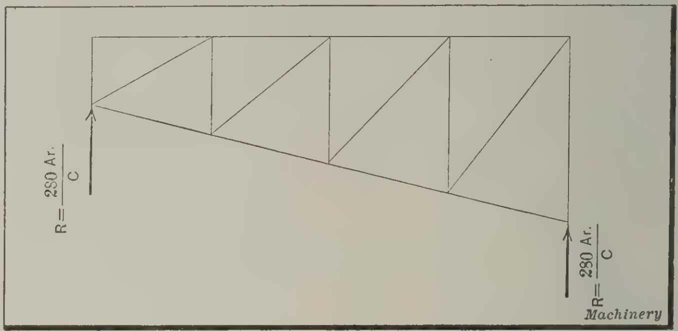


Fig. 5. Frame treated as Latticed Truss

transmit the other half to the opposite A-frame. The column AB (Fig. 1) is therefore designed to take the combined stress due to the direct vertical load and this horizontal load.

The A-frame is often used out-of-doors, and is therefore subjected to wind pressure, and often additional stresses are induced by the swaying of the live load carried by the crane or by an inclined pull caused by the load being out of plumb when the crane starts to lift it. All of these stresses must be considered and the design treated accordingly.

In the request for information that prompted this article, nothing was said relative to the stresses induced by forces in a plane at right angles to the plane of the trussing. If the moment of inertia of the cross-section of the column is not sufficiently strong to take care of these forces, side bracing should be used. The calculation of this bracing is made in a manner similar to that of the portal or intermediate bracing in a bridge.

* * *

COURT DECISION ON EMPLOYERS' LIABILITY

A recent unanimous decision of the Illinois Supreme Court in the suit of Milford Streeter of Aurora, Ill., against the Western Wheeled Scraper Works, establishes a new basis for the relation between employers and employes as regards accidents and accident prevention, this new basis being a consequence of the new state employers' liability law of Illinois, which is similar to those enacted in several of the other states. The court, affirming the decisions of two lower courts, holds that the old law, under which an employe could not recover if he knowingly worked on defective or unsafe machinery, is now a dead letter. The wording of the conclusion of the court's decision is as follows:

"The law does not leave to the employer's judgment the reasonableness of inclosing or protecting dangerous machinery, or permit him to expose to increased and unlawful dangers such of his employes as may be driven by force of circumstances to continue in his employ rather than leave it and take chances of obtaining employment elsewhere under lawful conditions. The guarding of the machinery mentioned in the statute is a duty required of the master for the protection of his workmen, and he owes the specific duty to each person in his employ. To omit it is a misdemeanor, subjecting him to a criminal prosecution."

* * *

The oldest metallic objects to which archaeologists have assigned a probable date are those found at Nagada in Egypt. These consist of some pieces of gold, a bead, a button and fine wire of nearly pure copper, which are supposed to be at least 6300 years old. Nearly all the ancient gold that has been examined contains silver enough to give it a light color.

SELECTING THE NUMBER OF TEETH FOR GEARS AND SPROCKETS*

BY G. M. BARTLETT†

The tables in the accompanying Data Sheet Supplement contain the decimal equivalents of all fractions with denominators up to 60. In machine design it is frequently necessary to determine gears and sprockets with low numbers of teeth to give approximately such ratios as can be expressed exactly only with very high numbers of teeth. For example, in a certain machine employing a chain drive, it is required to have the speeds of the driving and driven sprockets as near as possible to 1149 and 473 revolutions per minute. It is stipulated, however, that the number of teeth in the larger sprocket must not exceed 60. Dividing 473 by 1149, we find that the ratio is 0.4117. By referring to the table of fractional equivalents given in the accompanying Data Sheet Supplement, the nearest fractional value to this ratio, with a denominator less than 60, is found to be 7/17. Hence, the number of teeth in the two sprockets can be 14 and 34, or 21 and 51. This will give speeds of 1149 and 473.118 which introduces a comparatively small error. In the absence of such tables, the method of obtaining the approximate fraction 7/17 would be rather cumbersome, as will be seen from the following:

```
473 | 1149 | 2
       946
      ----
       203 | 473 | 2
             406
             ---
              67 | 203 | 3
                   201
                   ---
                     2 | 67 | 33
                         66
                         --
                          1 | 2 | 2
                              2
                              -
```

This is the operation by which the greatest common divisor is sometimes found. Next, place the partial quotients obtained in a row as below. Beneath the first number, write its reciprocal ½. Beneath the second number write a fraction, the numerator of which is the second number itself, and the denominator of which is the product of the first and second numbers plus 1. For the numerator of the next fraction, multiply the partial quotient (3) by the numerator of the second fraction (2), and add the numerator of the preceding fraction (1). The result is 7. For the denominator, multiply the partial quotient (3) by the denominator of the fraction just found (5), and add the denominator of the preceding fraction. The result is 17. Proceed in the same way for the succeeding fractional values, the method used being that of continuous fractions.

2	2	3	33	2
$\frac{1}{2}$	$\frac{2}{5}$	$\frac{7}{17}$	$\frac{233}{566}$	$\frac{473}{1149}$

These fractions approach the value of 473/1149 as we proceed towards the right, but as we cannot use more than 60 teeth in the sprocket, the fraction 233/566 cannot be used. Hence, we must use the fraction 7/17, or, if this fraction does not give a sufficiently close approximation, we must use some fraction between 2/5 and 7/17 that might come closer to the required ratio and which has a denominator less than 60. Between the values of 2/5 and 7/17 there are, then, the following fractions: 23/57, 21/52, 19/47, 17/42, 15/37, 13/32, 24/59, 11/27, 20/49, 9/22, 16/39, and 23/56. Whether or not any of these gives a closer approximation, can only be found by trial. In the present case, of course, the matter would be easily determined, as 7/17 comes so very close to the required ratio.

As another example, suppose it is desired to feed stock to a punch press through rolls of 4-inch diameter, the rolls being turned by a ratchet and pawl at the end of each stroke of the punch. The feed is to be as near as possible to 2¼ inches, and the number of teeth in the ratchet to be as low as possible. To find the answer to this problem with the aid of the tables in the Data Sheet Supplement, we proceed as follows: The feed for one revolution of the rolls is $4\ \pi = 12.5664$. To feed 2¼ inches, the rolls must make $2.25 \div 12.5664 = 0.1790$ of a revolution. Referring to the table, the nearest fraction to this ratio is 5/28; hence we choose a ratchet of 28 teeth, feeding five teeth at a stroke. The feed will be 2.244 inches instead of 2.25 inches, an error of only 0.006 inch. If we should choose the next higher fraction to the ratio 0.1790, which is 7/39, the ratchet will have 39 teeth, and the feed of seven teeth in this ratchet will be equivalent to a feed of 2.256 inches, which also involves an error of 0.006 inch.

If a plate cam is to be cut on a lathe, and it is necessary to feed the tool 0.53 inch for each revolution of the cam, and the lathe is so constructed that it takes 10.35 revolutions of the lead-screw to feed the tool 0.53 inch, the change gears must be so selected that there will be a velocity ratio of 1 to 10.35 between the work-spindle and the lead-screw. Two pairs of gears will be required. Assume the ratio of the intermediate gears arbitrarily as 1 to 3; it remains to find a combination with a ratio as near as possible equal to

$$3 \times \frac{1}{10.35} = 0.2899$$

Referring to the Data Sheet Supplement, the nearest fractions to a ratio of 0.2899 are 11/38 and 9/31. As change gears with multiples of these numbers of teeth are usually not available, we take the nearest available fraction, which is 7/24, giving gears with 28 and 96 teeth, respectively. The ratio 1/3 can be obtained by using gears with 24 and 72 teeth, and the value of the train of four gears, hence, is:

$$\frac{96 \times 72}{28 \times 24} = 10.286$$

which gives a feed of 0.527 inch per revolution instead of 0.530 inch, an error of only 0.003 inch.

Problems in cutting racks for gears of a given diametral pitch, or in cutting screw threads of unusual leads may be considerably simplified by the use of this table.

* With Data Sheet Supplement.
† Chief Engineer, Diamond Chain & Mfg. Co., Indianapolis, Ind.

* * *

IMPROVEMENTS IN GAS ENGINE DESIGN

BY GEORGE M. STROMBECK*

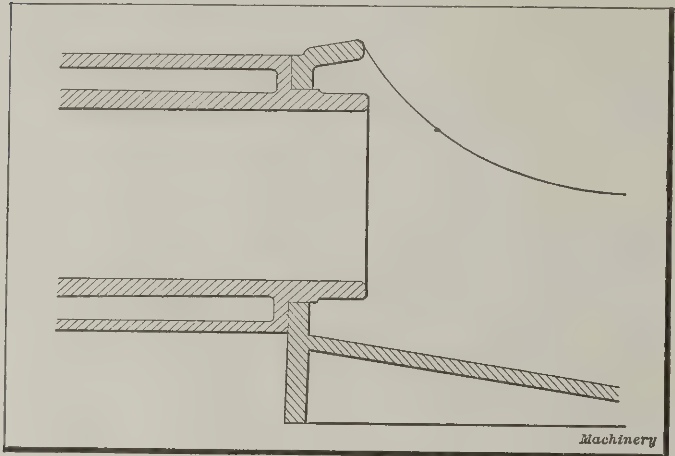
In gas engine design, as well as other matters, experience is the court of last appeal. When any particular practice has stood the test of years, it is not safe, except through knowledge gained by unusually wide practical experience, to condemn it, as there may be reasons for its existence that outweigh the theoretical objections to it. This is especially true in an industry where competition is so keen as in the gas engine business. While much of Prof. Hirshfeld's criticism of gas engine design in the July number of MACHINERY is justified, he attacks a number of things which the writer, after five years' shop experience, believes to be sound practice.

In regard to overhanging cylinders, it is doubtful if anyone would justify the construction in Fig. 1 of the previous article, but the modification hinted at in Fig. 2 and further developed in the accompanying illustration has much to commend it: first, the entire length of the cylinder on all sides is free to expand, and, second, the metal is uniform at all places; these are both the best possible conditions under which a cylinder can retain its shape, thus permitting lighter rings with consequent reduction in engine friction and wear. From a manufacturing point of view the construction is simpler than that shown in Fig. 4 (former article), because all the work can be done at one setting and in a lathe, making it easy to obtain true work. In reference to Fig. 4, every shop man knows that this design involves at least two settings for machining, and this increases the cost. Furthermore, there is a chance of getting the guides out of line with the bore; moreover, some parts of the cylinder section are heavier than others, and as the ribs are bolted to the frame there is a possibility of undue stresses not present with the overhanging cylinder. The makers of a very widely known and successful engine have manufactured over twenty thousand with an overhanging cylinder during the last dozen

* Chief draftsman, Root & Vandervoort Engine Co., Moline, Ill.

years, and have had no trouble whatever from them. In fact, they are so pleased with their performance that they are continuing this feature in a new line now being brought out.

Another point in design which the writer believes has more to justify it than to condemn it is the direct connection between the water jacket in the cylinder and in the head, Fig. 9. That solution of a problem which is direct, and, all things considered, saves most time, must be conceded to be the best engineering practice. Reasonable care in the machining of the ends of the cylinder and head will produce a surface that readily holds a gasket. The only time when trouble would be experienced would be when a part of the circumference is subjected to a much higher temperature than the rest, and when this is the case it would probably be difficult to make a tight joint even though the water jacket were not cut through. If only a part of the extra work necessary to provide other means of cleaning the jacket is applied to making the joint between the head and cylinder right, the trouble with the jackets will not be enough to deserve mention. Any other method would first of all deprive the foundry of a most positive means of holding and venting the jacket core, with a resulting higher loss of castings (with same care and labor). The cleaning out of the core sand and, later,



Method of Attaching and Supporting Gas Engine Cylinder

removing of scale would be much more difficult and far less certain if pockets or hand holes were used. There is a remarkable agreement among manufacturers in this point of design, which would not be the case had their experience proved to them that the present methods were wrong.

A minor point in design is the oil groove around the base. While this, no doubt, serves to collect some oil which would otherwise reach the floor, it is doubtful whether the advantages gained offset the foundry difficulties. To be of service, such a groove must be continuous, which can only be done by bringing it outside of the bosses for the anchor bolts. If this is done, larger flasks and the handling of more sand is necessary; but more objectionable than this is the fact that the sand forming the grooves is poorly supported, requiring careful securing. Even then it may wash away in pouring the casting. These objections have been sufficient to cause the removal of such a drain from such engines as were at first designed with it.

The splash collar on the crankshaft, Fig. 15, is, in theory, a fine thing, but its cost is disproportionate to its advantages. While it looks innocent enough, such a little knife edge would add a very large percentage to the cost of grinding the shafts, which is the present practice. With a straight shaft the operation is simple; with a splash collar more or less complication would be introduced, and much greater care in handling the finished product would be required. The splash collar is a refinement which a very large majority of users of small and medium sized engines would not want to pay for.

The use of malleable iron for connecting-rods is, according to experience, anything but an objectionable practice. The maximum return for minimum effort, that is, the cost, must determine this as well as all other problems in engineering manufacture. In small sizes, steel drop-forgings are the solution. In larger sizes, this is out of the question, and the designer must choose between the turned rod and a cast one. If he wishes the benefit of the economical I-section, the material must either be steel casting or malleable iron. The art of casting steel is not as advanced as that of casting malleable iron; hence, there is more uniformity with the latter.

William Kent, in the latest revised edition of his "Pocketbook," says, on page 430, of malleable iron: "For the repeated stresses of severe service the malleable casting ranks ahead of steel, and only where a high tensile strength is essential must it be replaced by that material." On page 431 he says: "The effect of annealing is to oxidize and remove the carbon from the surface of the casting, to remove it to a greater or less degree below the surface, and to convert the remaining carbon from the combined form into the amorphous form called a 'temper carbon' by Professor Ledebur, the German metallurgist. * * * In the American practice the annealing process is rather a heat-treatment than an oxidizing process." On the following page Mr. Kent says: "It was formerly the general belief that the strength of malleable iron was largely in the white skin always found on this material, but it has been demonstrated that the removal of the skin does not proportionately lessen the strength of the casting."

The above statements agree exactly with the writer's experience with malleable iron connecting-rods. Barring accidents, there has been no trouble with such rods. The effect of inertia on the rod, to be sure, makes it a beam under a continuous load, but this load does not act when the rod is under its greatest stress, nor is it at any time very large in engines of the size that are usually fitted with malleable-iron rods. Hugo Güldner, in his excellent book on gas engine design, gives the maximum bending moment M_b in the plane of the motion of the rod, caused by the inertia, as follows:

$M_b = 0.000002\ n^2 r A g L^2$, where

n = revolutions per minute,

r = radius of crank in inches,

A = area of mean section of rod in square inches,

g = weight of one cubic inch of the material of the rod in pounds,

L = length of rod in inches.

Applying this to an actual case will show the relative unimportance of this bending stress. An engine making 350 revolutions per minute has a connecting-rod 27 inches long. The mean section is I-shaped and has an area of 1.65 square inches, and a moment of inertia of 1.09. The bore is 6½ inches, and the stroke is 11 inches. Substituting in the formula:

$M_b = 0.000002 \times 350 \times 350 \times 5.5 \times 1.65 \times 0.26 \times 27 \times 27 = 421$ inch-pounds.

The rod section is 2¼ inches deep. The fiber stress is then, according to the usual formula:

$$S = \frac{M}{I/C} = \frac{421}{1.09 \div 1.125} = 435 \text{ pounds per square inch.}$$

When it is remembered that this stress does not occur until after the maximum force of the explosion has been exerted, it is plain that it needs but little consideration, and that the use of malleable iron in the connecting-rod is not objectionable.

Concerning the low-tension ignition system, it would seem singular that manufacturers should adhere to it so strongly if there were not much in its favor. Equally singular would it seem that all leading manufacturers of magnetos are now developing low-speed, low-tension magnetos for make-and-break service, if they did not believe in this system. The sooting up and fouling of spark plugs even with automobiles is proverbial. If this is the case in an engine which explodes regularly every cycle, what is to be expected in a hit-and-miss engine on a light load, where the explosions are far apart, giving plenty of time for lubricating oil and soot to foul the plug? With the make-and-break ignition, the motion of the igniter prevents this. The practice of the manufacturers is the result of the experience of numerous experts, continually in the field, who have had full opportunity to compare both systems under all conditions.

MANUFACTURING THE VIXEN FILE*

METHODS USED IN PRODUCING A CIRCULAR CUT FILE

BY CHESTER L. LUCAS†

Since the days when primitive man used the file for sharpening his implements of field and war, the file has been one of the most common tools. As in many other commonplace things, however, no one seemed to see room for improvement until, in 1900, Alexis Vernaz, of Yverdon, Switzerland, was trying to devise a hand tool for cutting a lot of exceptionally hard castings. The Vixen file was the result of his efforts. His whereabouts is not known at present, but there is an Elliott Cresson medal waiting for him that was awarded by the Franklin Institute in 1909 for making the first radical improvement in files for generations. The essential points of the Vixen file are well described by a sentence from the patent specifications: "A file provided with teeth cut in the form of arcs, having their bases located rearwardly with respect to the cutting edge of the teeth."

Fig. 1 illustrates a Vixen file, in which it will be seen that the radical difference between it and the ordinary file lies in the shape of the teeth. The object of curving the teeth is to provide a shearing cut, and by reason of this shearing cut

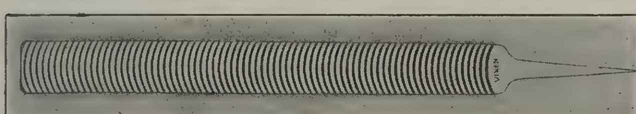


Fig. 1. The Vixen File

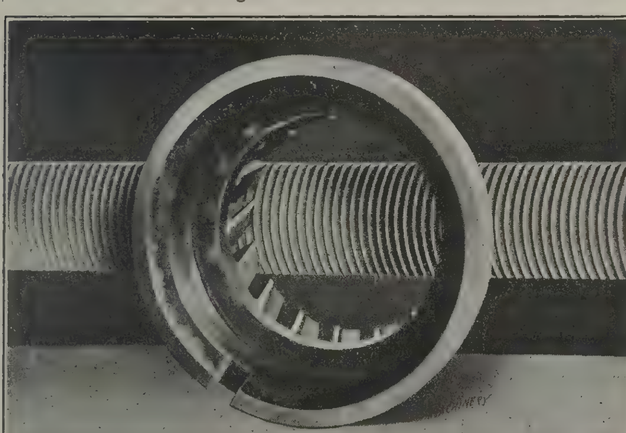


Fig. 2. How the Teeth are cut on Vixen Files

the file is self-clearing. The determination of the radii of the arcs of the cutting teeth of the various sizes of files was the result of experiments which indicate that the best cutting tooth is obtained by using a radius approximately the width of file being made. Teeth cut on smaller radii in proportion to the width of the file make it impossible to guide the file correctly, and teeth of much larger radii do not cut nor clear as easily. The teeth of Vixen files are milled with hollow cylindrical cutters. Several of these cutters are shown in

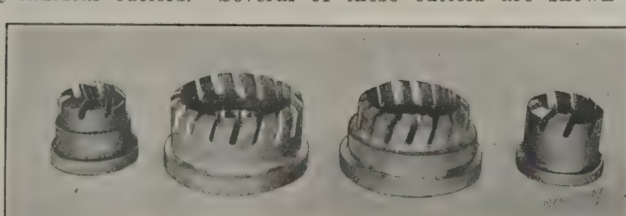


Fig. 3. Four of the Cutters

Fig. 3. Of necessity, the cutter is slightly inclined to the face of the file while cutting the teeth, in order that the side of the cylindrical cutter not being used may clear the parts of the file not being cut. This condition is graphically shown in Fig. 2. The amount of this inclination varies from 2 to 4 degrees, depending on the different depths of cut. By thus inclining the cutter to the work and securing a rake to the teeth, an added quality is given to the tooth, enabling it to cut rapidly. The inclination of the axis of the cutter results in cutting the teeth slightly deeper at the center than at the edges, therefore, the face of the finished file is slightly lower

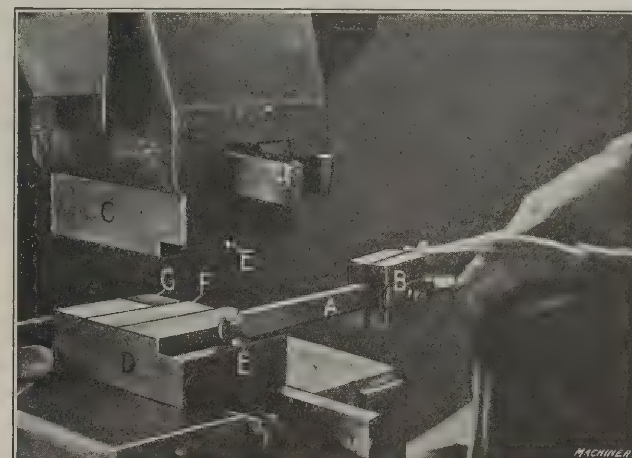


Fig. 4. Forging the Tang

in the center, the amount, however, is so small that it is practically imperceptible.

Steel for Vixen Files

The steel from which Vixen files are made is a Swedish chrome steel and is ordered on specification calling for chemical analysis as follows:

Carbon	1.20 to 1.35 per cent (1.25 per cent desired)
Chromium	0.40 to 0.60 per cent (0.50 per cent desired)
Manganese	not to exceed 0.40 per cent
Silicon	not to exceed 0.30 per cent
Phosphorus	not to exceed 0.03 per cent
Sulphur	not to exceed 0.03 per cent

The hardness, according to the Brinell hardness scale, should be from 130 to 170, a hardness of 150 being desired.

Operations in Making the File

The first operation in the making of the file consists in the shearing of the bar stock to length. This is an

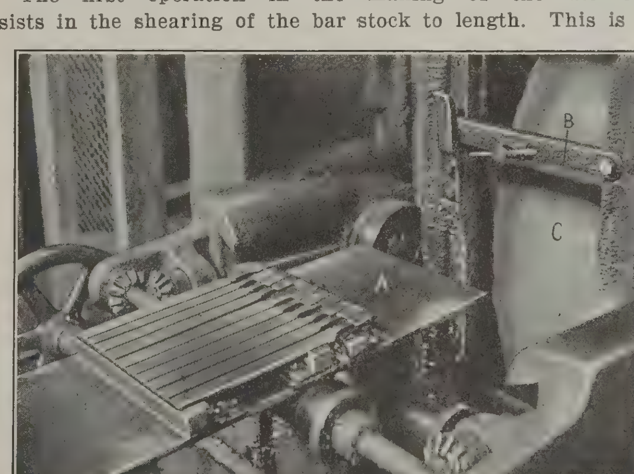


Fig. 5. Grinding the Sides

ordinary operation and is performed upon a shearing press of the usual type. From the shearing press the short lengths of steel go to the tanging hammer where the tangs of the files are forged in the manner illustrated in Fig. 4. The dies, and the beginning of the tanging operation are here illustrated. A helper hands the file blank, one end of which has been heated to a forging heat, to the operator of the hammer in which the tangs are forged. The blank *A* is held in special tongs *B*. The first part of the tanging operation consists in "nicking" the end of the file blank between the two half rounded projections *E* at the front of the dies *C* and *D*, leaving

* For further information on file making, see the following articles in MACHINERY: "File Making at a Sheffield Works," April, 1911, engineering edition; "Toolmakers' Files," January, 1911; "Vernaz Circular Cut File," October, 1909; "Making Swiss Files in America," September and October, 1907. See also MACHINERY's Reference Book No. 48, "Files and Filing."
† Associate Editor of MACHINERY.

the file blank in the condition shown. After this blow the operator shifts the file blank to the middle section F of the dies which have beveled faces corresponding with the taper of the tang. By rapidly turning the blank after each blow, the metal beyond the nicked portion of the blank is drawn out to approximately the shape of the finished tang, after which one or two blows are struck on the finishing faces G of the die to complete the tang. It is an almost incredible fact that the tang of an 8-inch file is forged in from ten to fifteen seconds from the time it is taken from the fire.

Following the tanging operation, the trademark impression is stamped upon the shank of the file, after which the blanks are annealed by being heated in large quantities in iron boxes and allowed to cool very gradually. The annealing operation decarbonizes the exterior surface of the steel, and before cutting the teeth it is important that this inferior surface of the stock be faced off. This operation, called stripping, is common in making files of all kinds, the metal being removed on large broad-faced grindstones, six feet in diameter. The files are held by the tangs on the plate shown at A in the illustration Fig. 5, which is dropped into position against the wheel and clamped by bar B, after which the holding plate and files are reciprocated in a vertical line against the face of the wheel C, at the same time being flooded with water and fed gradually against the wheel. By this means, 1/64 inch is removed from each side of the file-blanks, leaving them perfectly flat and ready for the cutting of the teeth.

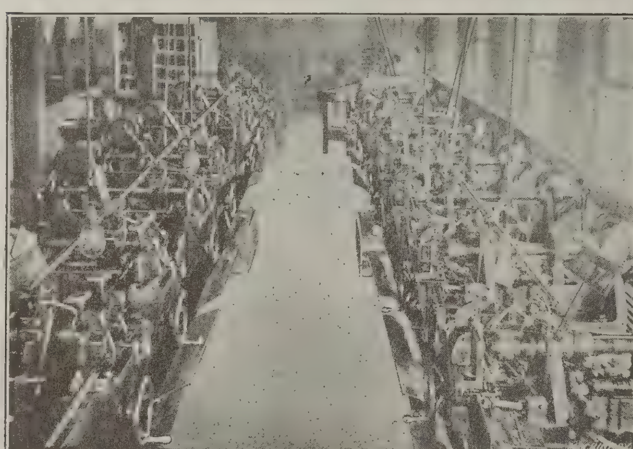


Fig. 6. Two Groups of the Tooth-milling Machines

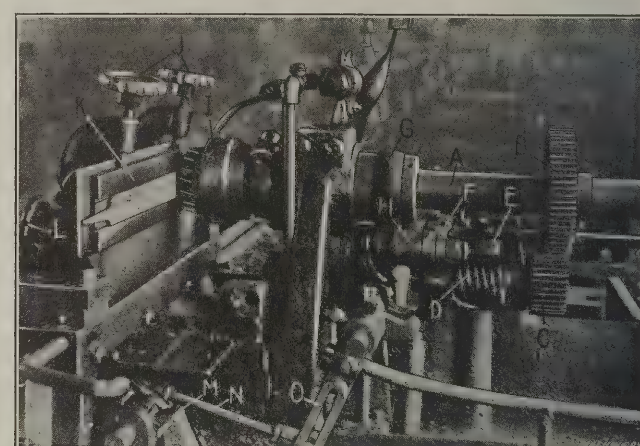


Fig. 7. Details of Machine for Milling Teeth

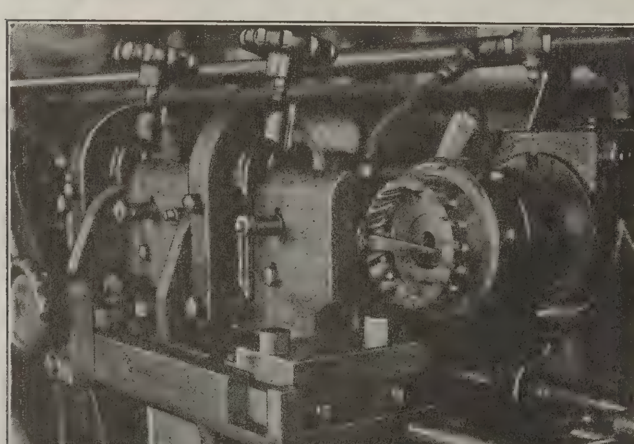


Fig. 8. Close Range View of Cutting Head

Fig. 9. Preparing the Files for heating in the Lead Bath

Cutting the Teeth

The most interesting operation in connection with the making of the Vixen file is the cutting of the teeth. The machines for cutting the teeth are operated in groups of eight, being driven from lineshafting at the rear of the rows of machines. Two of these groups of machines are shown in Fig. 6. The machine consists essentially of a spindle which carries the cylindrical cutter and a table which supports the file blank in a plane at right angles to that of the cutter spindle. As the cutter revolves, it is fed forward to the file blank, withdrawn, the file holding table moved forward the distance of one tooth and the cutter spindle brought forward again. Thus, the teeth are cut one at a time and the machine is automatically stopped after the last cut. Referring to Fig. 7, the cutter spindle, its method of feeding and the cross feed of the work table, may be seen. The cutter spindle shown at A is driven by bevel gearing from the extreme right-hand end of the machine. By means of gear B in mesh with gear C operating on a worm-shaft, the worm D engages a worm-wheel, not shown, which causes cam E to turn against yoke F. Yoke F is attached to collar G, and thus as the high part of the cam is reached, the cutter is fed forward to its deepest position with respect to the file and, of course, returned when the low part of the cam is reached. The double spring box H constitutes a means for insuring the feeding of the cutter to the proper depth of the tooth in each instance; the springs within the barrels overcoming any tendency for uneven feeding of the spindle caused by chips lodging upon the cam or from other sources.

The cutters themselves are made of Rex high-speed steel. Four of these cutters are shown in Fig. 3, and, as may be seen, they are milled very deep between the teeth, which allows them to clear themselves of chips rapidly and provides for many sharpenings before they are worn out. The cutting faces are ground to an included angle of 60 degrees and the cutter is held to the end of the spindle by a flanged sleeve I, shown in Fig. 7, which is tightened by a spanner wrench holding the cutter securely in place. The illustration Fig. 7 also shows the method in which the files are held for cutting, consisting of the two clamping screws J which operate against jaw K of the vise. For varying the depth of the tooth, handwheel L is used, thereby bringing the work table nearer to or farther from the cutter. The number of teeth cut per inch varies from 6 2/3 to 16, and for spacing the teeth there is a ratchet and pawl upon the end of the feed shaft. This pawl, shown at M in the illustration Fig. 7, is operated by a lever N which, in turn, is reciprocated by the arm O. Another view of this machine is shown in Fig. 8 which more clearly shows the cutter and its relation to the file blank.

The widths of the files vary from ⅞ inch to 1¾ inch.

There are, on each side, from 90 to 250 teeth, varying, of course, with the pitch and length of the file. It takes twenty-five minutes to cut the teeth in one side of an ordinary 12-inch Vixen file, as compared with one minute for cutting the teeth on one side of an ordinary commercial 12-inch file. Hence it is apparent that the manufacturing cost of a Vixen file is comparatively high.

Hardening

Previous to heating the files for hardening, they are treated with a charcoal and oil preparation to prevent the lead used in the heating from clinging to the teeth and thus interfering with the hardening. The files are brushed with this solution and placed against racks of steam pipes as shown in Fig. 9, to bake the coating on before the files are placed in the lead pot.

The molten lead in which the files are heated is kept at a temperature of 1400 degrees, its condition being indicated by a Bristol pyrometer. Several files are kept heating in the lead pot, being immersed to the tangs. A bar across the top of the lead pot holds the files beneath the surface of the

Fig. 10. The Cold-straightening Operation

molten lead so that they may be heated slowly and evenly. A file is taken from the lead pot by the hardener, and before being quenched in the brine solution in which the files are hardened, the red hot file is rapidly straightened across lead blocks with a wooden faced hammer. This operation, which is shown in Fig. 11, is necessary on account of the strains set up in the steel by the milling of the teeth. After straightening, which takes but a few seconds, the file is plunged straight down into the brine and moved rapidly up and down until the "singing" has nearly ceased. The file is then quickly removed, sighted, and again straightened after the manner shown in Fig. 10. For this purpose the file is clasped in an iron holder, *A*, after sighting, and placed with the high side down against the wooden bar *B*, the tip end of the file being caught under bar *C*. Pressure is then applied to straighten the file and cold water splashed upon the upper side to bring the file back to a straight condition. This operation of straightening requires a great deal of judgment, for, if the file is kept in the hardening tank a few seconds too long, it will break when pressure is applied for straightening, and on the other hand if removed too quickly, the temper of the file will be impaired.

Sharpening the Files

From the hardening department the files go directly to the sharpening machines. Unlike the sharpening of most tools, files are sharpened by being passed over jets of steam which is mixed with a cutting paste made with a fine mineral abrasive powder. The sharpening machine shown in Fig. 13 is equipped with three nozzles which are shown being used

Fig. 11. Straightening Hot Files

in the operation of sharpening Vixen files. The base of the machine contains the sharpening paste which is led to the nozzles of the steam pipes and thus is propelled against the sides of the file when it is moved backward and forward over the nozzle. A spool, shown just above the nozzle, is used to keep the file at the proper distance from the nozzle. In

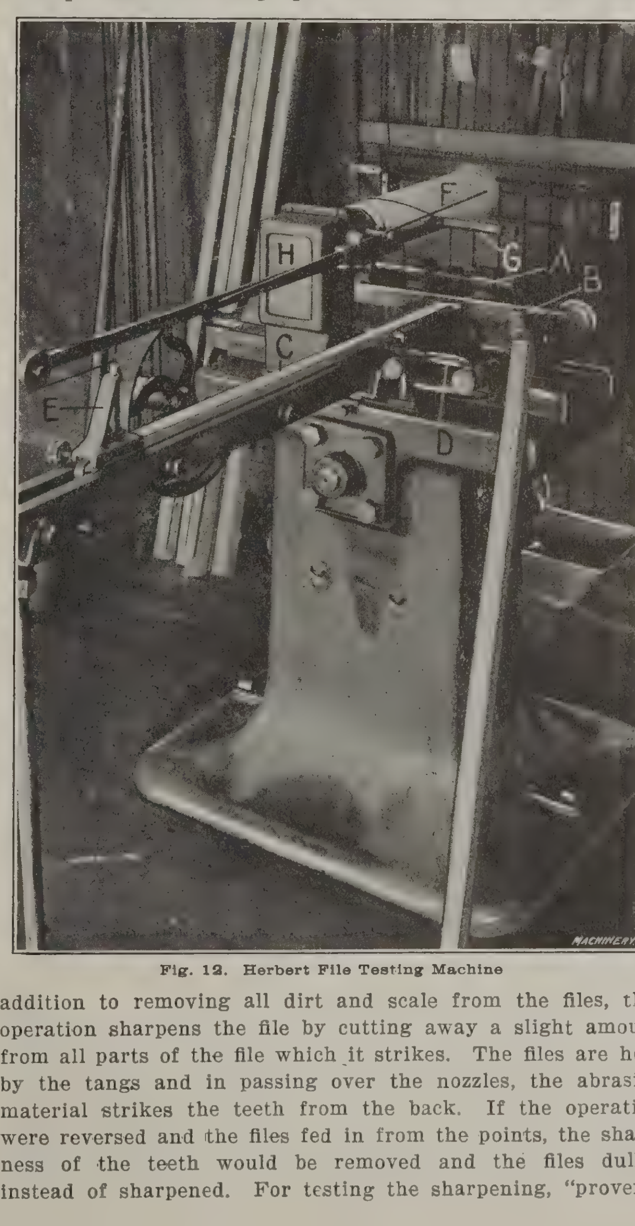


Fig. 12. Herbert File Testing Machine

addition to removing all dirt and scale from the files, this operation sharpens the file by cutting away a slight amount from all parts of the file which it strikes. The files are held by the tangs and in passing over the nozzles, the abrasive material strikes the teeth from the back. If the operation were reversed and the files fed in from the points, the sharpness of the teeth would be removed and the files dulled instead of sharpened. For testing the sharpening, "provers"

are used. These provers consist of short pieces of soft steel which are drawn over the file by hand. Even to those unaccustomed to this work, the prover indicates the fact that the file has been really sharpened, and to the sharpener the prover reveals any sections of the file which are not quite up to standard sharpness. Lime is added to the special sharpening compound to prevent the files from rusting after they leave the sharpening machine. The final operation consists in cleaning out the file under a jet of live steam, and after oiling, the files are ready for use.

Testing Files on the Herbert File Testing Machine

A Herbert file testing machine, shown in Fig. 12, the working parts of which are shown in detail in Fig. 14, forms the

Fig. 13. Sharpening the Files

only practical method of testing the cutting and enduring qualities of the file. This machine was described in detail in MACHINERY, December, 1907, and is also described in MACHINERY'S Reference Book No. 48, "Files and Filing." Briefly stated, the machine consists of a reciprocating file holder *A* in which the file *B* is held, backed up by suitable supports. The file is reciprocated across the end of the square test bar *C* at the rate of 50 strokes per minute. On the return stroke, the bar is withdrawn slightly by means of arm

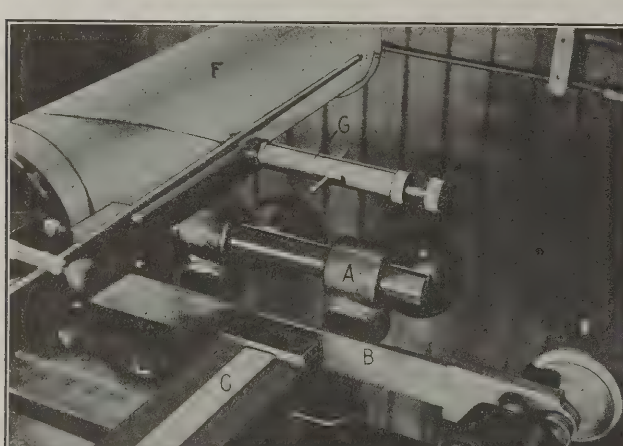


Fig. 14. Details of the File Testing Machine

D. The forward feeding of the bar is accomplished by means of a 30-pound weight which is attached to the bar at the front of the machine by a chain running over a pulley. The rate of forward travel of the bar is recorded on the chart *F*, by the pencil held in the holder *G*. By means of clockwork within the case *H*, the chart cylinder is turned slowly, with the result that a curve is traced upon the chart which indicates the cutting efficiency of the file tested.

Credit is due to Mr. W. D. Craft, manager, and Mr. C. M. Zubler, superintendent of the Vixen Tool Co., Philadelphia, Pa., for courtesies shown the writer in the preparation of this article.

* * *

Muzzling the gears may not stop them from biting, but it promises to muffle the bark.

MAKING THE FOSTER SAFETY SET-SCREW

BY CHESTER L. LUCAS*

In the new factory of the New Haven Machine Screw Co., New Haven, Conn., which appears in Fig. 1, a considerable part of the work consists in the making of the Foster safety set-screw. The factory is of reinforced concrete, and in designing the building, special attention was given to the lighting system; as may be seen, almost all of the wall space is taken up by windows. Fig. 2 shows a view of the automatic

Fig. 1. Home of the Foster Safety Set-screw

turret lathe department in which the blanks for the set-screws are made. Low carbon steel is used in making the set-screws. The turret lathes used are of the multi-spindle type, operating on four bars of steel at once, and when the blanks are dropped from these machines they are in the condition shown at *A*, Fig. 3, having the point roughly shaped, the opposite end rounded, and the stock drilled from the central hole.

In the second operation the hole is broached to a hexagonal

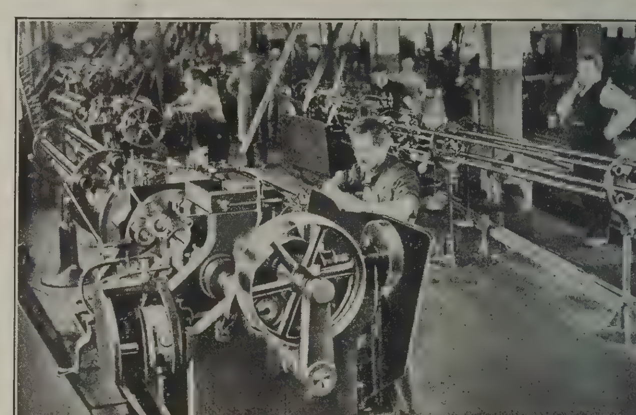


Fig. 2. The Automatic Turret Lathe Department

shape.† This operation is performed in a punch press, using the attachments shown in Fig. 4. Referring to this illustration, *A* is a dial revolving on a stud *B* which is fitted to the bed of the press. Around the edge of this dial, bushed holes are spaced to receive the set-screw blanks being broached. The dial is turned, bringing each of these holes successively under the broaching punch *C* by means of an indexing arrangement at the side of the press. This indexing arrange-

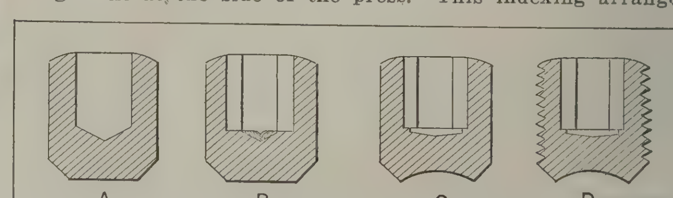


Fig. 3. The Four Steps followed in Making the Set-screws

ment consists of a lever *D* fulcrumed on the stud *E* and operated from the main shaft of the press. At the lower end of the lever, motion is transmitted to an arm *F* which reciprocates the indexing pawl *G* at each return stroke of the press ram. In broaching, the operator places the blanks in the holes in the revolving dial, and as they are indexed to the position under the punch, they are broached. Upon reach-

* Associate Editor of MACHINERY.

† A method of progressively broaching square holes in socket wrenches was described in the March, 1902, number.

ing the position directly under finger *I*, they are ejected from the dial by being pushed out by this finger at the down stroke of the press. By referring to *B*, in Fig. 3, which shows the result of this broaching operation, it will be noticed that the metal removed from the six corners of this hole is pushed into the conical end of the hole. In order to clear out these chips and make a neater looking hole, the set-screws are re-drilled in the machine shown in Fig. 5. This machine works upon the blank from both ends, the blank being held by means of jaws *A* and *B*, of which jaw *A* is movable and

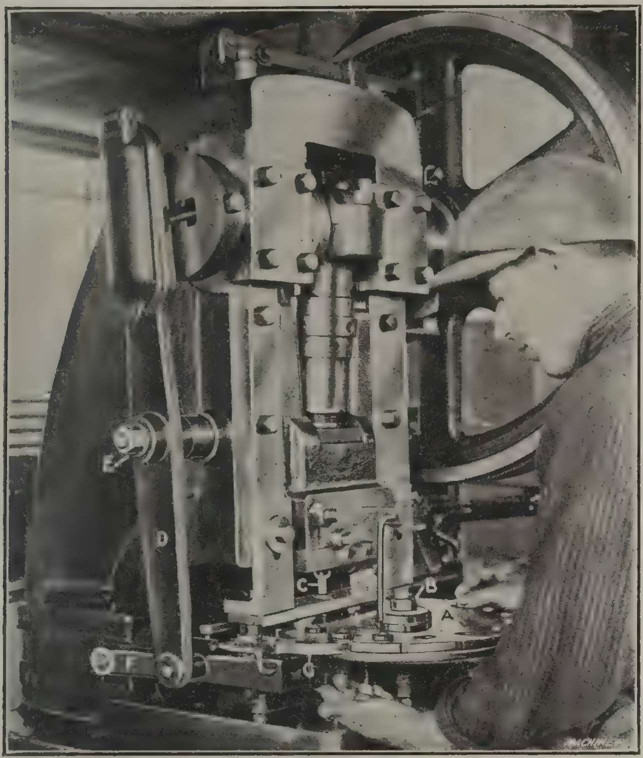


Fig. 4. Broaching the Holes

is clamped upon the work by the foot pressure of the operator. In re-drilling it is only necessary to remove enough metal to clear out the chips and leave the bottom of the hole clean. While re-drilling the blank set-screws from the one end, a forming tool is countersinking and shaping the point of the set-screw, and when taken from this machine the set-screw has assumed the shape shown at *C* in Fig. 3, and is ready for threading.

The threading of Foster safety set-screws is performed on Geometric threading machines, and the details of the thread-

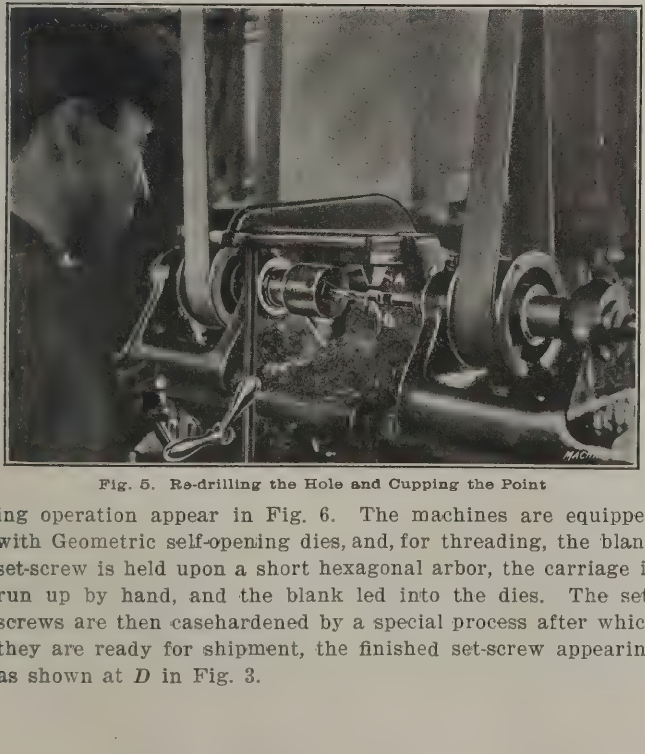


Fig. 5. Re-drilling the Hole and Cupping the Point

ing operation appear in Fig. 6. The machines are equipped with Geometric self-opening dies, and, for threading, the blank set-screw is held upon a short hexagonal arbor, the carriage is run up by hand, and the blank led into the dies. The set-screws are then casehardened by a special process after which they are ready for shipment, the finished set-screw appearing as shown at *D* in Fig. 3.

GENERATORS FOR THE KEOKUK POWER PLANT

The General Electric Co., Schenectady, N. Y., is building a number of very large electric generators for the hydro-electric power plant at Keokuk, Iowa, where ultimately 300,000 horsepower will be developed from the water power of the Mississippi River. This hydro-electric development has been made possible by the building of the greatest power dam ever constructed. The dam is built entirely from concrete. It has a total length of 9096 feet and rises 50 feet above the average river bed. The initial electric installation consists of fifteen alternators connected to the same number of vertical hydraulic reaction turbines of the single runner type. Each turbine and generator form an independent unit. The turbines are mounted on vertical shafts 25 inches in diameter, and will operate at a speed of 57.7 revolutions per minute, the normal capacity being 10,000 horsepower. The generators are installed on the top of the wheel pits directly over the turbines and will generate a three-phase alternating current at 11,000 volts. Transformers will be installed for stepping up the voltage of the current which is to be distributed over the high-tension transmission lines to 110,000 volts. The power will be distributed within a zone of 150 miles radius. Owing to the slow speed of the generators, their dimensions are very large. They are 32 feet in diameter and 12 feet high, the total weight being over 300 tons. One of the cities to

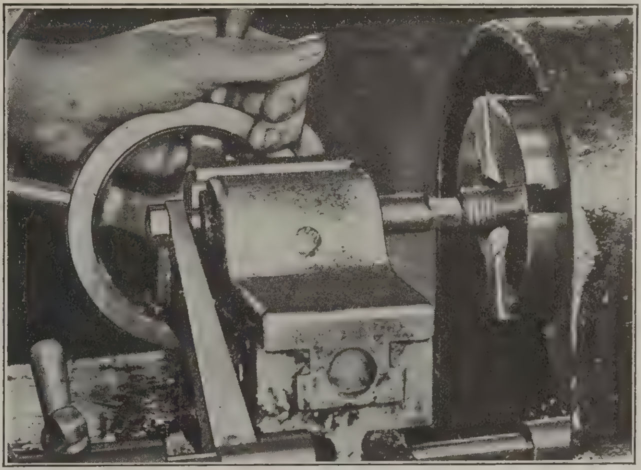


Fig. 6. Threading the Screws

avail itself of the power developed is St. Louis, located 135 miles from Keokuk. The street railway and electric light companies in that city have already contracted for 60,000 horsepower.

* * *

TEST ON SECTIONAL FIREBOX BOILERS

An interesting demonstration of a new type of boiler was recently made at Coatesville, Pa., under the direction of Dr. W. F. M. Goss, dean of the College of Engineering, at the University of Illinois. Two full sized locomotive boilers, designed for high-speed passenger service, were each subjected to severe low water tests. Both boilers were identical in size and design except that one was provided with a Jacobs-Shupert sectional firebox built by the Jacobs-Shupert Firebox Co., while the other had an ordinary radial stay firebox. The observations were taken from a safe location 200 feet away from the boilers. After the boilers were in normal operation, the feed water supply was shut off, the crown sheet and other portions of the heating surface being still subjected to the heat of the fire. The boiler having the Jacobs-Shupert sectional firebox was tested under these severe conditions for 55 minutes without failure, notwithstanding the fact that the level of the water fell to a point more than 25 inches below the crown sheet. The ordinary stay boiler exploded after the test had continued for 23 minutes, the water level having fallen to 14½ inches below the crown sheet. The crown sheet and the stays which hold it in place, having become highly heated, pulled away from each other and released the pressure in the boiler. The damage to the boiler was such as to make entire reconstruction necessary.

EFFICIENCY OF WORM GEARING FOR AUTOMOBILE TRANSMISSION*

RECORDS OF A NUMBER OF TESTS MADE ON VARIOUS TYPES OF WORM GEARING

The investigations recorded in the following were made at the plant of the Brown & Sharpe Mfg. Co., Providence, R. I., for the purpose of determining the efficiency of three types of

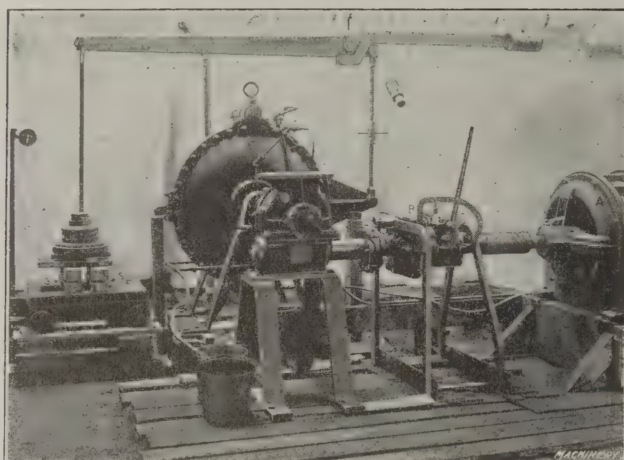


Fig. 1. Arrangement Used for Testing Efficiency of Worm and Gear Drives

worm gearing for use in an automobile transmission system, and the heating effect due to continuous running. The power for these tests was obtained from a 50 H. P. induction motor, running at approximately 870 R. P. M. at full load. Between

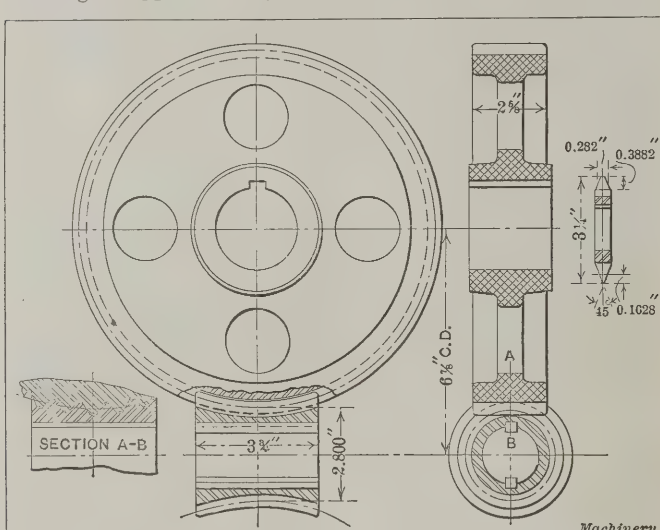


Fig. 2. Worm-gear Drive No. 1

the motor and the worm-gear case was placed an automobile transmission-gear case to enable tests to be made at two lower speeds. Between this and the worm-gear case was placed a transmission dynamometer designed by the author. (See

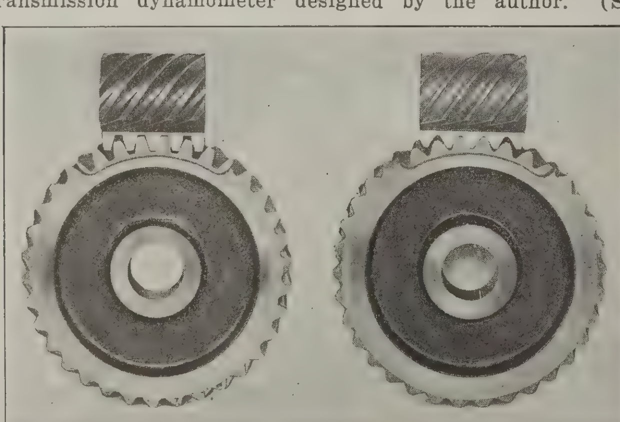


Fig. 3. Section through Teeth, Drive No. 2

Fig. 4. Section through Teeth, Drive No. 3

MACHINERY, June, 1909, engineering edition, for description of this device.) An Alden brake was used to absorb and measure the power transmitted by the gears under test. The apparatus is shown in Fig. 1 as arranged for testing worm gears; A is the motor, B the automobile transmission-gear case, C the transmission dynamometer, D the case containing the worm gear under test, E the Alden brake, and F the platform scale which measured the load on the Alden brake.

The apparatus was so arranged that as the load was imposed, the weight on the platform scale was removed, and all vibration of the scale beam was eliminated by interposing springs S between the blocks G which sustained the weight

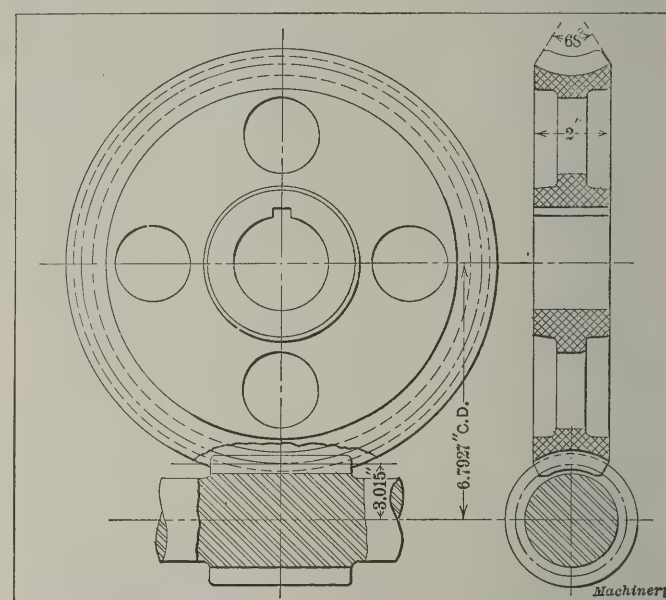


Fig. 5. Worm-gear Drive No. 3

on the scale, and also by suspending by a wire from the weight at the end of the scale beam a plate which dipped into a pail of oil, thus acting as an efficient dashpot. It was found possible by careful manipulation to maintain a steady and easily read load on both the transmission and absorption instruments.

With this arrangement of the transmission dynamometer and brake, runs were made at various loads, and the torques corresponding to horsepowers per 100 R. P. M. marked on the dial

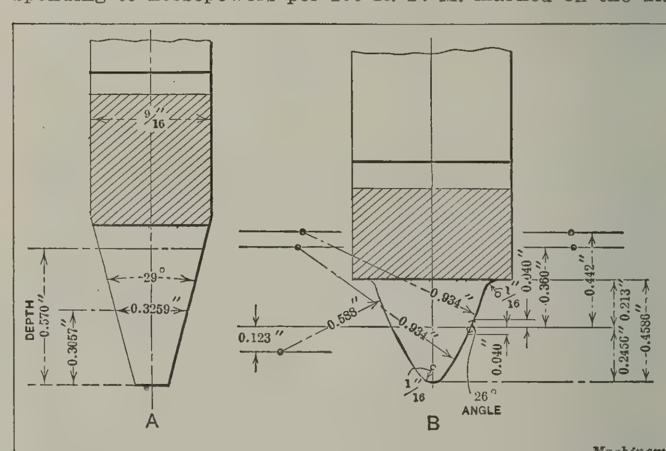


Fig. 6. A, Cutter for Gear No. 2; B, Cutter for Gear No. 3

of the transmission instrument, corresponding to similar loads as indicated on the brake. It is evident that by this method of comparison the two instruments must check each other exactly. A thermometer placed in the oil-well at the back of the worm-gear case D indicated the temperature of the oil, and another thermometer placed on the wall near the apparatus indicated the room temperature. The oil employed to lubricate the gears was one intended for use with superheated steam, having a specific gravity of 26 Baumé, a flash point of 625 degrees F., and a viscosity at 212 degrees F. of from 260 to 265. The case contained about five quarts of the oil.

In all the trials the worm was located underneath the gear.

* Abstract of a paper by Prof. Wm. H. Kenerson, of Providence, R. I., presented before the American Society of Mechanical Engineers.

Fig. 7 shows a section through the gear case. As indicated, both shafts are mounted on ball bearings and end-thrust ball bearings take care of the thrust on the worm and worm-wheel. All the worms were made of machine steel, casehardened, and the worm-wheels of phosphor-bronze.

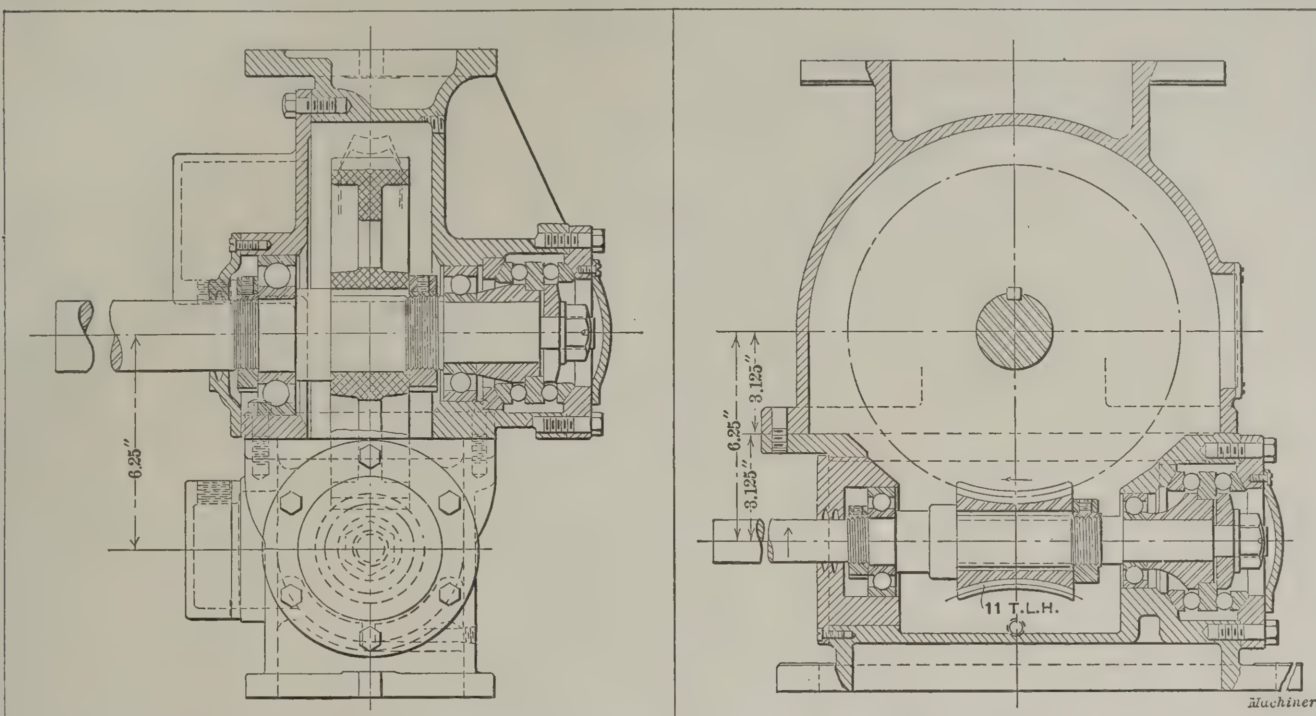


Fig. 7. Section through Gear Case used for Testing Worm-gear Drives

The first worm and wheel tested are shown in Fig. 8, and are similar to those used for driving the spindle on the Brown and Sharpe automatic spur gear machines. This pair of gears is an unusual case of the worm and worm-wheel. The smaller gear is hobbed with a hob of the size of the larger gear, thus making possible adjustment of the larger gear, which would not otherwise be the case. While in appearance this gear resembles a Hindley worm, it is not of this type. The smaller gear will be called the worm and the larger, the worm-wheel, in the following description. Fig. 2 gives the dimensions of the worm and gear shown in Fig. 8. The specifications for this pair of worm and worm-wheel are as follows: worm-wheel, phosphor-bronze; No. of teeth, 43 left hand; pitch diameter, 10.95; outside diameter, 11.28; circular pitch, 0.800; angle of teeth with axis, 45 degrees; normal circular pitch, 0.5657; pitch of cutter, 5.553; addendum, 0.1628 (not standard); thickness of tooth, 0.282; whole depth, 0.3882; included angle of cutter, 45 degrees. The worm-wheel was cut with the cutter shown, and the shape of the teeth on a section through the worm and worm-wheel, parallel to the axis of the worm, is also shown.

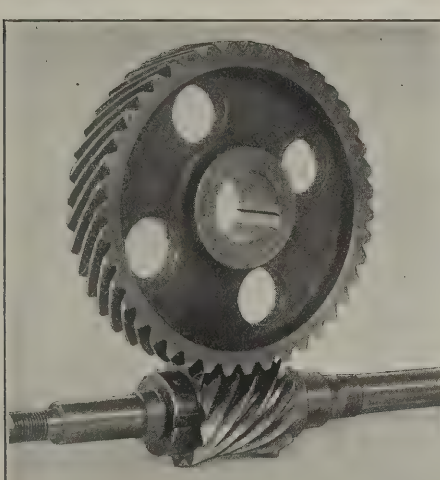


Fig. 8. Worm-gear Drive No. 1

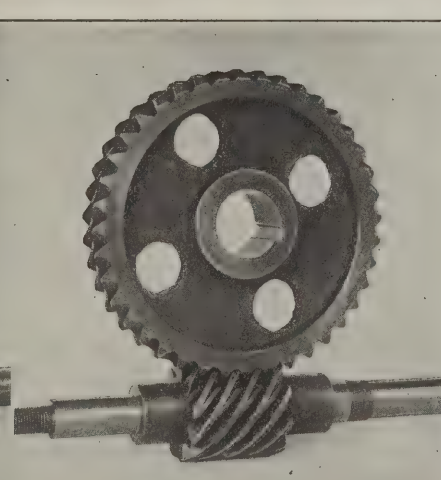


Fig. 9. Worm-gear Drive No. 2

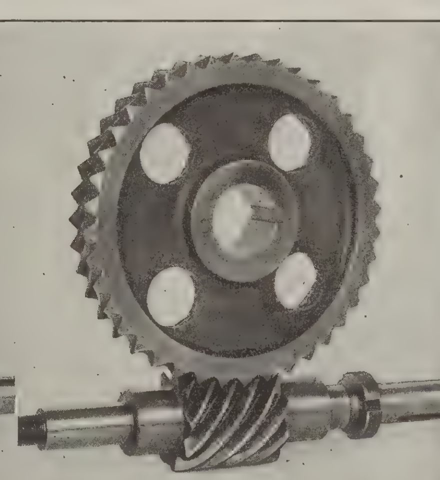


Fig. 10. Worm-gear Drive No. 3

TABLE I. EFFICIENCY TEST OF NO. 2 WORM-GEAR WHEN ON DIRECT SPEED

R.P.M. Motor	R.P.M. Worm	R.P.M. Worm-gear	Speed of Worm in Feet per Min.	Initial Load	Reading on Scale	Load on Brake 315-foot Radius	Brake H.P. per 100 R.P.M.	Total Brake H.P.	Total Transmission Dynamometer H.P.	Efficiency of Worm-gears	Transmission Dynamometer Reading				Temperature at End of Test		Time		Duration, Minutes
											1	2	3	Av.	Oil	Room	Start	Finish	
875	875	196.9	690.7	104	55	49	24.5	48.24	49.26	97.9	5.6	5.65	5.65	5.63	268	65	10:14	10:20	6
873	873	196.4	689.1	104	60	44	22.0	43.22	44.35	97.5	5.1	5.05	5.1	5.08	273	65	10:20	10:25	5
880	880	198.0	694.6	104	65	39	19.5	38.61	40.92	94.4	4.7	4.65	4.6	4 65	276	66	10:25	10:30	5
880	880	198.0	694.6	104	70	34	17.0	33.66	36.26	92.8	4.15	4.1	4.1	4.12	275	66	10:30	10:33	3
883	883	198.7	697.0	104	75	29	14.5	28.81	31.17	92.4	3.55	3.55	3.5	3.53	273	66	10:33	10:37	4

The general appearance of pairs Nos. 2 and 3 are shown in Figs. 9 and 10, and the dimensions in Fig. 5. The difference between gears Nos. 2 and 3 is principally one of shape of the worm threads. This difference is clearly brought out in the

sections of the worm and wheel shown in Figs. 3 and 4. The specifications for the No. 3 worm and worm-wheel are as follows: Worm-wheel, phosphor-bronze; number of teeth, 40; pitch diameter, 10.5704; throat diameter, 10.9964; circular pitch, 0.8302; angle of teeth with axis, 38 degrees 16 minutes; normal circular pitch, 0.6518; pitch of cutter, 4.8196; addendum, 0.213; thickness of tooth, 0.3568; whole depth, 0.4586. Worm: Aurora steel, casehardened; number of teeth, 9; pitch diameter, 3.015; outside diameter, 3.441; circular pitch, 1.0524; angle of teeth with axis, 51 degrees 44 minutes; thickness of tooth, 0.295; lead, 7.4719; ratio of wheel to worm, 40 to 9.

TABLE II. AVERAGE EFFICIENCIES OF WORM AND GEAR NO. 1

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Worm	Worm-Wheel	Input	Output	Oil	Room	
First Speed	254.2	65.03	26.18	24.06	206	73	91.9
	254.6	65.13	24.75	22.47	217	73	90.8
	254.5	65.11	22.98	20.81	225	73	90.5
	255.1	65.25	21.17	19.25	228	73	90.9
	255.3	65.30	19.56	17.63	232	73	90.1
	255.7	65.41	17.76	16.02	233	74	90.2
	255.9	65.48	16.00	14.41	233	74	90.1
	256.3	65.60	14.31	12.79	233	74	89.4
	256.5	65.62	12.37	11.15	231	74	90.2
	256.8	65.69	10.55	9.53	229	74	90.2
Second Speed	545.2	139.5	43.48	41.16	178	73	94.8
	546.9	139.9	40.54	37.78	207	70	93.0
	547.8	140.1	36.88	34.33	214	70	93.2
	548.8	140.4	33.47	30.89	217	70	92.3
	550.2	140.7	29.76	27.44	218	70	92.3
	550.5	140.8	26.01	23.94	218	71	91.3
	551.1	141.0	22.22	20.45	217	71	92.0
Direct	859.5	219.8	66.43	64.86	178	69	97.0
	864.5	221.1	62.80	50.71	201	70	94.9
	871.0	222.8	59.23	54.60	214	70	92.2
	874.5	223.7	54.22	49.22	224	70	90.8
	878.0	224.6	48.60	43.80	230	70	90.1
	882.0	225.6	42.25	38.36	233	70	90.8
	884.0	226.1	36.24	32.79	237	71	90.5

The shape of the teeth on the worm in Fig. 3 was produced with a cutter, the included angle of which was 29 degrees, and the depth of tooth 0.570 inch. This depth was based on the axial pitch, whereas the usual method on multiple worms is to base the depth on the normal pitch. The object in using this cutter was to obtain as many teeth as possible in contact at one

TABLE III. AVERAGE EFFICIENCIES OF WORM AND GEAR NO. 2

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Worm	Worm-wheel	Input	Output	Oil	Room	
First Speed	254.7	57.32	19.26	18.34	164	69	95.3
	254.7	57.32	17.99	16.91	160	69	94.1
	254.5	57.25	16.73	15.46	162	68	92.5
	254.3	57.22	15.08	14.02	142	69	93.1
	255.1	57.39	13.52	12.63	159	69	93.5
	254.9	57.35	12.14	11.18	160	69	92.2
	254.8	57.34	10.69	9.75	160	69	91.4
Second Speed	544.2	122.4	36.95	36.11	178	70	97.7
	545.0	122.6	34.61	33.10	184	70	95.6
	546.7	123.0	32.09	30.14	188	70	93.9
	548.4	123.4	28.90	27.15	187	70	93.9
	549.0	123.5	25.80	24.08	186	71	93.3
	549.6	123.7	22.59	21.03	163	70	93.1
	551.0	124.0	19.12	17.98	163	70	94.0
Direct	873.5	196.5	49.35	48.14	265	66	97.5
	875.0	196.9	44.50	43.30	256	65	97.3
	878.0	197.5	40.40	38.50	260	66	95.2
	881.0	198.2	36.40	33.70	261	66	92.4
	883.4	198.8	30.73	28.84	262	66	93.8

time and also a shape that could be ground with a straight-sided emery wheel. The teeth of the worm in Fig. 4 were cut with a cutter shaped as shown at *B* in Fig. 6, which is an arbitrary shape made to produce the greatest effective breadth possible.

In conducting the trials, the load was maintained at the desired point by one observer who adjusted the brake. Readings were then taken on the transmission instrument by two independent observers. The speed of the motor was observed in each case, and from this, knowing the gear ratio, all the other speeds were easily computed. Temperatures were taken immediately following each series of observations. For purposes

TABLE IV. AVERAGE EFFICIENCIES OF WORM AND GEAR NO 3

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Worm	Worm-wheel	Input	Output	Oil	Room	
First Speed	254.1	57.19	18.75	18.30	136	79	95.5
	254.8	57.33	16.54	15.48	144	79	93.1
	255.0	57.38	13.75	12.62	149	79	91.8
	255.4	57.47	10.80	9.77	150	79	90.5
	255.6	57.52	7.38	6.90	149	79	93.6
Second Speed	543.2	122.2	38.59	36.06	204	77	93.4
	543.8	122.4	35.36	33.04	215	77	92.4
	544.8	122.6	33.12	30.03	219	77	90.7
	545.8	122.8	29.82	27.02	221	77	90.6
	546.5	123.0	26.70	23.98	222	78	89.8
	547.2	123.2	23.56	20.95	222	78	88.9
	548.3	123.4	20.02	17.89	221	78	89.4
Direct	866.0	194.8	49.95	47.72	215	77	95.5
	868.2	195.3	45.68	42.98	223	77	94.1
	870.8	195.9	41.20	38.20	228	77	92.7
	874.0	196.7	36.88	33.45	230	77	90.6
	876.0	197.1	31.45	28.60	230	78	90.9
	878.8	197.7	26.45	25.73	229	78	89.7

of comparison, a series of trials was also run on a pair of bevel gears. The specifications for this bevel gear and pinion are as follows: Driving pinion, 5 per cent nickel steel, casehardened; pitch, 5; number of teeth, 14; angle of edge, 15 degrees 4 minutes; angle of face, 71 degrees 5 minutes; outside diameter, 3.3359. Driving gear, 5 per cent nickel steel, casehardened; pitch, 5; number of teeth, 52; angle of edge, 74

TABLE V. AVERAGE EFFICIENCIES OF BEVEL GEARS

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Pinion	Gear	Input	Output	Oil	Room	
First Speed	254.2	68.43	20.92	20.19	....	70	96.6
	254.5	68.51	17.50	16.78	....	70	95.9
	256.1	68.95	14.54	13.44	....	69	92.4
	256.5	69.05	10.95	10.01	....	70	91.4
Second Speed	541.8	145.0	39.64	39.37	....	67	99.3
	544.1	146.4	33.43	32.22	....	67	96.4
	545.7	146.9	26.25	24.98	....	67	95.2
	548.5	147.6	18.75	17.72	....	67	94.5
Direct	872.0	234.7	52.05	51.63	....	70	99.2
	878.6	236.6	42.09	40.22	....	70	95.5
	884.4	238.2	30.40	28.58	132	79	94.0

degrees 56 minutes; angle of face, 13 degrees 47 minutes; outside diameter, 10.4627.

Table I is a record of one set of observations, typical of the series. Tables II, III, IV and V summarize the results of all the trials, and the curves of Fig. 11 show the average efficiency of the different gears at the various loads and speeds. In conjunction with the efficiency trials, a series of runs was made to determine the heating effect due to continuous running. In these trials, which were in effect endurance tests, a constant load was transmitted through the gearing, and the temperature of the oil in the gear case and the temperature of the room noted at frequent intervals. From these observations it was found that at the beginning of the run the oil temperature rose rapidly and somewhat irregularly. As the run continued, however, the rise became much more gradual and regular. In the runs where the smaller amounts of power were transmitted a point was reached where the temperature remained constant. This indicated that radiation was sufficient to carry away the heat due to power lost through friction in the gearing, or in other words, that the gears would run indefinitely at that load. The heat curves of the No. 1 worm and gear are shown in Fig. 12.

The higher loads indicated were abnormal for the gears under consideration, and would not occur in any use to which the gears would normally be put. The fact that these trials continued for from 60 to 80 minutes without failure indicates that the structure is both strong and enduring and that, should such temperatures be reached for any accidental reason, the gears would not be destroyed. The result of the trials was of particular interest because of the very high efficiency and carrying capacity of the gears tested.

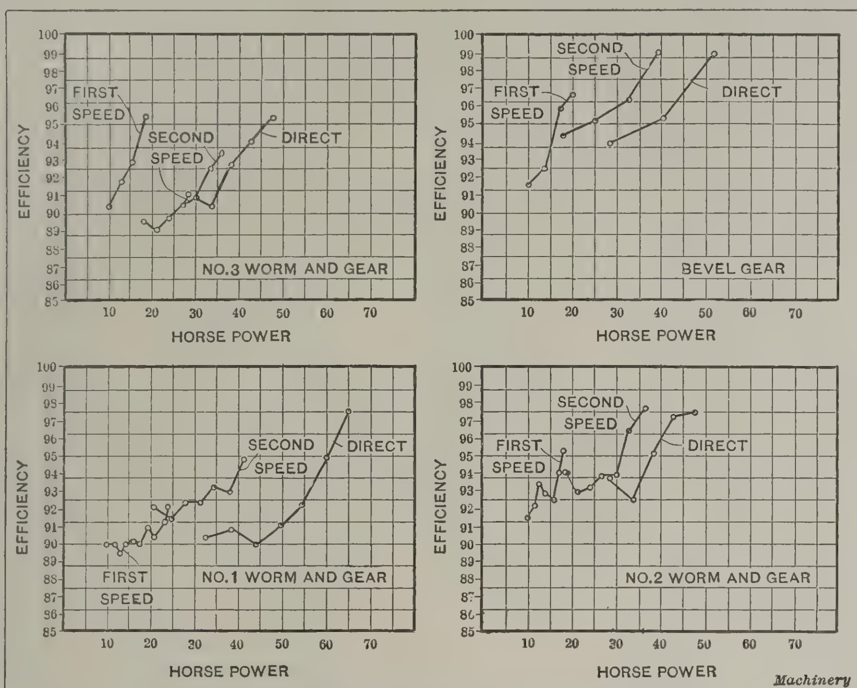


Fig. 11. Efficiency Curves at Various Loads and Speeds

Every possible precaution was taken to secure accuracy in the results, and the high degree of accuracy obtained is due largely to the skill and care of Mr. B. F. Waterman of the Brown & Sharpe Mfg. Co., under whose personal supervision the apparatus was erected and all the trials were conducted.

* * *

A new development in pneumatic tires of a revolutionary nature promises to make considerable improvement in what now is the weakest member of the automobile. The ordinary pneumatic tire is inflated with air, compressed to a pressure of about eighty pounds per square inch. In the new tire the

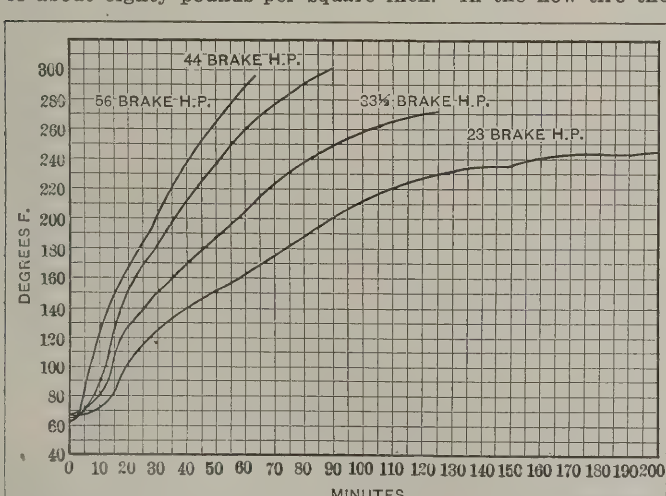


Fig. 12. Heat Curves for No. 1 Worm and Gear

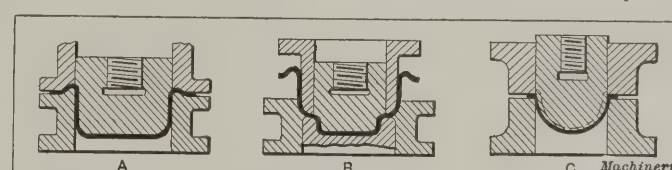
condition of air pressure is reversed, the air being pumped out, leaving the internal pressure at about eight pounds absolute. The external pressure, of course, tends to collapse the walls, which are so shaped that the internal cross-section assumed is a flattened ellipse with the long axis vertical. Load on the tire tends to separate the sides and press them outward against the external or atmospheric pressure. Thus the tire rides on external air pressure instead of internal pressure, as in the common type.

PREVENTION OF WRINKLES IN DRAWN WORK

The formation of wrinkles in drawing operations is a source of great trouble, and there are many pieces of drawn work which could be performed in a single operation were it not for the wrinkles that would inevitably appear. In drawing operations, the tendency to wrinkle starts with the first contact of the punch upon the metal.

The usual method of preventing wrinkles is to provide the punch with a blank-holder which is operated by springs of sufficient tension to allow the metal to be pulled from beneath it for drawing, but maintaining pressure enough to keep the metal free from wrinkles. At *A*, in the accompanying illustration, reproduced from the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, appears a section of a simple drawing die in which it will be noticed that the die is provided with a raised ridge around its opening, the blank-holder having a corresponding depression. Consequently, the sheet metal being drawn is pulled over this ridge, and as the space between the blank-holder and the top of the ridge is purposely made slightly less than the thickness of the metal, it will be seen that as the stock passes through this opening any wrinkles are "ironed out." At *B*, the shell from the dies at *A* is shown undergoing a second operation.

For strength and protection in hardening, as well as to facilitate the drawing operation, the ridge is provided with a fillet where it joins the flat surface of the die. It is obvious that the addition of this ridge to the drawing die occasions a little extra work in the die-making, but this work is offset by the fact that the blank-holder and upper surface of the drawing die do not have to be ground perfectly smooth and parallel, as is ordinarily re-



A Method of Drawing Sheet Metal by Means of which Wrinkling of the Stock is avoided

quired. The size of the ridge around the die should be in proportion to the diameter of the shell. A shell 4 inches in diameter is most easily drawn with a die having a ridge of 7/16 inch radius. For a shell of 8 inches diameter the radius of the ridge should be ½ inch. For a shell 12 inches in diameter the radius of the ridge should be ⅝ inch. For a shell 16 inches in diameter the radius of the ridge should be ¾ inch, and a shell 20 inches in diameter would require a ridge having a radius of 1 inch.

It is obvious that the completed shell will have a ridge left at the edge. On work which is to be wired or for work on which the edge is to be turned over, this additional ridge is no detriment as it can be made use of directly. Moreover, if a succeeding operation is to follow, deepening the shell slightly, this ridge will provide the surplus metal required. This point is illustrated at *C*. In other cases, the extra metal left at the edge may be removed when the shell is trimmed. It is claimed that this improvement in drawing dies is being employed with success. By its use, wrinkles are absolutely prevented, and, moreover, the drawing operation puts less stress upon the metal.

* * *

The J. N. Lapointe Co., Marlboro, Mass., maker of broaching machinery, recommends the use of the following compounds when broaching steel: 2½ pounds of soda-ash; 3 gallons of mineral lard oil; and 50 gallons of water. Mix the soda-ash and the lard oil with 10 gallons of water, and add the other 40 gallons afterward.

LETTERS ON PRACTICAL SUBJECTS

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CENTERING DROP-FORGED CRANKSHAFTS

The usual method of centering drop-forged crankshafts for the lathe, *viz.*, by marking off on centers and surface plate is very slow when a great number of crankshafts are to be centered. The method described in the following is considered by the writer to be an improvement upon previous methods.

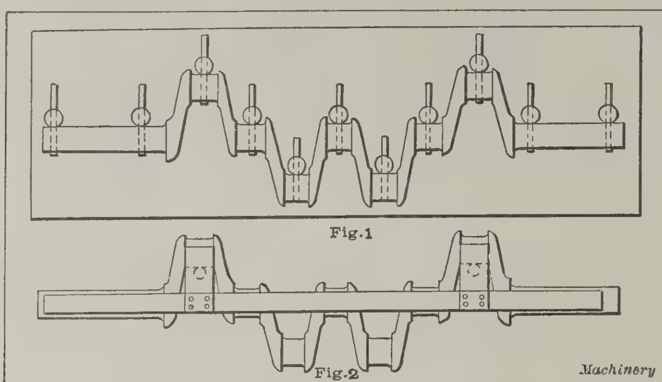


Fig. 1. Plate used for Correcting Warped Crankshafts. Fig. 2. Gage for Cutting off Crankshaft to Right Length

The drop-forgings are first tested for alignment, as they often warp slightly in hardening. This warping should be corrected by the aid of a plate fitted with pegs, as shown in Figs. 1 and 3. The pegs are a good fit in the holes in the plate and correspond to the correct outline of the crankshaft. Each peg has a piece of steel rod projecting through it at each side and resting on the surface of the plate. The drop-forging is placed on these projecting rods and is straightened until each journal and throw has a reasonably close contact with them, the variations allowed depending upon the amount of material left for machining in the drop-forging. The small steel rods keep the webs of the crank from touching the plate, while the vertical pegs give the correct alignment to the throws and journals in planes at right angles to the plate.

The ends are next sawed off to within ¼ inch of the finished length; a simple templet, as shown in Fig. 2, is used for marking this length correctly. The crank is now ready to have the centers put in. This is done on a sensitive drilling machine, the column of which is provided with a pivot carrying the centering jig shown in Fig. 4. This jig consists of a

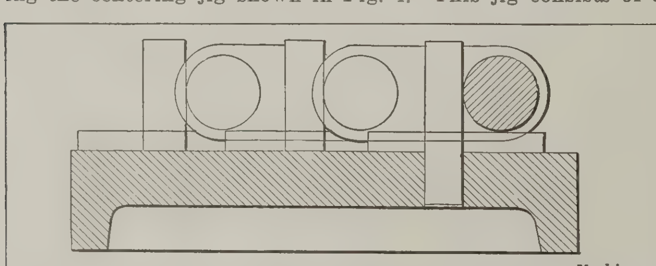


Fig. 3. Section of Plate and Crankshaft in Fig. 1 in Enlarged Scale

stiff cast base or bar, pivoted at the center, with a T-slot along its full length. At each end a bracket is mounted, the position of which is adjustable to suit the length of the crankshaft. These brackets are fitted with bushings to suit the diameter of the center drill. One end of the bushing is enlarged to form a cap for the end of the crankshaft. The hole in this cap should be larger in diameter than the diameter of the largest drop-forging likely to be used. The ends of the crankshaft are held in this cap by means of four set-screws.

Setting gages are used as indicated in Fig. 4. These are bolted in the T-slot at the correct position for each throw and journal. These gages are made of thin spring-steel blades of suitable length, allowance being made for the material to be left for machining. They can be easily changed for different sizes of crankshafts and are cheap to make.

One end of the crankshaft is now placed in the cap at the bottom. The top bracket is raised to allow the crankshaft to enter into its cap, and then the crankshaft is secured in the caps by the set-screws. When clamped it is turned and tried against the steel blades, the set-screws being adjusted until the best average position is obtained. Then the center is drilled at one end, the jig swiveled around, and the center drilled at the other end. It would be a still further improvement to mount the jig horizontally and use a simple drill head at each end of the crankshaft. In this case, a swiveling jig would not be required and both centers could be drilled at the same time.

It will be found that in addition to having obtained a better and quicker method of centering than is afforded by the usual

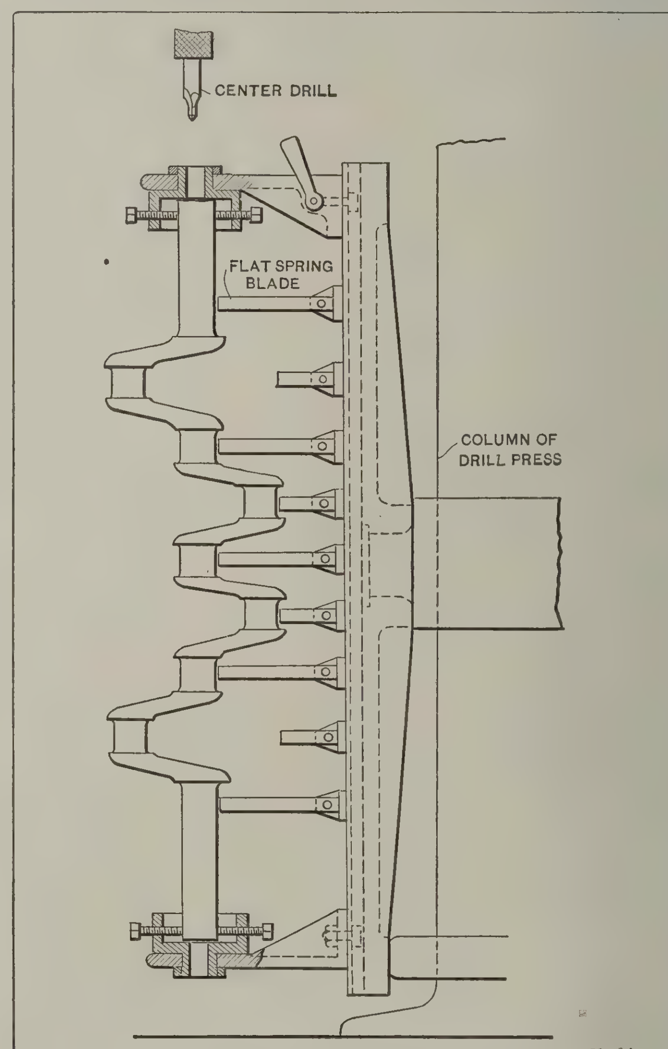


Fig. 4. Centering the Crankshaft in the Drill Press

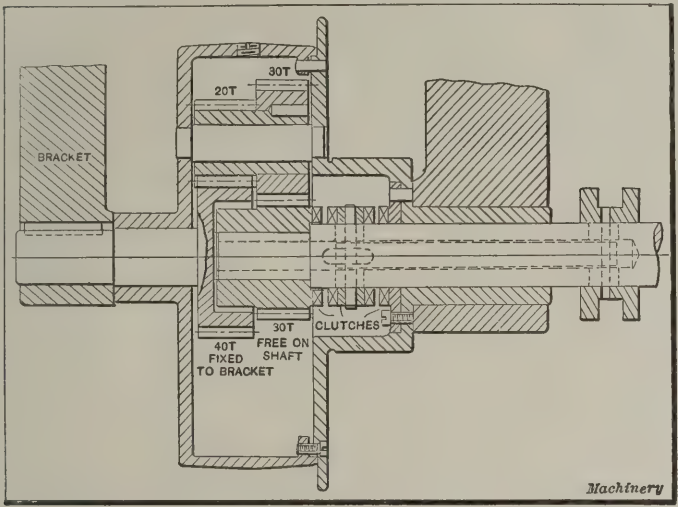
marking-off method, there will be fewer broken center drills, owing to the fact that the crank is held steadily and its weight is not taken by the weak point of the drill. G. R.

PLANETARY GEARING—OIL-PUMP TROUBLES

A writer in the May number of MACHINERY mentions an instance of the successful employment of planetary or differential gearing as a speed reducing mechanism. That gearing of this type may be successful at low speeds such as cited (120 revolutions per minute) is, no doubt, possible, but when the speed rises to say 500 revolutions per minute, the experience of the present writer goes to show that it ought not to be employed. In one case a number of machines furnished by a high-class concern were driven in one direction by a direct drive. To obtain a reverse drive certain clutches were used to throw into action a train of epicyclic gears. All gears were regular spur gears, no in-

ternal gear being used. The accompanying illustration shows the arrangement of the gears. All the gears ran in oil, but, nevertheless, the noise, right from the beginning, was more than normal, and it increased the longer the machines were used. Finally an examination disclosed that the teeth of some of the gears had worn so badly that they had broken off; the wear was also very unequal. It was assumed that the gears were too weak, and, hence, they were replaced by carefully made hardened steel gears. These, however, were so noisy that it was finally decided to eliminate the planetary gearing and use a reverse countershaft.

There seems, at first, to be no good reason why planetary gearing should cause any more noise or wear than ordinary gearing, but that some reason exists is certain. The writer believes that the trouble is due to the fact that the resultant of the various forces is a constantly changing one, due to



Arrangement of Clutches and Epicyclic Gearing

the varying positions of the planetary gears in their motion. Sometimes the forces will tend mainly to draw the centers closer together; at other times there will be forces tending to force them further apart. Hence, there is a constant sliding movement between the teeth of the meshing gears which accounts both for the excessive wear and the noise, particularly at high speeds. In some cases the trouble may be due to the pull of the belt and the pressure from the gears being in different planes, thus tending to tilt the gears, the amount of this tilting action varying according to the varying direction of the resultant force. As the various shafts and bearings wear, this creeping between the teeth with accompanying noise and wear, will become intensified.

The variations in the resultant force will not be so great when three, four, or more planetary gears are used, but then the manufacturing difficulties are greatly increased; in fact, so many factors require attention as regards accuracy, as to make it almost impossible to insure that each planetary gear would bear its fair share of the duty. Take the case of four planetary gears as an example. Here we have the possible inaccuracies of four radial distances and of the four center-to-center distances between the planetary gears themselves; then there are ten gear diameters to be taken into account, the errors in which may or may not balance each other. Furthermore, each of the double planetary pinions must have their teeth exactly in the same relation on each gear. In fact, the only possible way to get anything like an equal load on each gear is to allow plenty of freedom in all running parts, but this would tend neither to freedom from noise nor from wear.

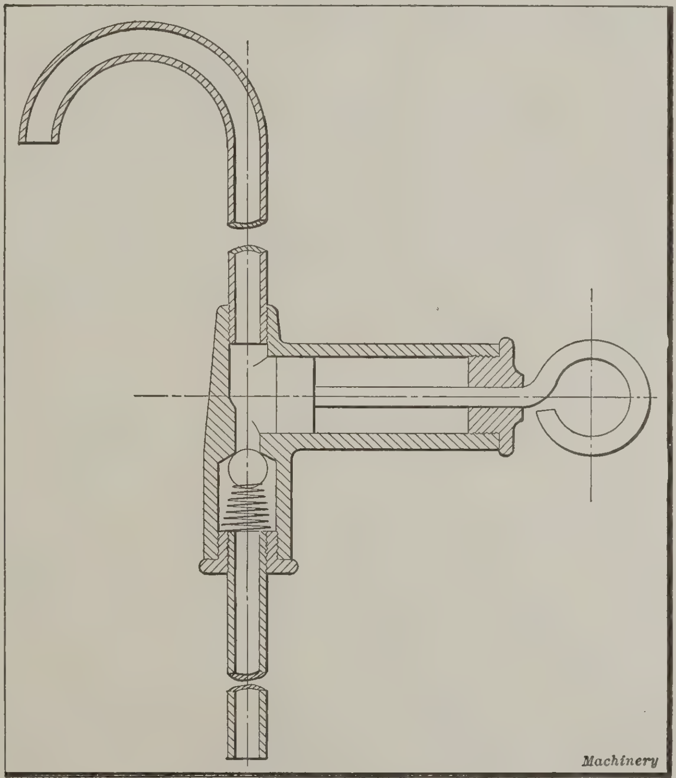
A little incident which occurred in connection with the same machines affords a good example of how small points are apt to be neglected. After the machines were put into operation with a reverse countershaft, it was found that the oil-pump failed to act on the reverse drive, owing to the change in direction of the rotation of the driving pulley. It was, however, necessary to supply oil while the machine was running in the reverse direction also. One remedy, of course, would have been to replace the pump by a reversible one. However, one of the operators conceived the idea of replacing the pump pulley by two pulleys side by side, each bearing a bicycle free-wheel or coaster fixed to drive in opposite directions. Two belts, one open and one crossed, were used to drive the pulleys. Then, no matter which way the machine was running, one of the free-wheels would drive the pump.

E. P. Ciclick

DEVICE FOR EMPTYING OIL DRIP-CUPS

On advertising page 177, in the July number of Machinery, the following "Don't" for machinists is given: "Don't work on any machine if the countershaft hangers are loose." While the writer does not know of any case where anyone has been hurt by the countershaft falling down, he does know of cases where the oil drip-cups have come down. These drip-cups must be emptied at intervals, and, apparently, they are not always put back in position as tightly as they ought to be. Perhaps, also, the looseness is produced by their being removed and put back again at frequent intervals. To empty them, it is necessary to go up on a ladder, which is, in itself, dangerous.

The accompanying engraving shows a device by means of which the oil drip-cups can be emptied without removing them, and much more rapidly than by the ordinary methods. This device the writer has seen in use "on the other side of the pond." The device consists of a long length of piping projecting from the top of the main body, and having a bent or hooked end. The piping used is ⅜-inch gas pipe. At the bottom end a short straight length of piping projects. The ball in the valve shown is held in position by a light spring, just strong enough to support its weight. To the right is a projection containing a pump piston.



A Convenient Device for Emptying Drip-cups

The manner in which this device is used is as follows: The man emptying the oil drip-cups goes around with this device and a pail. To empty the oil drippers he simply hooks the pipe end onto the dripper and pulls out the piston once, so as to start a syphon action; after this the oil will empty into the pail very quickly. The ball valve stops the air from being drawn into the cylindrical section when the piston is drawn out, but it does not stop the oil from flowing past it when it comes down the long pipe. This device does away with the necessity of loosening the drippers; the action is quick, and no danger is attached to its use, as when a ladder has to be employed.

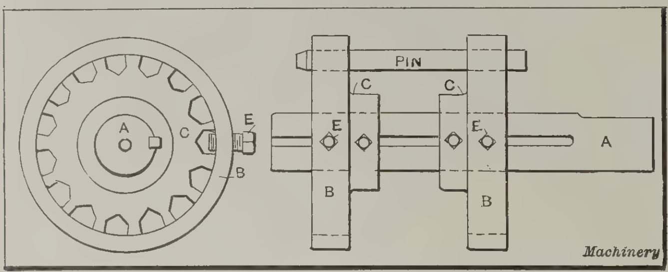
Richard W. Dickinson

Pawtucket, R. I.

DEVICE FOR SIZING PRESSURE PINS

Many mechanics, in making combination cutting and drawing dies for single-acting punch presses, have undoubtedly experienced difficulties with trying to make pressure pins of an equal length. With the aid of the device or mandrel shown in the accompanying engraving, the old cut-and-try methods are entirely done away with, and a complete set of pins can be faced at both ends to equal length at one setting. The mandrel shown has a maximum capacity for fifteen ½-inch pins.

In the engraving, the mandrel *A* is made of tool steel, and has a flat milled for the set-screw of the driver. The collars

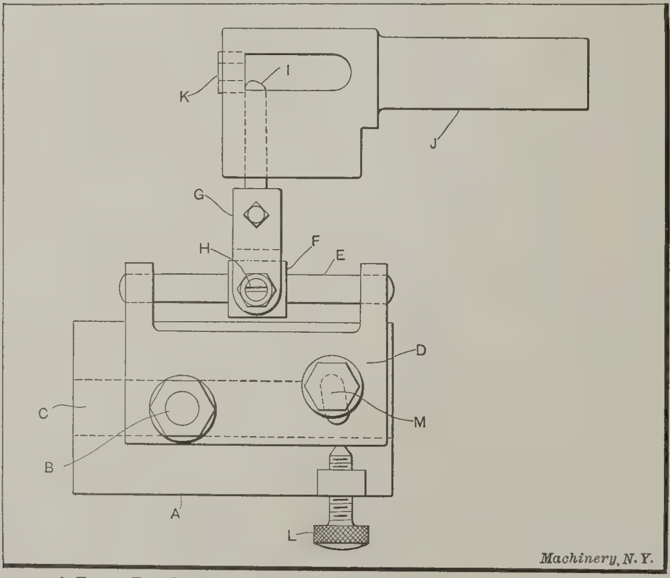


Mandrel for Holding Sets of Pressure Pins while Sizing

C are made of cast iron and have slots milled in them for the pins. They are fitted to the mandrel *A* by keys to insure rigidity, and the slots are milled after the collars are fitted to the arbor, so that the grooves will line up. The machine steel rings *B* carry set-screws *E*, which latter should be quite smooth and flat on the ends, so as not to mar the pins. Rings *B* are shrunk onto the collars. When using this device, it is advisable to keep the collars as close to the ends of the pins as possible, to insure good support. Light cuts should be taken, and a fine cross-feed used. A grinder is to be preferred to a lathe when such a machine is available. A. J. B.

A TAPER TURNING TOOL FOR THE AUTOMATIC SCREW MACHINE

The accompanying illustration shows a taper turning tool used in the automatic screw machine for turning taper pins. This tool, however, cannot be used where it is necessary to revolve the turret, and the feeding finger alone is used to govern the length of the stock. This device consists mainly of a base *A* held on the cross-slide, by a bolt and nut *B*, the



A Taper Turning Tool used in the Automatic Screw Machine for Turning Taper Pieces

base being located by the tongue *C*, which fits in the slot in the cross-slide. Attached to the base *A* is a member *D* which swivels on the bolt *B*. Driven into the member *D* is a pin *E* on which the bushing *F* slides. The tool-holder *G* is cut out to fit over the bushing *F*, and is held to it by two cone-pointed screws *H*. This tool-holder *G* holds the turning tool *I*, which slides freely in the member *J* held in the turret. A bushing *K* which has a hole in it of the same size as the diameter of the stock to be turned, is driven into the front end of the member *J* to support the work.

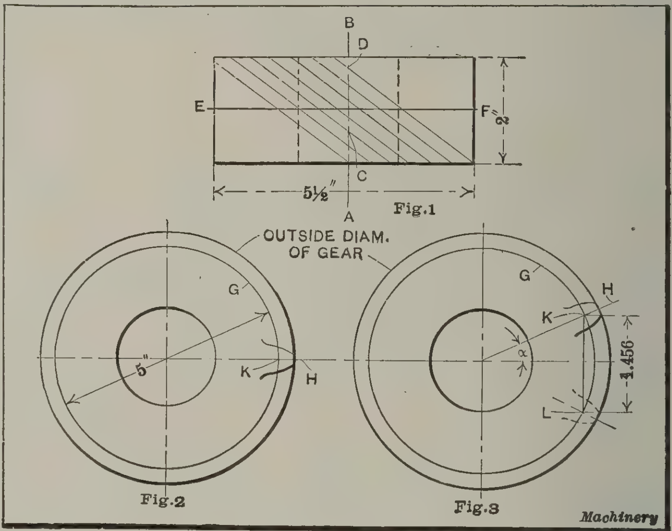
In operation, the cross-slide is held stationary, the turret alone advancing. The taper on the work is governed by swinging the member *D* to the desired angle, and when in the desired position, it is stopped by the knurled screw *L*, and clamped by the cap-screw *M*. A slot is cut in the swinging member *D* so that it can be adjusted to various angles. When the tool is set correctly, the feeding device is then set so that it will feed the stock out to the desired length. When the pin has been turned it is cut off by a circular tool held on the rear cross-slide. While the pins cut off vary slightly in length, they are close enough for most purposes.

Detroit, Mich. DAVID MELVILLE

DETERMINING THE LEAD OF SPIRAL GEARS

A spiral gear of 5½-inch diameter and 2-inch face was sent to the shop with the order, "Make a duplicate at once as something has happened to this one." This last assertion no one was inclined to dispute, as there was not one uninjured tooth on the gear, which, moreover, was broken into two pieces. The first requirement, in order to be able to duplicate the gear, was to find the lead of the spiral.

The usual method, to scribe a line *AB*, Fig. 1, parallel with the axis of the gear, measure with a height gage the distance between two intersections of tooth edges, as *CD*, multiply by



Figs. 1 to 3. Method used for Determining Lead of Spiral Gear

the number of teeth in the gear, and divide by the number of tooth spaces between *C* and *D*, is not always entirely accurate in practice, although admirable in theory. In this case, this method could not be employed as the gear was so injured that no place could be found where a line so drawn would cut the edges of two teeth.

The man to whom the job was given drew a line *EF*, Fig. 1, at right angles to the axis and midway between the end faces of the gear. He then tied the two halves together, inserted a size plug in the hole in order to obtain a center, and with dividers scribed a circle *G* as shown in Fig. 2 on each end of the gear. This circle was 5 inches in diameter. He then put the gear on an arbor clamped in a V-groove in the vertical face of a cube-shaped piece which rested on the surface plate. If this appliance had not been available, he could have put the arbor between the centers of a lathe, laying a parallel across the shears as a base from which to measure.

Setting the height gage to the center height of the arbor and using a lens to insure all possible accuracy, he scribed in the center of each end of one tooth a radial line as shown at *H* in Fig. 2, choosing a tooth which showed line *EF* on the top of it; then, turning the gear so that the intersection of *EF* and the center line on the top of the tooth were in a horizontal plane passing through the arbor center, he measured with the height gage to the point *K* on each end of the tooth. The difference between these measurements was 1.456 inch which represented the advance of each tooth in the width of the gear

face (2 inches). This advance is not 1.456 inch on the circumference of the circle but is the chordal distance KL, Fig. 3. Now the length of KL divided by the diameter of the circle G equals the sine of angle a.

$$\frac{1.456}{5} = 0.2912; \text{ hence } a = 16 \text{ deg. } 56 \text{ min.}$$

This angle is to 180 degrees as 2 is to the spiral lead L of the teeth. Hence:

$$\frac{16.93}{180} = \frac{2}{L}; \ L = 21.26 \text{ inches.}$$

As the gear was of 12 diametral pitch, this lead gives an angle of spiral of about 38 degrees.

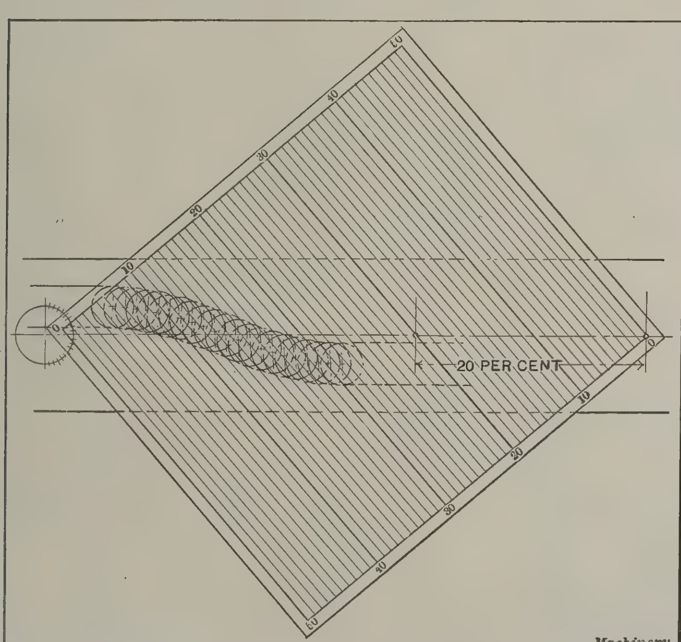
The accuracy of this method is limited only by the workman's ability to scribe and measure accurately, and with a sharp scriber in the height gage and painstaking care, very close results can be obtained. In this instance, the error was small, as subsequent correspondence with the maker of the gear showed that it had been designed for a lead of 21.262 inches, and very likely had been cut with a lead of 21¼ inches. The lead of spiral milling cutters often has to be determined in order that they may be recut. A similar method can be followed for these tools, the point K from which the measurement KL is taken being determined by the intersection of the circle drawn on the end of the cutter and the radial face of a tooth.

GUY H. GARDNER

Revere, Mass.

DEVICE FOR LAYING OUT DRUM CAMS

The accompanying illustration shows a simple device which is used in laying out drum cams. The writer has found this device to be a time-saver to draftsmen and believes it will prove of interest to some of the readers of MACHINERY. In laying out drum cams, it is necessary to lay out the percentages



Device for Laying out Drum Cams

of the cam movement on the center line of its lift. When doing this work in the ordinary way, the total length of the cam circumference is first laid out and then this length is divided up into percentages by some geometric method. This procedure, however simple, must be repeated for every section to be laid out.

The writer's method consists in having a piece of tracing cloth divided and ruled as indicated in the engraving, each tenth line being made slightly heavier than the others so as to make the counting of the divisions easier. This piece of tracing cloth is laid over the layout with the zero point at one of the ends of the line to be divided, and then the tracing cloth is swung around until the other end of the line to be divided coincides with the line on the tracing cloth numbered with the required number of divisions. The divisions to be laid out can then be pricked through onto the layout by the dividers. In the engraving is illustrated the method for laying out a 20 per cent cam movement. If two sheets are used, ruled with divisions 0.25 and 0.40 inch apart, respectively, these sheets will cover a large range of cam diameters.

ALFRED LAURENS

CURLING AND CLOSING DIE

The die shown in Fig. 1 is used for curling the hollow ring-shaped cup shown at A in Fig. 2 and locking the steel band shown at B within it. The punched cup shown at A, Fig. 2, is as it comes from the drawing die and trimming lathe, ready for curling and assembling with the band shown at B. The central portion of the cup A is left in place until

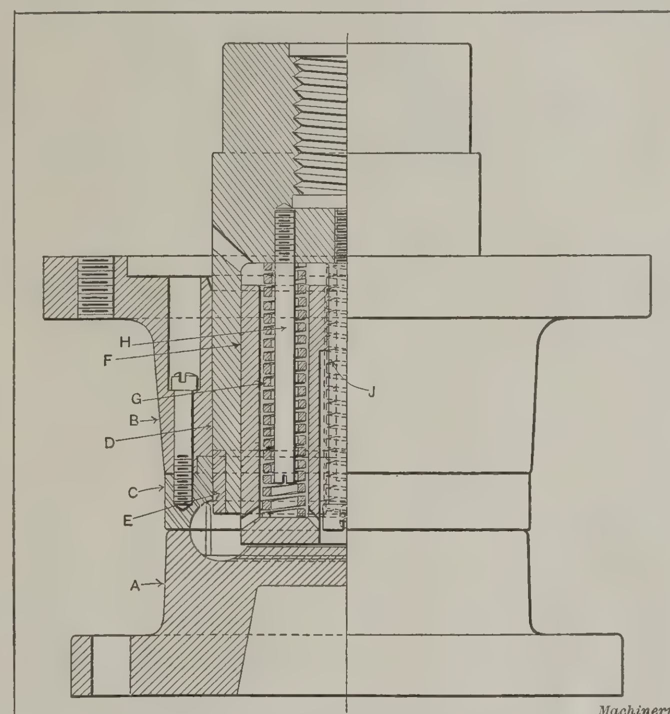


Fig. 1. Curling and Closing Die for Assembling

after the assembling operation is completed, as it serves to stiffen the work and enables it to be held more securely.

The base A of the die in Fig. 1 is an iron casting and is recessed in its upper surface to fit the cup, Fig. 2. As there is no rubbing or abrasive action in this die A, the cast-iron surface is of ample hardness, and saves the expense of inserting a steel ring. The upper portion of the tool consists of a cast-iron holder B, to the lower face of which is pivoted and screwed the curling die ring C, made from hardened tool steel. The closing punch-holder D is made of cast iron, bored out to receive the pressure pad F, which is acted upon by four stiff helical springs G, and is limited in its travel by the shoulder stud J.

The pilot studs H are of cold-rolled steel and are screwed

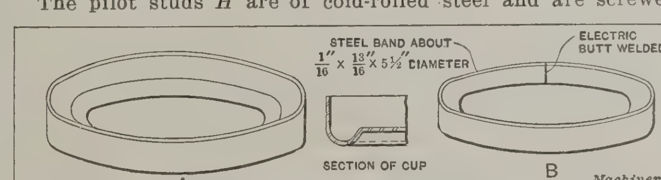


Fig. 2. (A) Cup before Curling and Closing. (B) Band to be assembled with Cup

into the punch-holder D for the purpose of guiding the helical springs into their pockets, and to prevent the pad F from rotating around the stud J. A steel band E is pressed onto the lower end of the punch-holder D to withstand the abrasive action to which it is subjected.

This die is held in a double-action press and is operated as follows: The cup A, Fig. 2, is placed in the groove in the base A, Fig. 1, and the band B is dropped into the cup. The punch descends, first holding the cup securely with the pressure pad F. Then the curling die descends, closing in the top of the cup, after which the closing plunger, which

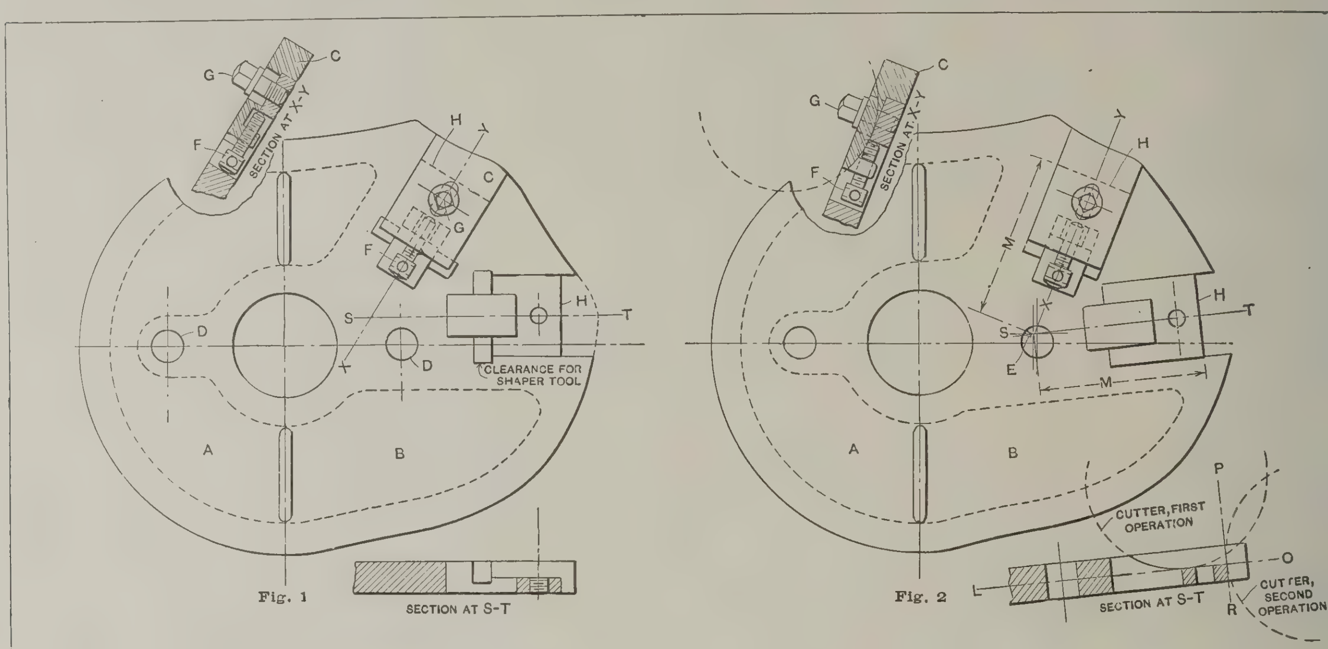
comes down slightly behind the curling die, operates and locks the band securely in place. The fact that the drawing punch of a double-action press descends after the blank-holder slide, combined with the necessity of holding the work when operating, in this case with the curling die first, makes it essential to use the long-stroke pressure pad and springs.

Detroit, Mich. ARON LAWRENCE

JIG FOR MILLING CAM SLOTS

In Fig. 1 is shown a cam used on a knitting machine. It consists of two halves, *A* and *B*, fastened to a flange, in the position shown, by the holes *D*. Part *B* is provided with two convenient manner The design of such a fixture, however, is not as easy as would be thought at first glance, since the center lines of the two slots in the cam intersect at a point which is not at the same distance from the edges *H* of the slots. In order to simplify the design of the fixture, the design of the cam was altered to that shown in Fig. 2. It will be seen that in the new cam the direction of the center lines of the slots is changed in such a way that the point of intersection *E* is at the same distance from the edge *H* of both slots. The parts *C*, however, remain at the same points on the outline of the cam.

Two operations are necessary for each slot. During the first operation the cutter finishes the top part of the slot, cutting



Figs. 1 and 2. Old and New Designs of Cam

slots which receive steel parts *C*. The latter fit exactly into the slots and may be adjusted by a hardened adjusting screw *F*. Another screw *G* is provided to hold parts *C* in their respective positions after being adjusted. These parts, however, are adjusted only at intervals, on account of the excessive wear at these points, although the adjustment also makes it possible to alter the shape of the cam to some extent when this is required.

along the line *LO*, while the second operation takes care of the front part and the correct length *M*, the cutter cutting along the line *PR*. The fixture used is shown in Figs. 3 to 6, inclusive, and is used for all the milling operations. It consists of a cast-iron base *A* (see Fig. 6) with two bearings *C*, each having a removable cap *D*. A cast-iron center piece *F* swings between these bearings by means of two journals *G* extending from *F*. These journals are cast hollow to reduce

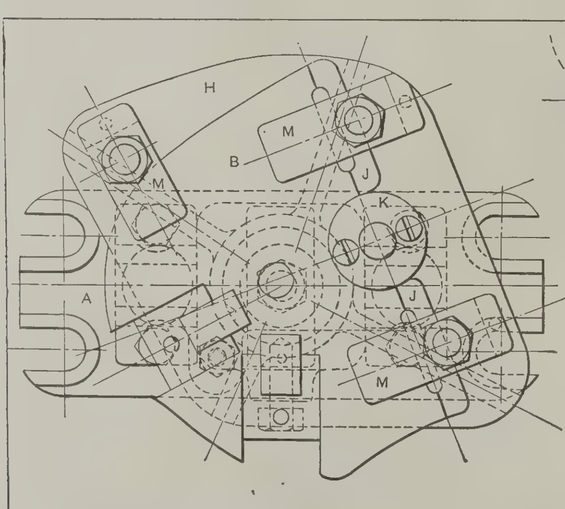


Fig. 3. Plan of Fixture

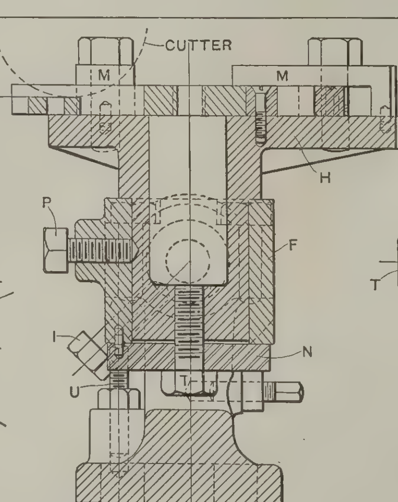


Fig. 4. Section of Fixture

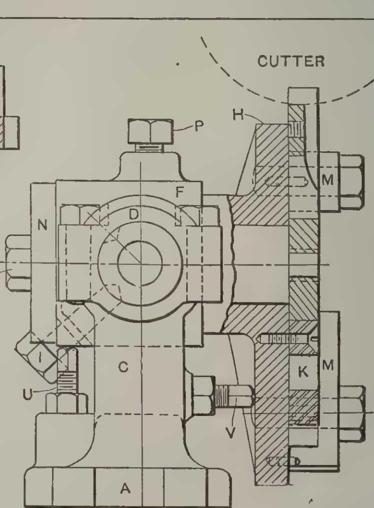


Fig. 5. Side View of Fixture

Some years ago the slots for these adjustable parts *C* were shaped and the parts made to suit, but as the cams were later used in large quantities, this method proved unsatisfactory and it was decided to mill both slots by one cutter, so as to be sure that they would be of the same width. The parts *C* were to be finished by straddle milling cutters set the required distance apart. It was then required to construct a jig for performing the milling operation for both slots in an easy and the weight. In *F* a finished hole is provided at right angles to the axis of bearings *C*, to receive the cast-iron table *H*, which revolves in *F* and is provided with two projections *J* and a round steel disk *K*, the latter of which suits the bore of half-cam *B*. The cam is located by means of lugs *J* and disk *K* in such a way that the intersection point *E* (Fig. 2) of the two center lines of the slots coincides exactly with the axis *L* of the journal bearing about which it revolves.

Clamps *M* serve to hold the cam in position while it is milled. The clamps are provided with small steel pins which prevent it from turning around their bolts. The table *H* may be fixed in two positions so as to bring the center lines of the two slots into line with the cutter. The hardened center point of screw *P* fits into two corresponding holes drilled into the journal of table *H* at the proper places. The table is rigidly held to the center piece *F* by means of screw *T* and the bridge piece *N*. The latter is also provided with a small pin *S* and thus fixed in its position with relation to the center piece *F*. Fig. 6 shows the top view of the table set for the first slot, while Fig. 3 represents the same view with the table turned to cut the second slot.

After the top parts of the slots are finished, the latter must be cut to the correct length, finishing the front part at the

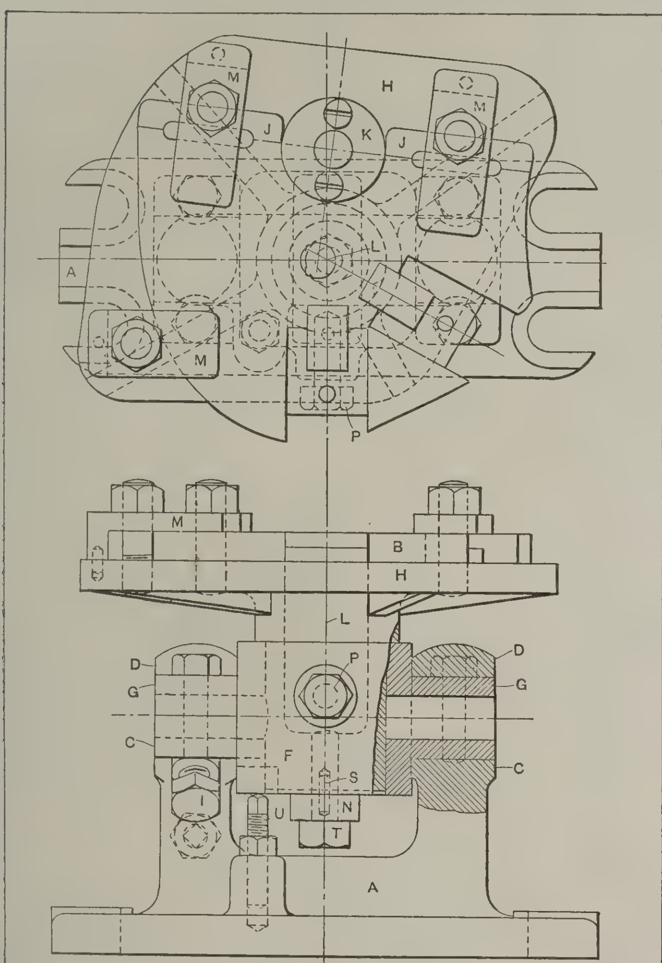


Fig. 6. Plan and Front View of Fixture

same time. To do this, the set-screw *I* is loosened and the center piece and table are swung around 90 degrees. In the first position, shown in the side-view section, Fig. 4, the center piece rests upon a screw *U*, while the top part of the slot is finished. When it is swung over, however, it rests against screw *V*, Fig. 5. Countersinks to suit screw *I* are drilled in the left side of the journal of the center piece *F* at the correct angles. The axis of *F* is arranged in such a way that the fixture is at once ready for the second operation, and no resetting of the cutter is necessary. To cut the front part of the second slot, table *H* is simply revolved as described before. It will be seen that in this way all the operations can be carried out rapidly and conveniently and without resetting the cutter or re-adjusting the milling machine table.

Wyomissing, Pa. CHRISTIAN F. MEYER

REPAIRING A CRACKED WATER JACKET

In the April, 1910, number of MACHINERY, a method of repairing a cracked water jacket of a gas engine cylinder was illustrated and described. In the following is given a different method for making repairs of a similar nature.

On the line of the fracture, drill and tap for a ⅜-inch threaded copper rod. This rod is screwed in firmly to a depth about equal to the thickness of the metal of the water jacket. Cut off the copper rod with a hacksaw, allowing it to project about 1/32 inch; then drill succeeding holes, each hole being drilled partly into the previously inserted copper plug, so that when all of the plugs are placed in the cylinder casting, they form a continuous band of copper along the line of the fracture. The copper plugs should now be peened down and trimmed off flush. The only possible chance for leakage, after having repaired the crack in this manner, is for the water to follow the joint between the metal of the jacket and the copper plugs, but, as the copper rods are threaded into the casting, it is not likely to occur. Should leakage take place, a little extra peening will suffice to prevent it.

Wilmerding, Pa. E. R. GROMAN

SEASONING CAST IRON

In response to the question in the "How and Why" section in the June number of MACHINERY, the writer would offer the suggestion that the best solution lies in so designing the parts that seasoning is either no longer necessary or so that the time required would be considerably reduced.

Every foundry-man knows that badly proportioned castings, that is, castings in which the metal cools at different rates, are subject to greater distortion than well proportioned ones. When cold, the stresses in the parts which cooled first are particularly severe, since added to their own stresses are the stresses due to contraction of the last cooled parts. Hence, if in any way an equal rate of cooling can be induced, castings less internally stressed will result. In the first instance, then, it is to the designer one must look for the cure, or rather the prevention. Let him see that the thick parts are reduced to the utmost possible extent, and then balanced by equally thick parts directly opposed. In certain cases the molder can influence the result by baring the thicker parts after solidification. He can also cast in proximity to the thin parts masses of metal to retard the cooling. The writer has often adopted this method. One case which migh be cited involved pulleys with a very thin rim, in which case a ring of metal was cast surrounding but not touching the rim. In another case of long angle bars, two bars of metal were cast along the two edges.

By any of these means the internal stresses are reduced; hence, their effect when metal is removed will be less also. But having attended to all these half remedies, there is another possibility. Take, for instance, a lathe bed, which by the best firms is always subjected to the ageing process. The top is planed and stresses are thereby released. It would, perhaps, be more correct to say that the metal under the severest stress is removed, and the planed surface is distorted by the pull from the metal at the opposite, that is, the bottom side. Why not remove an equal quantity of metal at the opposite side and so neutralize the effect? This is again a matter for the designer. As a rule, in a lathe bed, it is necessary to turn the bed over to plane the seatings for the legs. Why not extend the leg seatings the whole length of the bed? Then, before planing, lay out so as to insure an equal cut on both top and bottom. The writer has, in some instances, adopted this practice with the result that it was no longer necessary to season. FRANCIS W. SHAW

Manchester, England

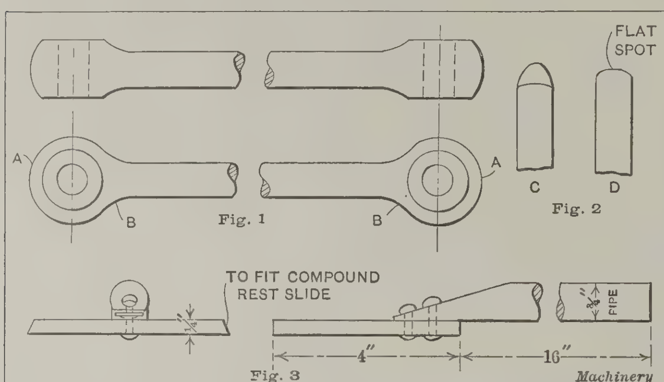
SPHERICAL TURNING

The spherical turning device described by Mr. C. Boella in the July number of MACHINERY, is probably good for the class of work for which it was designed, but the fixture is expensive and there are many classes of work that can be produced cheaper and simpler by the method described in the following.

In a large air-compressor plant where a great deal of spherical turning is done, various devices have been tried and discarded in favor of the simple method of using the compound rest as a spherical turning device. An example of the work done is shown in Fig. 1. This illustration shows a Corliss valve driving-rod having spherical surfaces turned at the ends *A* and fillets at *B*. When turning these, the compound rest on the

lathe is set so that the point about which it is swiveled is vertically beneath the center of the spherical section to be turned. The rest is then oscillated or swiveled so as to turn a spherical surface. The tool can be set at once to the desired radius when forgings are being turned having only a small allowance for finish. When, however, it is desired to take two cuts, the feed of the compound rest can be used for feeding in the tool for the second cut.

In order to be able to oscillate or swivel the compound rest, the binding screws are loosened enough so that an easy working fit is produced. The feed handle is removed and the operator uses the end of the compound-rest feed-screw as a means for swiveling the rest about its center, feeding the tool slowly around the work. Some operators reverse the compound rest so that the feed handle is at the back of the lathe, and then



Figs. 1 to 3. Work requiring Spherical Turning, and Tools used

use a handle as shown in Fig. 3. This consists merely of a piece of steel beveled to fit the slide in the rest and having a ¾-inch pipe about sixteen inches long riveted to it. This handle is inserted in the compound-rest slide and the pipe acts as a lever arm making it easier to swivel the slide about its center. In machining the fillet *B*, Fig. 1, the tool point, of course, must be moved past the swivel center, of the compound rest.

The points of the cutting tools are shown in Fig. 2, where *C* shows an ordinary round-nosed tool which is used for roughing cuts, and *D*, a finishing tool. This is ground off to a comparatively large radius and is flattened off about 3/32 inch at the end. This tool, with soda solution as a cutting lubricant, finishes and polishes the work in one operation.

New Britain, Conn. J. M. Henry

CUTTING TWELVE TEETH IN A THIRTEEN-TOOTH BLANK

In the June number of Machinery, engineering edition, Mr. G. R. Hulsberg, in commenting upon Wuest herringbone gears, takes exception to some of the methods adopted in calculating and cutting these gears. He concludes as follows:

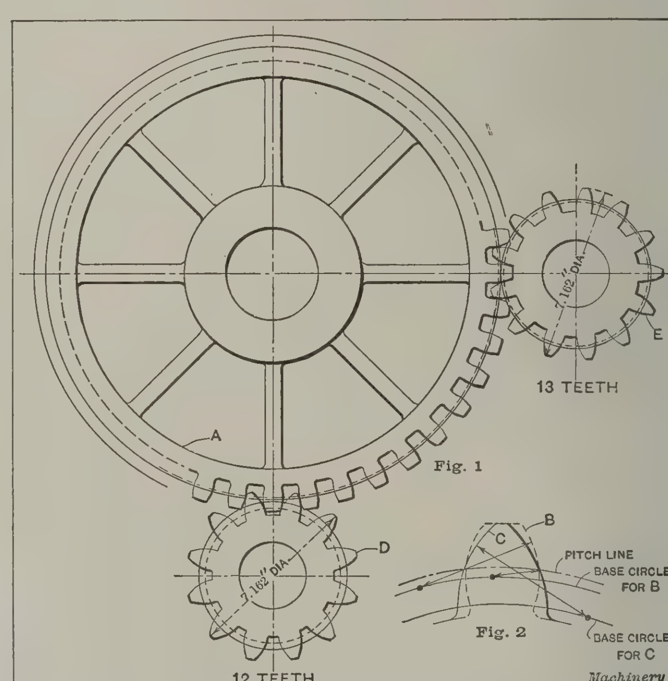
"Furthermore, in order to keep the center distance to some even dimension, the author simply reduces the pitch diameter of the gear to suit the center distance. By doing this, and keeping all the other quantities the same as before, the pitch of a gear is changed without changing the pitch of the pinion; hence, the gears will not mesh perfectly. The difference may be small, but interchangeability cannot be claimed on this basis."

The writer's experience with involute gearing indicates, however, that this supposition is not correct, and that, in fact, the diameter of the gears may be varied considerably from the calculated diameters without affecting the running qualities in the slightest degree, provided the proper method of forming the teeth is used. Some time ago a number of old planers were renovated, and, among other things, it was necessary to provide a complete set of new gearing and racks. The rack pinion was of mild steel, 13 teeth, 1½-inch pitch; the face width was 9 inches, the bore 3¼ inches, and the total length of bore 21 inches. It will be readily understood that the machining of the blank for this pinion from a solid 7¼-inch diameter steel bar involved considerable work, and that the finished gear was a fairly valuable piece. After the blank had been bored and turned the next operation was the cutting of the teeth. This was done in a gear-cutting machine, two cuts being taken.

Unfortunately, when gearing the indexing motion of the gear-cutting machine, the operator made one of those mistakes which seem almost inexplicable after they are discovered—he geared the machine for twelve teeth instead of for thirteen, and did not discover the error until one-half of the spaces had been roughed out. At first it seemed as if the only thing to do was to discard the blank and start on another. The writer remembered, however, that if a gear was cut in a generating machine (as distinct from a formed cutter machine) variations in the blank diameter were, within limits, unimportant. In fact, it is a recognized practice in some classes of work to increase the diameters in order to give the pinion teeth increased strength and durability. One firm in the town where this work was done had a generating machine large enough to cut pinions of the size mentioned. Arrangements were made with this firm, and in a few hours a finished gear was completed from the blank which had seemed to be only fit for the scrap heap. In fact, the pinion finished with twelve teeth was a better job than if it had had the full complement of thirteen teeth, as originally intended.

It may be suggested that the pinion could have been turned down to the correct diameter for twelve teeth and the teeth cut in the usual way. This, however, would have required another bull gear, and would also have left very little stock at the bottom of the teeth. Of course, the ratio of the gearing was affected by this alteration, but this was allowed for by a slight change in one of the other pairs of gears.

At *E* in Fig. 1, the pinion is shown as originally designed; *A* is the bull gear, and *D* is the pinion as actually made with



Figs. 1 and 2. Comparison of Tooth Forms in Pinions of Same Diameter with Twelve and Thirteen Teeth

twelve teeth. The dotted circles just inside of the pitch circles, in each case, represent the tooth curve base circles. It will be seen from Fig. 2 that the teeth of gear *D*, shown by full lines *C*, are stronger than the teeth of gear *E*, as shown by the dotted lines *B*. In this particular example we have the apparently paradoxical situation of a gear having 1½-inch pitch teeth accurately meshing with a pinion having 1⅝-inch pitch teeth, but there is no doubt whatever that if gears are cut by the generating process a slight variation in diameter makes no difference in their smooth working.

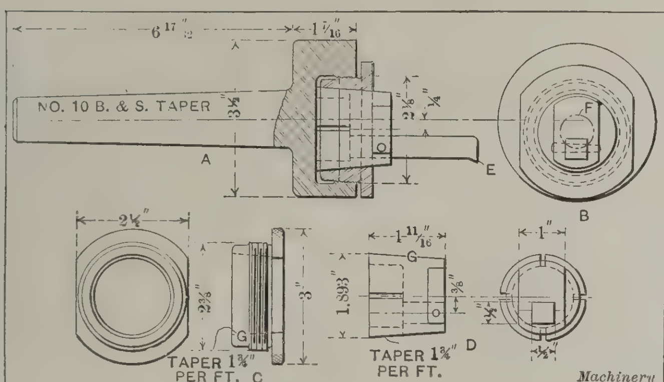
In conclusion the writer might mention that this twelve-tooth pinion has been in operation for about a year and the tool marks are still visible on the teeth. This is a good indication of the durability of the teeth when it is considered that the pressure on the teeth is about 9000 pounds during the cutting stroke and about 5000 pounds during the return stroke.

G. Ear

IMPROVED DESIGN OF BORING-TOOL HOLDER

The accompanying illustration shows a jig-boring tool that requires no set-screw to hold the tool. The use of set-screws, unless of the headless variety or those which do not project, is to be avoided in designing moving parts of machines or tools.

Referring to the illustration, *A* is the front elevation, shown partly in section; *B* is the end view of the assembled tool; *C* is a detail view of the locking nut; *D* shows the tool sleeve and *E* the tool, which can be made of any convenient dimension to suit the work. The shank of the tool-holder is tapered to fit the milling machine spindle. The head of the holder is



Improved Design of Boring-tool Holder

bored with an eccentricity of ¼ inch, and the square hole through the tool sleeve is also ⅜ inch off center. The circle *F* shows the amount of adjustment possible with the tool, which in this case is ¾ inch. The tool *E* is held in the tool sleeve by a taper pin.

In operation, this boring tool is similar to any other boring tool, except for the manner of varying the amount of eccentricity. This is accomplished by loosening the retaining nut, turning the tool sleeve and tool slightly, and tightening the sleeve again. The pressure of the retaining nut upon the tool sleeve holds the tool firmly, thus insuring an accurate cut.

Providence, R. I. ROBERT MAWSON

AN EFFICIENT ANGLE-PLATE FOR JIG WORK

When boring out jigs which require being clamped to the faceplate as well as to the angle-plate, strains are set up in the jig, so that when removed to drill a cross-hole, it will be found difficult to get the two holes in perfect alignment. An angle-plate which eliminates clamping strains, and does away with the necessity of clamping the work to the faceplate is

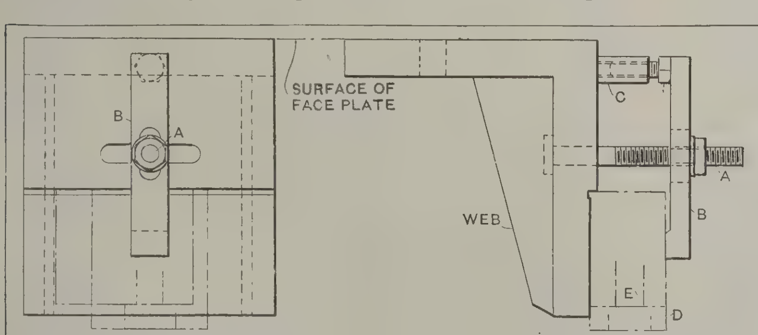


Fig. 1. Efficient Angle-plate for Jig Work

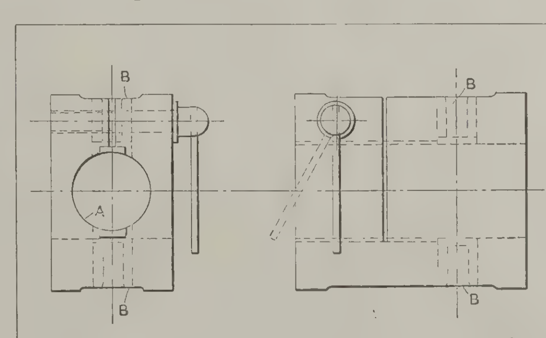


Fig. 2. Block Jig illustrating Application of Angle-plate in Fig. 1

shown in Fig 1. This plate differs from the ordinary plate only in that it is provided with a clamping bolt *A*, strap *B*, and is planed out on the front end as shown, so that the jig will have a seat or shoulder to bear up against. A jack consisting of a stud and nut *C* is also provided to block up the strap.

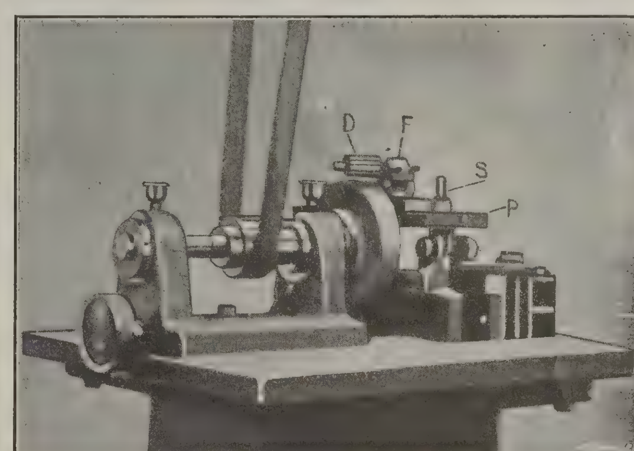
A jig which illustrates the application of this angle-plate is shown in Fig. 2, this being used for drilling and reaming a hole through a round bar. This is a simple jig, and is shown merely to illustrate one use of the angle-plate. In Fig. 1, the dot-and-dash lines *D* indicate the jig block in position for drilling, boring and reaming the large hole *A* in the jig, Fig. 2, while the dot-and-dash lines *E* show the jig block in position for drilling the small holes *B* in the jig Fig. 2. It is important when clamping the jig block to the angle-plate, that the block when changed from one position to the other should always have the same side in contact with the angle-plate, thus insuring that the holes will be in perfect alignment. JOHN R. JARVIS

New Haven, Conn.

EMERY-WHEEL TRUING DEVICE

The grinder shown in the accompanying illustration is used for grinding a special edge tool made in large quantities, the tools being gripped in a fixture reciprocated on the table *P*, the table being set at just the right height to clean up the face of the tools as they pass by the grooved surface of the wheel. These tools are ground with their faces straight and parallel within 0.001 inch, and hence the horizontal planes of the wheel, fixture, and table must be parallel. It was found that an adequate device must necessarily be provided for truing the wheel.

The table *P* swings about a horizontal axis through a short arc, and is held in position by lock-nuts on the stud *S*. The adjustment permits the wheel to be followed up at the pre-



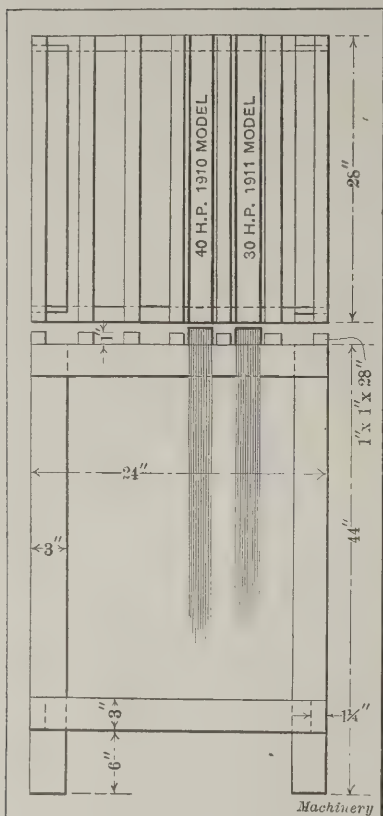
Device for Accurately Truing Emery Wheels

determined distance as its face wears off. No diamond was at hand for the truing of the wheel, and an ordinary emery-wheel dresser was out of the question for producing a straight parallel surface with sharp corners. The device shown in the illustration was, therefore, made, consisting of the cast-iron base *F* which is quickly attached to table *P* by thumb-screws, a half-inch shaft, and the dresser *D* which is made of a piece of carbon steel having a U. S. standard thread cut on its exterior, and then slotted longitudinally so that an end view has the appearance of a star wheel with sharp points. This tool is hardened but not drawn, and the hole in it is lapped to fit the shaft. When the base is attached to the table, the latter is lowered by the adjusting nuts until the wheel just touches the dresser, the machine being in motion. The dresser is then fed across the face of the emery wheel a couple of times. This device has proved very satisfactory, and produces a straight, sharp-cornered free-cutting face.

Middletown, N. Y. DONALD A. HAMPSON

DRAWING CABINET

The accompanying engraving shows a cabinet or rack for holding drawings or blueprints that have been bound together in volumes and are used regularly in the shop. It is simple in construction, but answers the purpose better than many more elaborate drawing cabinets and racks. It does not take a great deal of floor space, as the drawings are hung in a vertical position, while in most cabinets the drawings are laid flat, in a horizontal position. The title of each set of drawings is written on the back of the cover, so that it is always in plain sight and easily read. The top of the rack can be used as a reference table, it being level and of the proper height for that purpose. The construction of this rack is so simple that it can easily be made by any ordinary carpenter. The dimensions can be arranged to suit the conditions.

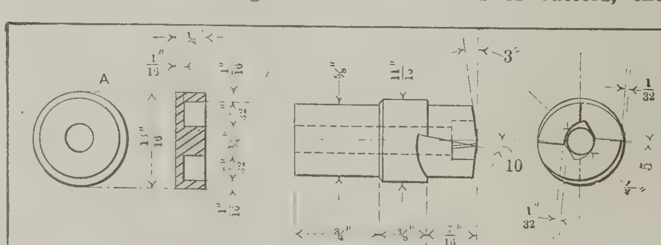


Useful Rack for Bound Volumes of Blueprints

Providence, R. I. ROBERT MAWSON

COMBINATION HOLLOW MILL AND COUNTERBORE

The accompanying illustration shows at *A* a section of a part made on the screw machine which, at first, appears to be a rather "mean" job. It will be seen that the recess is not very wide and the principal difficulty, obviously, is that when running at anything like an economical feed, a tool point small enough to do the work would spring slightly, cramp and break off. Having tried several forms of cutters, the



Combination Hollow Mill and Counterbore and Piece made by it

two-toothed mill shown was finally adopted and has given excellent results. It will be observed that one tooth cuts the outside of the recess, and the other finishes the cylindrical surface of the hub. Thus, with each tooth finishing a surface of its own, there is no cramping action. By having only two teeth, it is possible to make them strong enough to stand up and cut to size without springing. The large body of the tooth serves at the same time to rapidly dissipate the heat generated. The face angle is five degrees, the clearance three degrees, and the rake ten degrees. The work was done on a No. 2 Brown & Sharpe automatic screw machine.

P. A. FREDERICKS

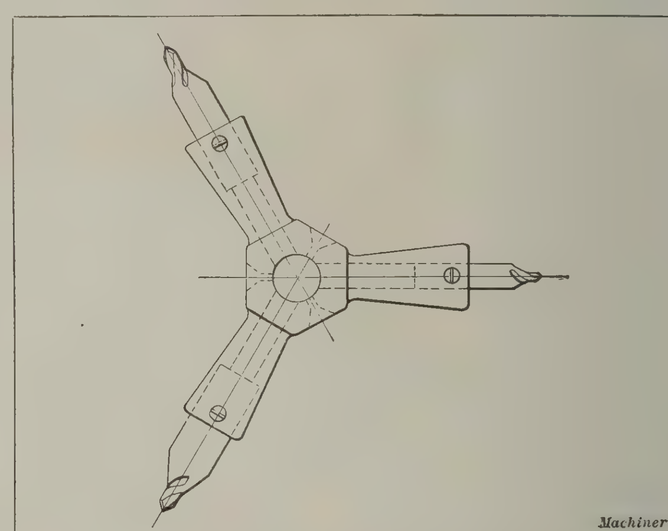
ERASING INK MARKS FROM TRACINGS

Inked-in tracings are easily discolored, marred and sometimes ruined through lack of proper treatment when making changes, but disfigurement of the tracing is not at all necessary if the alterations are made in a suitable manner. The above-mentioned faults can be avoided by observing the following rules. Always allow the ink to dry thoroughly, and do not use a blotter. In rubbing out, constantly turn the eraser so that different edges will be presented to the drawing. Using one portion of an eraser heats it up, and it will soon burn a hole in the tracing. After erasing a line or other inked-in part, rub the section slightly with soapstone. This will restore the finish to the cloth and prevent the ink from spreading. A small piece of soapstone will last an indefinite length of time and should be in every draftsman's kit. It is far superior to a knife handle and other similar contrivances which are sometimes used for this purpose. The above method of erasing will be found efficient if used with discretion.

Los Angeles, Cal. L. R. W. ALLISON

A CENTER REAMER HOLDER

A center reamer holder which will be found useful in connection with lathe work is shown in the accompanying illustration. It saves the trouble of chucking the center reamer every time it is necessary to drill a center in the end of a piece. The holder is held up against the tailstock center of the lathe and the reamer fed into the work. The three



Holder for Various Sizes of Center Reamers

holders make provision for accommodating center reamers of various diameters. The holder itself can be made from a 3½-inch round bar by cutting it off to the required thickness and then milling and turning it to form the three arms. Holes to suit the shanks of the center reamers can then be drilled, and 5-32-inch screws supplied for holding them.

C. E. D.

CUTTING WORMS OF STEEP PITCH IN THE LATHE

When cutting worms of steep pitch in the lathe, it is sometimes found impossible to drive the lead-screw through the usual train of gearing on account of the heavy stress that is placed on the first gear in the train, which frequently strips the teeth. The writer has overcome this difficulty by driving the lead-screw directly from the cone gear, using an attachment which would permit of this. The back-gears being in use, the cone on the lathe referred to had a velocity ten times that of the spindle; with the cone gear used as the driving gear in the train for the lead-screw, this had then ten times the velocity that the driving gear would have had if the drive were through the usual gearing. Hence, the stress on the teeth was proportionately reduced. Assume that a worm having 3½-inch lead is to be cut with a lead-screw having four threads per inch. The ratio of the spindle speed to that of the lead-screw is 14 to 1, but, by driving directly from the cone gear, the ratio will be 14 to 10, which makes it easy to obtain the gears; in fact, some leads could not be cut in any other way, as it would not be possible to obtain the required ratio by the gears available.

Brooklyn, N. Y. GEORGE E. OWEN

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

AMERICAN TOOL-ROOM LATHE

The American Tool Works Co., Cincinnati, Ohio, is manufacturing a new design of high-duty tool-room lathe, which is made in 14-, 16-, 18- and 20-inch sizes. These lathes have many features common to the standard design built by this company, including the drop-V bed, double-plate apron, quick-change mechanism giving 48 thread and feed changes, phosphor-bronze bearings, etc. In addition, the lathe is fully equipped with the various attachments required for tool-room work, such as taper, draw-in, and relieving attachments. It also has a pan for retaining the lubricant, as shown by the accompanying illustration Fig. 1. In case all of the attachments mentioned are not needed, any one of them can be furnished separately.

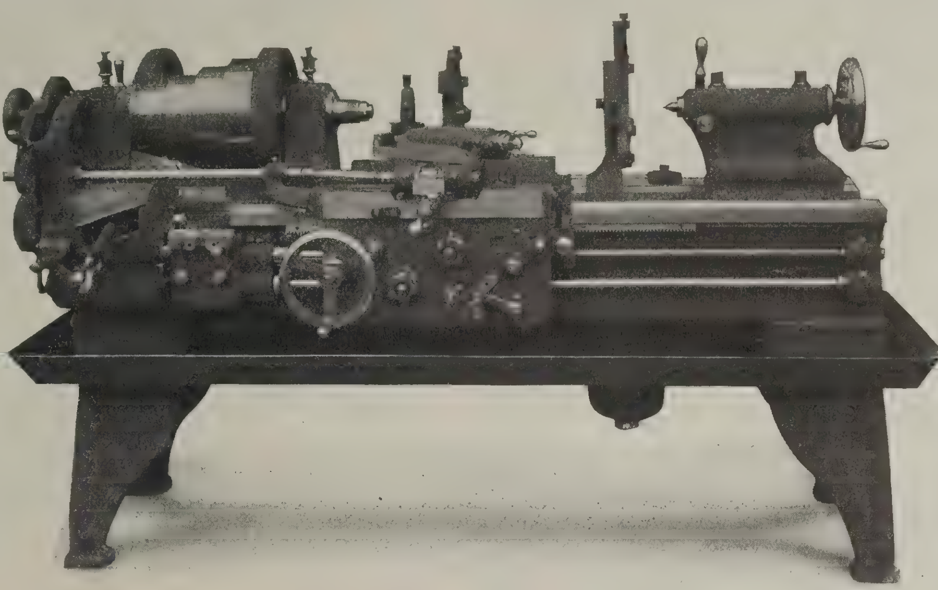


Fig. 1. American High-duty Tool-room Lathe

The taper attachment is simple, both in design and operation, and it is rigidly constructed, thus insuring accurate work. The attachment is bolted to and travels with the carriage, and can be engaged quickly at any point along the lathe bed, by simply tightening one binding nut on the clamping dog. When arranged for taper work, the sliding shoe is directly connected with the bottom slide of the tool-rest by a heavy cast-iron yoke which may be seen in Fig. 2. This construction eliminates lost motion and insures accuracy. The nut for engaging the sliding shoe is arranged to slide in a slot in the connecting yoke, and it is attached or released by tightening or loosening a single screw. Accurate graduations are provided and there is a hand-screw having a graduated collar for obtaining fine adjustments.

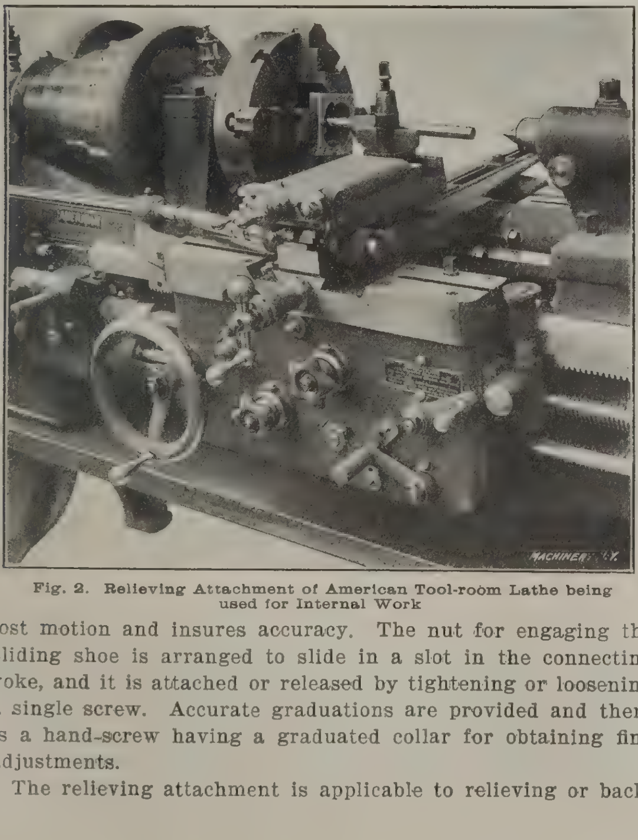


Fig. 2. Relieving Attachment of American Tool-room Lathe being used for Internal Work

The relieving attachment is applicable to relieving or backing off the flutes of cutters, taps, reamers, end mills, hollow mills, dies, etc. This attachment is universal in its operation, and end or internal relieving can be done just as easily as straight work. It has a direct drive and is of simple construction. The change-gear mechanism is supported by a bracket located on top of the quick-change gear-box, as shown in Fig. 1. The change gears are carried by a small quadrant which is used to disengage the drive when not required.

The power is derived from a spur gear located on the end of the main spindle, and motion is transmitted through the change-gear mechanism to the driving shaft which extends through the supporting bracket on the quick-change gear-box, and is journaled at the other end in a bracket fastened to the left side of the carriage as shown. Between the carriage bracket and tool-rest there is a universally jointed telescoping shaft which permits cross movement of the tool-slide.

The driving shaft revolves constantly in one direction until the rotation of the spindle is reversed, at which time the driving shaft ceases to reciprocate the tool-slide; consequently, the latter remains stationary when the direction of the carriage travel is reversed while the half-nuts are engaged. This feature is obtained by interposing a clutch connection between the cam and driver, which is operative in one direction only. Therefore, the reversal of the driving shaft causes the clutch, which is held into engagement by a spring, to be withdrawn from the cam with the result that the cam remains stationary. In order to cover the entire range shown by the relieving attachment index plate, three cams having one, two and four

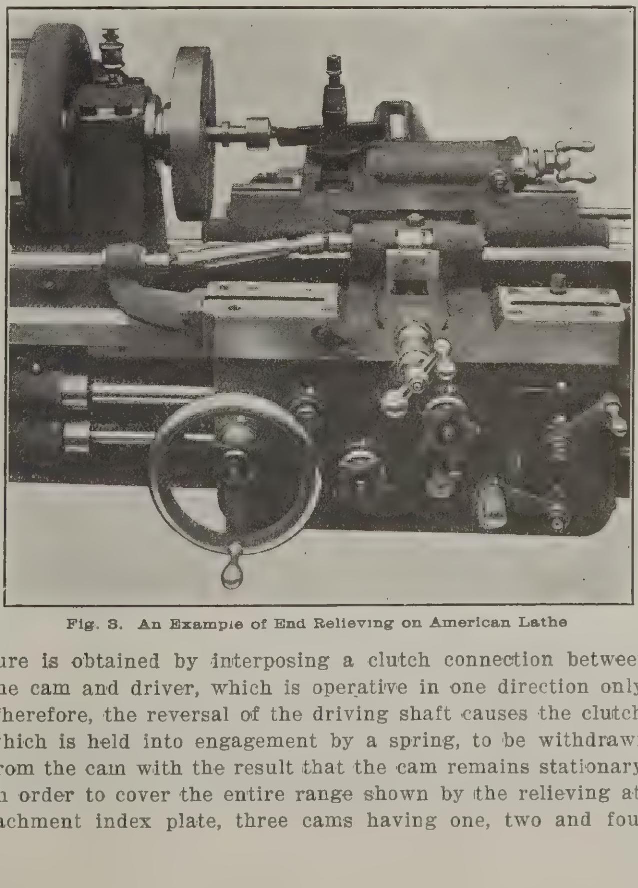


Fig. 3. An Example of End Relieving on American Lathe

rises, respectively, are provided in addition to the change gears. These cams can readily be interchanged, and they run in an oil bath.

This attachment permits the tool-slide to be operated at positions 30 degrees apart, thus providing twelve operating positions within a circle. This feature makes it possible to relieve side cutters, end mills, and various other tools. Fig. 2 shows the lathe being used for internal work and Fig. 3 its application to end relieving. Aside from adjusting the tool-slide to its proper position, no change or re-adjustment of the mechanism is required for internal or end relieving. Convenient means are provided for obtaining the various degrees of relief for either external or internal work. Adjustment is made at the front of the tool-slide by means of a thumb-screw, and the depth of relief is indicated by a graduated scale. This attachment can be applied and operated independently of the taper attachment.

A standard compound rest is furnished in addition to the special relieving rest, the former being recommended for general work. The compound rest can quickly be interchanged with the special tool-slide. The attachment can be arranged for relieving taps or hobs having spiral flutes by the addition of extra gears. In the construction of this attachment high-grade materials are used throughout. The cam yoke is forged and the cams, cam shoe and crank members are of tool steel, hardened and ground. The index bar in the top slide is of forged steel, and all shafts and gears are well proportioned. All gears are covered for the protection of the operator.

The draw-in attachment furnished with this lathe can be equipped with collets for holding stock up to 7/8 inch diameter on the 14- and 16-inch sizes, and up to 1 inch diameter on the 18- and 20-inch lathes.

COMBINED DOUBLE-HOUSING AND OPEN-SIDE PLANER

The planer illustrated in Figs. 1 and 2 was built for the Gas Traction Co. of Minneapolis, for planing the engine base castings used by that company in the manufacture of tractor engines. These bases require planing on the bottom, top and on both angular sides, as well as on the ends. As they are over six feet long, a standard planer, if used for planing the ends as well as the other surfaces, would, of course, have to be wide enough to permit the casting to pass between the housings, unless some form of extension tool were used, which would be undesirable. As the castings have a width of less than three feet at the top, the planing of the sides on such a wide planer would be objectionable, because of the distance to which the side-heads would have to be extended. Moreover a rigid support for the tools was desired to permit taking heavy cuts when planing the angular surfaces.

The planer illustrated herewith was especially designed for this work by Mr. C. C. McConville (general superintendent of the Gas Traction Co.), assisted by the engineering departments of the Rockford Machine Tool Co. and Jos. T. Ryerson & Son. This machine has two heads on the cross-rail, two side-heads and, in addition, an auxiliary housing carrying a single head and located approximately four feet in front of the main housings. The engine bases are machined by first planing them on the bottom, two castings being finished at one setting. They are next mounted one at a time on a fixture which is pivoted in the center and can be accurately located in the different positions required by a heavy stop-pin. This fixture with an engine base mounted on it, is first placed parallel with the planer table and the top and two angular sides of the work are planed simultaneously. Fig. 2 shows the special tool bars or holders which are attached to the standard side-heads for this operation. This view also clearly shows the brackets which are clamped to the housings to provide a rigid support for the tool bars directly back of the cutting tools. After the sides are planed, the fixture carrying the castings is swiveled to a right-angle position and the end of the casting is finished by means of the head mounted on the auxiliary housing. This housing, which is shown in detail in Fig. 3, is located back far enough to permit the casting to clear it without changing the position of the work.

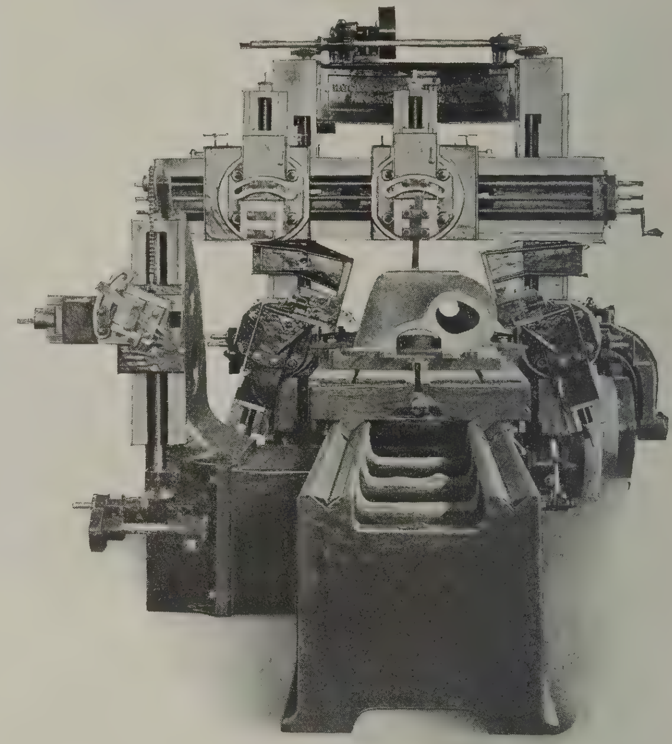


Fig. 2. End View of Combined Double-housing and Open-side Planer

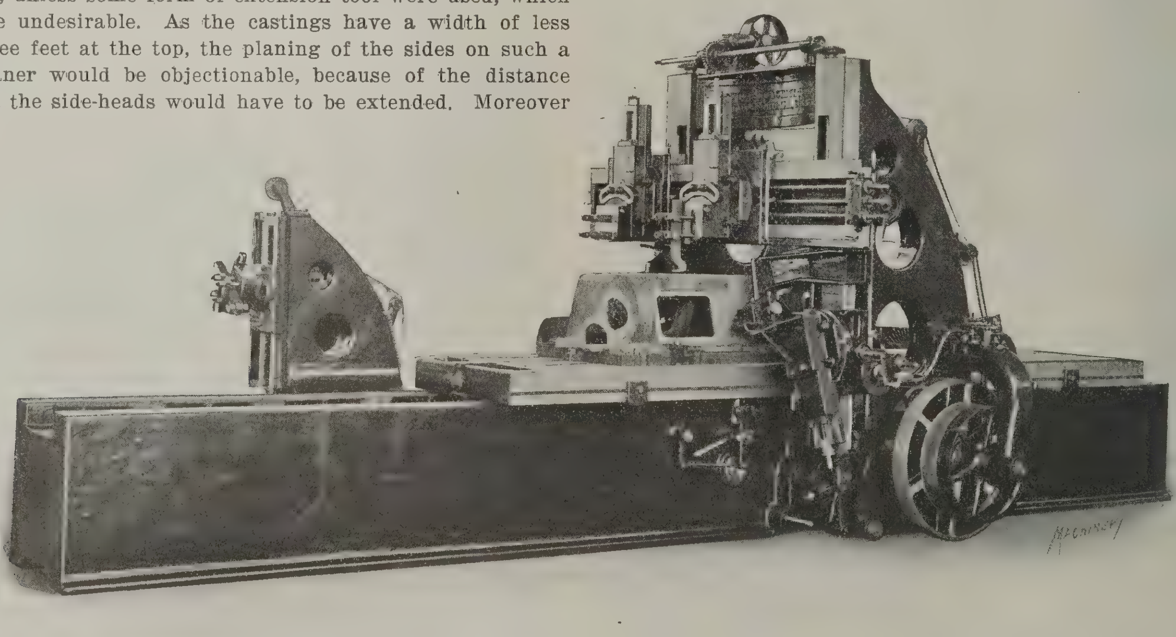


Fig. 1. Special Planer built by Rockford Machine Tool Co., Rockford, Ill.

The bed of this planer is a deep pattern, thoroughly braced by box form cross-girders, and it is further strengthened where the gearing and uprights are mounted. The length is such that there is very little overhang of the table when planing on full stroke. The table is of unusual thickness and the

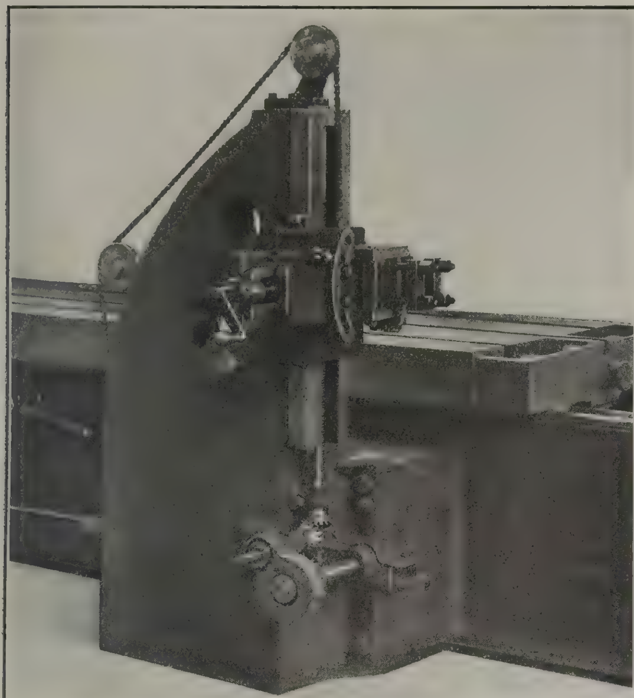
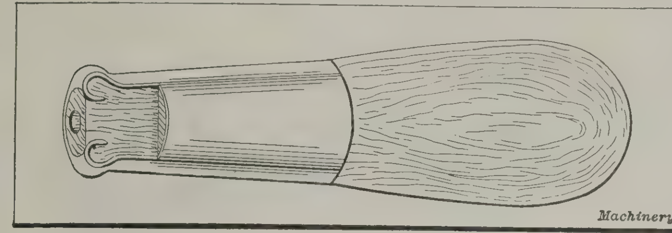


Fig. 3. Auxiliary Housing of Planer shown in Fig. 1

T-slots are exceptionally deep and planed from the solid. The cross-rail is of extra depth, and the down feed to the heads is unusually long. The saddle is graduated in degrees around the entire circle for angular adjustments. The side-heads are provided with vertical, horizonal and angular power feeds, and can be run below the top of the table when not in use. The down feed screws have micrometer dials, which are very convenient for making rapid and accurate adjustments for depth of cut. The shifting device is simple and is designed to transfer the belts quickly and noiselessly. There are shifter levers on both sides of the planer so that the operator can control the motion of the table without walking around the machine. Aluminum driving pulleys are used and all feed racks, pinions, and driving gears are of steel.

REINFORCED FILE HANDLE

The file handle illustrated herewith is a non-splitable type just placed on the market by the Doane Mfg. Co., Boston, Mass. This handle has a heavy pressed-steel ferrule which is enlarged at the end and curved inward as shown by the sectioned part of the illustration. When the ferrule is driven into place the end of the handle is locked within the enlarged or beaded end. These handles are made in five different sizes. The smallest



Non-splitable File Handle

size takes files from 4 to 6 inches, whereas the largest size takes 18- and 20-inch files.

HIGH-SPEED SLOTTING MACHINE

The slotting machine, front and rear views of which are shown in Figs. 1 and 2 respectively, was designed for slotting keyways in milling cutters and small parts such as are used in the manufacture of motorcycles, firearms, typewriters, sewing machines, etc. This machine has a vertical tool-slide and a horizontal work-slide which is gibbed in the body of the machine and serves as a fixture for holding the work. By turning a small handle in the front of the machine, this slide can be removed whenever it is desired to replace it with another slide or fixture especially designed for a given class of work.

The feeding movement, as well as the relieving of the tool, is accomplished automatically by the motion of the work-slide. This slide is advanced for feeding the work to the tool, in intermittent steps between which there is a short reverse motion for withdrawing the work from the tool during the upward stroke. This feeding movement and reverse motion is derived from the tool-slide, which has two lugs on the left side as shown in Fig. 1. These lugs alternately engage a short lever or finger attached to a rockshaft which, in turn, is connected with the feed mechanism by a vertical rod, as shown in the rear view.

The action of the feed mechanism is as follows: When the tool-slide reaches the end of its downward stroke, the upper lug strikes the finger of the rock shaft, thus imparting a vertical reciprocating motion to the rod in the rear. This rod has a cam-shaped end which transmits the motion to a horizontal feed bar and the latter, in turn, gives a reverse movement to the tool-slide for relieving the tool on the upward stroke. When the top of the stroke is reached, the lower lug on the tool-slide engages the finger of the rock shaft and the resulting motion operates a ratchet and pawl mechanism, which, in connection with a screw on the feed bar, serves to advance the work-slide automatically a distance equal to the feed desired.

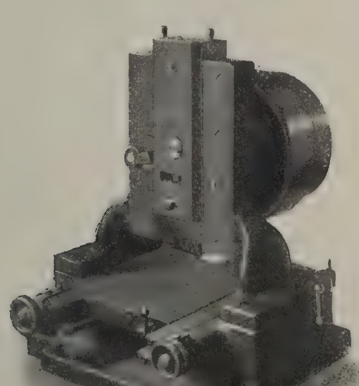


Fig. 1. Slotting Machine built by Swind Machinery Co.

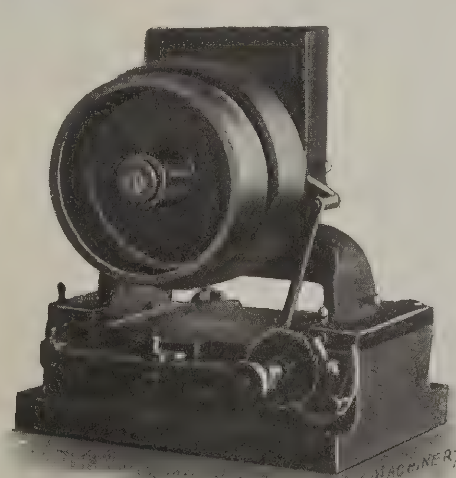


Fig. 2. Rear View of High-speed Slotting Machine

The feed mechanism has an automatic stop which can be set for any predetermined depth of cut and enables parts to be duplicated within close limits. The tool-head or slide is made of steel and is carefully scraped and gibbed. The vertical motion for the slide is obtained from a crank and connecting-rod driven by the two-step cone pulley in the rear. This machine has a capacity for cutting 3/8-inch keyways in cast iron and 5/16-inch keyways in steel. The maximum length of stroke is 2 inches, and a bench space of 16 by 16 inches is required. It is manufactured by the Swind Machinery Co., Bourse Bldg., Philadelphia, Pa.

EXTENSION HACKSAW FRAME

The hacksaw frame shown in the accompanying engraving is a style just placed on the market by the West Haven Mfg.

Co., New Haven, Conn. The back of this frame, instead of being collapsible, is made of a solid piece of 3/4 by 3/16-inch cold-rolled stock, thus eliminating any buckling action. The handle of this new frame is another noteworthy feature. It is

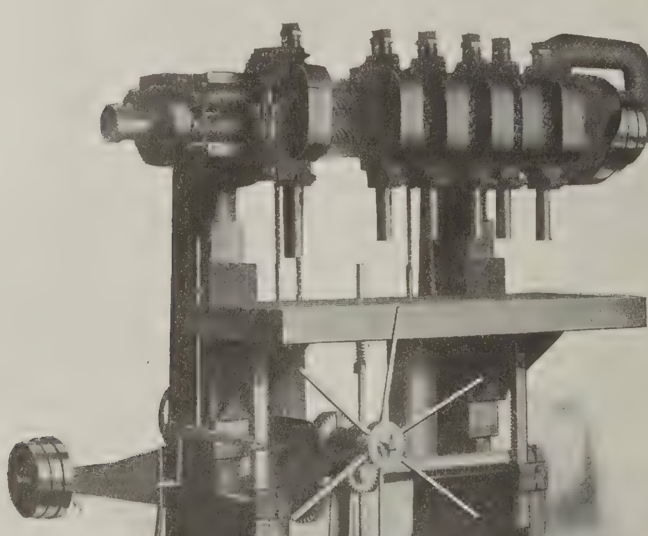
West Haven Mfg. Co.'s Hacksaw Frame

molded from a special composition and is made to fit the hand so as to give an easy, natural grip. The frame is polished and nickel-plated and can be adjusted for blades varying from 8 to 12 inches in length.

MOLINE BORING AND DRILLING MACHINE

The Moline Tool Co., Moline, Ill., has added to its line of drilling machinery a No. 12D heavy type boring and drilling machine adapted for rod boring and similar work. This machine has the double spiral drive which is regularly used by this company, but instead of having the lower spindle bearing vertically adjustable, the spindles run through the lower bearing full size. The lower bearing is bronze bushed and split so that the spindle wear can always be taken up, making in effect a lathe spindle construction. The spindles can be adjusted vertically by means of the upper bearings which are threaded, and they are equipped with ball-thrust bearings.

The heads are planed and scraped to an exact thickness and they can be equipped with tie-rods and spacer washers for setting them accurately to any distance along the rail. This is not necessary, however, for the general run of work, as the heads can be securely clamped in any position. The spindles



Moline Heavy Type Boring and Drilling Machine

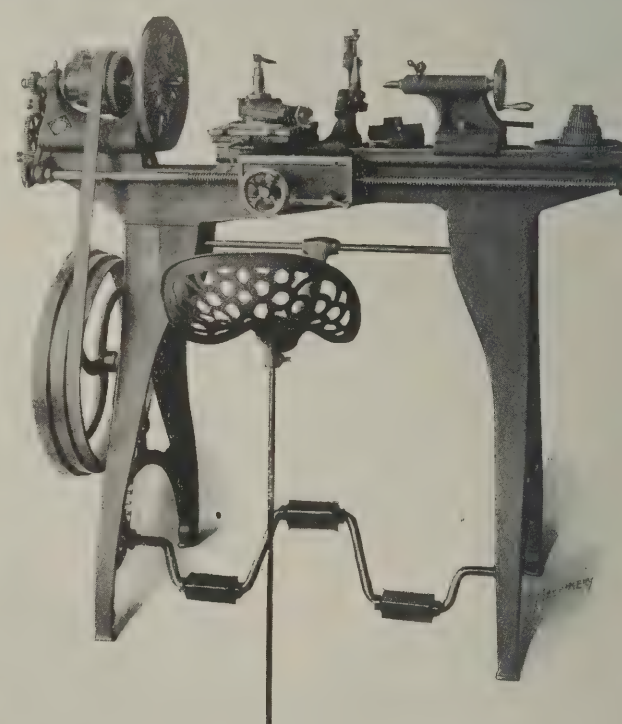
can be furnished with the Morse taper extending entirely below the bearing and with a regular driving slot for moving the drills, or with short hollow spindles so that a knockout rod can be used. In the latter case, the Morse taper extends up into the bearing. The spindle shown at the left is back-geared for extra heavy boring.

As the illustration shows, the cone pulley is provided with an outboard bearing. A plain table having five T-slots is recommended for cast iron work, but for steel a table that has three T-slots and is entirely surrounded by an oil groove, is furnished. In either case, the table is counterbalanced and it is fed by double, steel racks and pinions. The pinions are cut integral with the feed shaft and the latter is driven by steel and phosphor-bronze 4-pitch spiral gears. The table is provided with an automatic trip, a spring down stop and a positive depth gage. The hand feed is back-geared, and for facing operations the automatic trip can be set to disengage slightly ahead of the depth gage, for feeding the table up to the positive depth gage stop by hand. By pulling the pilot wheel out, a quick return is secured for the table.

BARNES NO. 5 GAP LATHE

The W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., is now manufacturing a No. 5 gap lathe of 11–15-inch swing. The particular lathe shown in the accompanying illustration is equipped with a foot-power drive, but a friction-clutch countershaft can also be furnished for power driving. This lathe is a screw-cutting type and the change-gears provided can be combined for cutting threads ranging from 4 to 40 per inch. In addition, other pitches not given on the index-plate can be cut.

The carriage has a compound rest, and the tailstock is the offset type which permits the compound rest to be set parallel with the bed. The compound table has transverse T-slots for clamping parts that require boring or milling operations. This



Barnes No. 5 Gap Lathe

is a very convenient and valuable feature, especially when the lathe is to be used for a wide range of work. The headstock boxes are accurately fitted to the spindle and provision is made for taking up wear. The spindles of both head- and tail-stocks are of steel and have accurate taper holes for the reception of the centers. The gearing is accurately cut from the solid, and the works are carefully protected from chips and dirt.

The No. 5 gap lathe is made in one style only and with one length of bed. The swing over the bed is 11 inches; over the tool carriage, $6\frac{5}{8}$ inches, and in the gap, 15 inches. The width of the gap from the faceplate is 5 inches, and the maximum distance between the centers, 29 inches. The net weight of the lathe is 500 pounds.

LEBLOND HEAVY-DUTY CONE-TYPE MILLING MACHINE

The R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has brought out a new line of cone-type milling machines. Figs. 1 and 2 show the side and front views, respectively, of a No. 4 size of the plain type. The distinctive feature of this design is that the machine is essentially right-handed. A study of productive and non-productive movements resulted in placing all the controlling levers on the right-hand side and grouping them for right-hand manipulation. The operator can control

every function of the machine without changing his position, unless the range of a machine is so large as to make this impossible.

The column is a one-piece heavy-ribbed box casting and it is cast integral with the base in order to transmit the strains due to heavy milling through the vertical walls to the base.

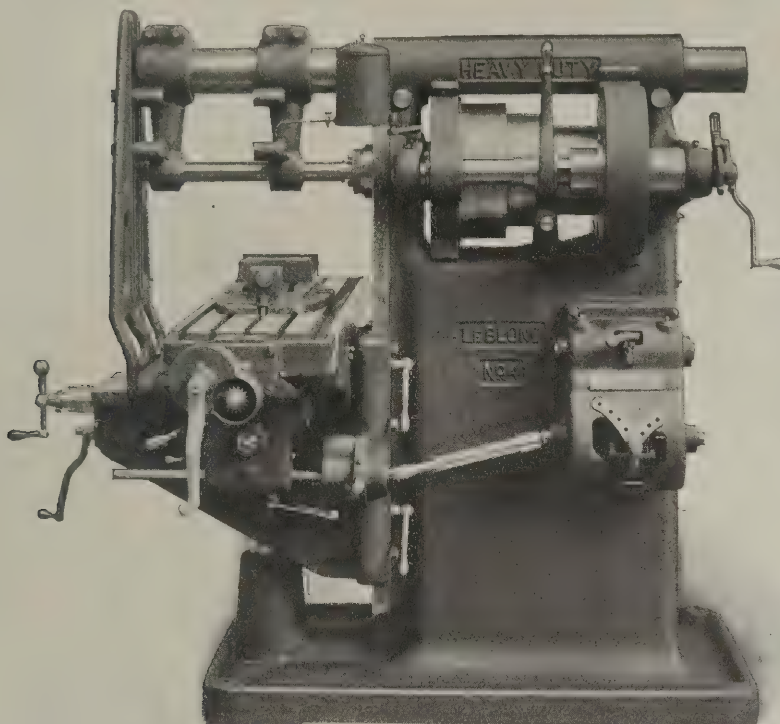


Fig. 1. The Le Blond No. 4 Cone-type Milling Machine

The back-gears are of the double-friction type. They are thrown in and out of mesh by a conventional eccentric shaft arrangement, and are clutched to the back-gear shaft by a powerful friction in the hub of each gear. This friction consists of three parts, *viz.*, a hardened steel double-taper key, a hardened steel plug with an acute taper, and a cast-iron friction ring. When the key is drawn against the plug, the friction ring is expanded in the gear hub. This ring is snapped over the hub to prevent any drag when the clutch is released, so that the lever may be used for starting and stopping. The change from a high to a low ratio can be made while a cut is being taken, and the driving tension can be varied by regulating the pressure on the lever.

The feeding movements are all derived from a single self-contained unit attached to the side of the column. Front and rear views of this feed-box are shown in Fig. 3. The initial drive is from a gear, mounted on the cone so that any change in the driving speed also effects a change in the feeds. The initial shaft is given three speeds; first, with the open belt drive, second, with the low ratio back-gear, and third, with the high ratio back-gear engaged. The feed-box is controlled by the two levers shown. The changes are advanced in small steps by the lower lever, whereas the upper one is used for compounding. Sixteen changes are obtained in the feed-box, and as there are three speeds for the initial driving shaft, a total of forty-eight changes, advancing by small increments, is available. The feeds are inversely proportioned to the speeds, thus obviating speeds that are detrimental to the gear-box. When high spindle speeds are used, the box is driven by a pinion, and when heavy cuts are being taken, thus necessitating large cutters and coarse feeds, the box is driven by a large gear, which increases the speeds about eight times. The gears are all made of crucible steel and they are brought into mesh by peripheral and sliding engagement. The sliding gears have rounded teeth to facilitate meshing, and the tumbler gears have pointed teeth and a heavy root section.

A universal shaft transmits power to the feed trip and reverse box. From this point, motion is imparted to the table through accurately cut spiral gears and spur gears. The feeds are tripped by a single plunger having a direct lever arm action. The trip acts directly on the releasing lever which drops into a neutral position after being tripped. Depressing this lever, feeds the table to the right, and elevating it feeds the table to the left.

The spindle is made of 60-point carbon, crucible steel. For the front bearing, a hardened steel taper bushing is pressed over the spindle and runs in a special close-grained cast-iron box that is drawn into the column by a nut on its rear end. The journals soon become highly polished as the result of contact with the hardened steel spindle, which, in conjunction with the thorough lubrication, reduces the bearing friction to a minimum. The rear bearing is a bronze mixture and has a straight fit in the journal, but is tapered on the outside so that it can be drawn into the column to adjust for wear. There are large cored pockets under each bearing from which the oil is drawn through a piece of felt by capillary attraction. In this way, the bearing is supplied with a flow of filtered lubricant and the flow increases as the speed increases.

The steps of the cone pulley are unusually large in order to use a wide belt operating at rational speeds. The countershaft is so speeded that a shift from high to low is always intermediate to a change on the cone pulley. This enables the countershaft speeds to be kept close together so that on the slow speeds, when the most power is required, the countershaft is operating at a high speed, and maintaining a high belt velocity and high initial torque. This also permits the eighteen spindle speeds to be obtained successively, with but eight belt shifts.

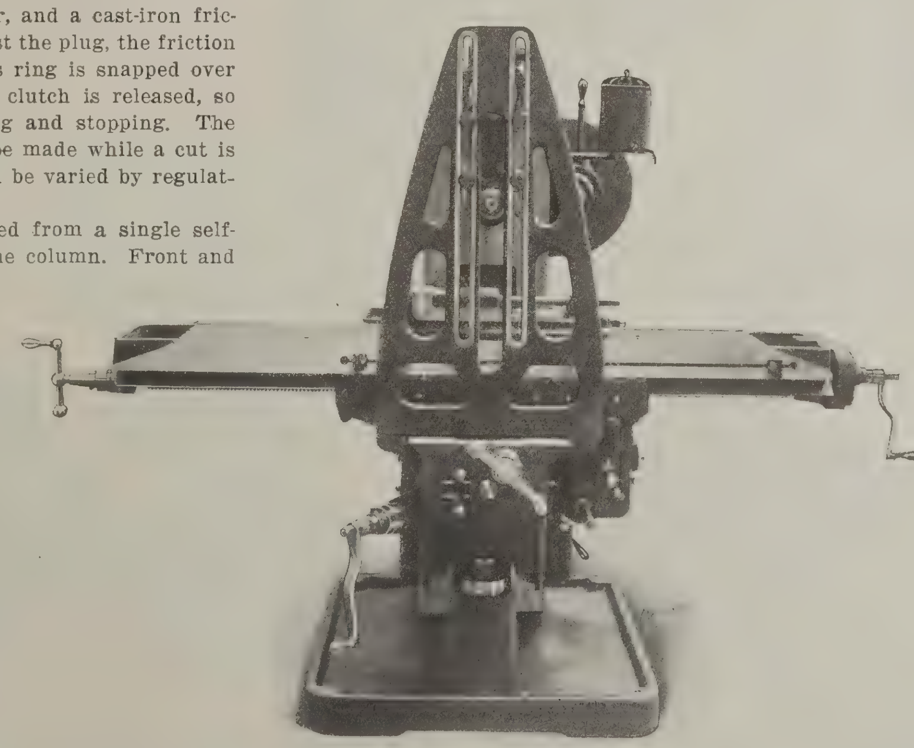


Fig. 2. Front View of Le Blond Milling Machine

The knee is a full box section, ribbed laterally and transversely to resist torsional and collapsing strains. All the openings have been reduced to a minimum and are located so

as not to impair the strength. The ribbing divides the casting into a series of box-section compartments. The cross-feed screw is in the center of the knee so that there are no unbalanced strains. The saddle is a heavy well-ribbed casting that occupies as little vertical space as is consistent with the required rigidity. The design of the saddle is shown in Fig. 4, which is a detailed view with the table removed. The knee and saddle are bound in their respective positions by heavy

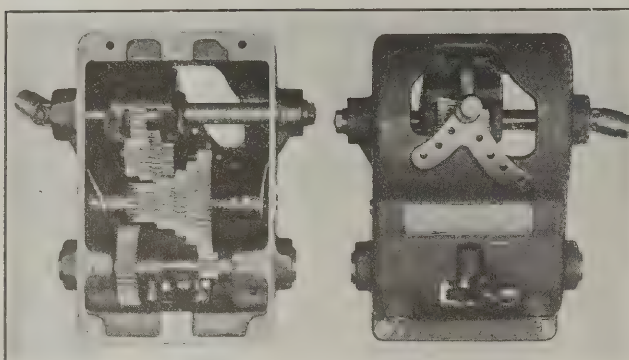


Fig. 3. Feed Mechanism of LeBlond Milling Machine

binder handles. By means of these handles a double-angle gib is operated which draws the parts together against the solid angles and at the same time maintains a continuous metal-to-metal contact.

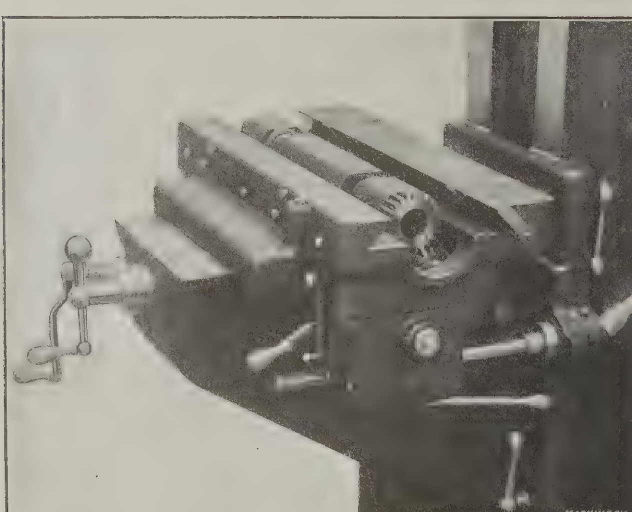
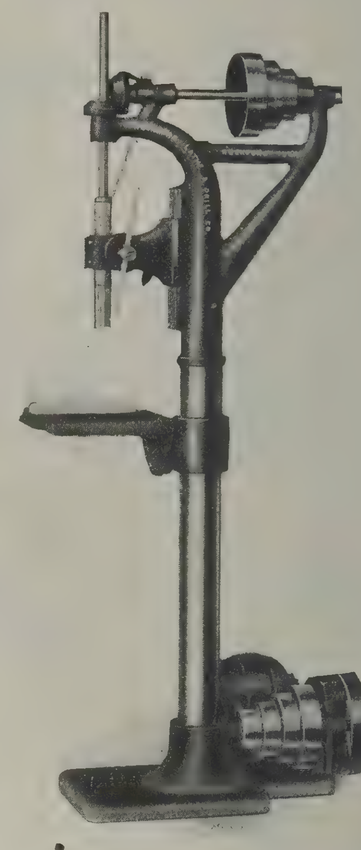


Fig. 4. Saddle and Knee of LeBlond Machine

The table is a semi-steel casting, having considerable vertical depth to resist buckling when the work is clamped to it. An oil channel is cast completely around the table and there is a pad at the extreme end for mounting the dividing head. In this way the capacity between centers is increased about eight inches. The feed-screw is cut from a 50-point carbon, crucible steel bar and has a lead of 2/5 inch. The brace, which is clearly shown in Fig. 2, is a solid casting designed to resist the strains to which it is subjected. The overarm is a solid steel bar which is accurately ground to size. This new line of milling machines includes sizes from No. 0 to No. 4, in both plain and universal designs.

ROCKFORD 14-INCH MOTOR-DRIVEN DRILL

The motor-driven drilling machine shown herewith is an improved design brought out by the Rockford Lathe & Drill Co., Rockford, Ill. This machine is driven by a ½-horsepower motor which can be furnished to run on either a direct or alternating current of any required voltage. The power is transmitted to the lower cone pulley through a train of gears containing a rawhide idler which gives a silent drive. There is a tilting table which can be securely clamped at any angle. This feature, in conjunction with an angular bracket on the table, makes it comparatively easy to do many difficult drilling jobs.


Rockford 14-inch Motor-driven Drilling Machine

The spindle is of high-carbon steel, forged and ground. It is fitted with a ball thrust bearing and is counterbalanced either by a weight and chain or a quick-return spring. The distance from the column to the center of the spindle is 7¼ inches; the diameter is ⅞ inch; and the diameter of the sleeve 1⅝ inch. The spindle has a vertical travel of 5½ inches, and the maximum distance from the end of the spindle to the table is 35 inches. The head has a vertical adjustment of 9 inches. The table is 11 inches square. The largest and smallest steps on the cone pulleys have a diameter of 7¾ inches and 3⅝ inches, respectively, and the steps have a face width of 1⅝ inch. The machine has a ¾-inch capacity, and its net weight is 355 pounds.

CLEVELAND FRICTION CLUTCH

The friction clutch shown in the accompanying illustrations is made by the Cleveland Clutch Co., 224 High Ave., Cleveland, Ohio. This clutch is an expanded-ring self-oiling type. The principal advantages claimed for the design are, durability, simple construction, smooth positive action, ease of adjustment, adaptability and high efficiency. In addition, it is dust-proof and oil-tight and is well balanced.

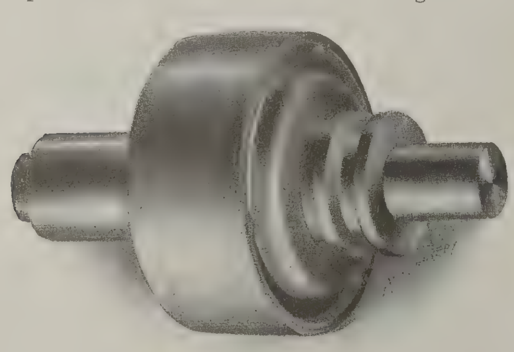


Fig. 1. Cleveland Friction Clutch

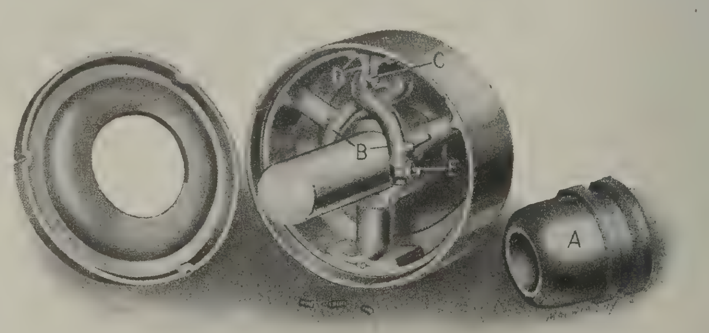


Fig. 2. Interior View of Cleveland Clutch

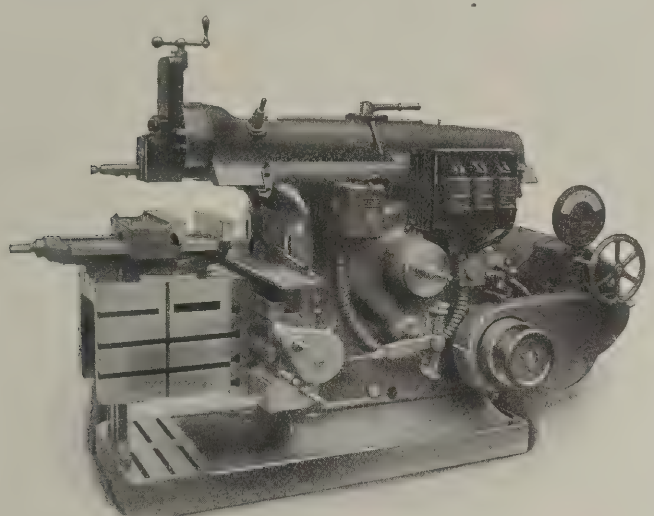
Fig. 2 shows clearly the construction. The spider is keyed to the shaft and the clutch is operated by shifting cone *A*, which engages fingers *B*. The latter are held by a floating center *C*, which causes points *D* to move along the same arc as the friction band. Both casing and spider are made of cast iron. The expansion band is of semi-steel and the fingers are

drop-forgings. The cone is of Bessemer steel and the pins are of casehardened steel.

Provision for easily adjusting the clutches for a given load is made by set-screw and lock-nut *E*. The friction surfaces have metal-to-metal contact and no wood or fiber is used in the construction. A film of oil has to be displaced before the clutch is fully engaged, so that it takes hold gradually but releases instantly. After the clutch is once oiled, it can be operated for months without further attention. It is not affected by centrifugal force and is adapted to either high or low speeds.

GOULD & EBERHARDT 24-INCH SHAPER

Gould & Eberhardt of Newark, N. J., has recently designed a new line of shapers adapted to the heavy work required in steel mills, railroad shops, drop-forging shops, etc. The bull gear of this new design has been raised considerably and it



Gould & Eberhardt Shaper with Variable-speed Motor Drive, Automatic Starter, and Dynamic Brake Control

is a new patented construction. This improved feature is said to greatly increase the mechanical efficiency of the shaper. In addition to this change in the design, there are the following improvements: The outside diameter of the bull gear hub has been increased from 3¾ to 6 inches; there are larger V-bearings, and the gib is so arranged that there is a solid metal-to-metal construction on each side of the ram bearing; the main lever has a solid top; the overhang of the crankpin has been reduced to a minimum; the crankpin thrust is taken by solid walls in the bull gear similar to the ways of the ram; the ratio of the "double-train gear drive" has been increased; the front table support is of heavier design; and the head, ram and frame are of more massive construction.

In the design of the V-gib bearing, which gives a solid metal construction on both sides of the ram, a taper gib is provided having two parts. These can be adjusted independently of each other from the side, near either the front or the back end. This adjustment is in an upward direction between the ram bearing and the solid bearing in the frame, and it is effected by means of set-screws. The arrangement is such that the ram has a solid metal-to-metal bearing for all positions of the adjustable gibs.

In order to determine the relative merits of the V-form of ram, as compared with the square-gib type, a test was made at the University of Michigan with two Gould & Eberhardt shapers, one having the V-ram and the other the square-gib construction. A partial report of this test is as follows:

"The results show the V-form of ram to be superior in all but one of the points investigated. In the horizontal deflections, the square machine has a uniform advantage. In vertical deflections, wear, efficiency and convenience, the V-shaper shows a marked superiority, and it is the author's opinion that a more thorough and exhaustive test would place the V-slide even further in the lead as an accurate, efficient and economical means of transmitting linear motion."

The V-gib of this new shaper has an angle of 55 degrees instead of 45 degrees. This angle was adopted as being better able to withstand the horizontal strains of the ram, without sacrificing the advantages of the V-type bearing for taking the vertical strains. The amount of bearing surface has also been increased in order to further preserve the alignment and accuracy of the ram.

The main lever, instead of having a hole at the top for use when keyseating long shafts, has been made solid to increase the strength, and means are provided for keyseating by placing a hole in one side of the frame, through which shafts up to 3 inches in diameter can be passed. This arrangement is patented. By reconstructing the main bull gear, the overhang of the crankpin, with relation to its distance from the large gear hub bearing in the frame, has been reduced to a minimum. Straps and bolts for holding the crankpin to the large bull gear have been done away with, and solid V-ways similar to the ways of the ram are provided. This forms a solid dovetail bearing for the crankpin, which is superior for taking the strains and thrusts.

The ratio of the double-train gear drive has been increased by giving the shaper a greater initial speed and increasing the ratio of the gearing. This gives more power to the machine when running in single gear or with the back-gear engaged. The ratio of the single gearing is 6.64 to 1; the ratio of the back-gearing, 32.06 to 1.

This shaper weighs 4800 pounds, and is shown in the illustration with a direct-connected, Reliance, variable-speed motor, an automatic starter and dynamic brake control. The horizontal travel of the table is 28¼ inches and the vertical travel, 14 inches. The maximum distance from the ram to the table is 17½ inches and the tool-head has a vertical movement of 8 inches. The vise jaws measure 14½ by 3 inches and the vise has a maximum opening of 16 inches.

NEW BRITAIN AUTOMATIC MULTIPLE SPINDLE CHUCKING MACHINE

The "size 33" automatic multiple spindle chucking machine shown herewith (which is built by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn.) embraces several improvements, and also permits the machining of pieces which heretofore could not be done on this machine. It will be noticed by referring to Fig. 1 that this machine is of the single-head type.

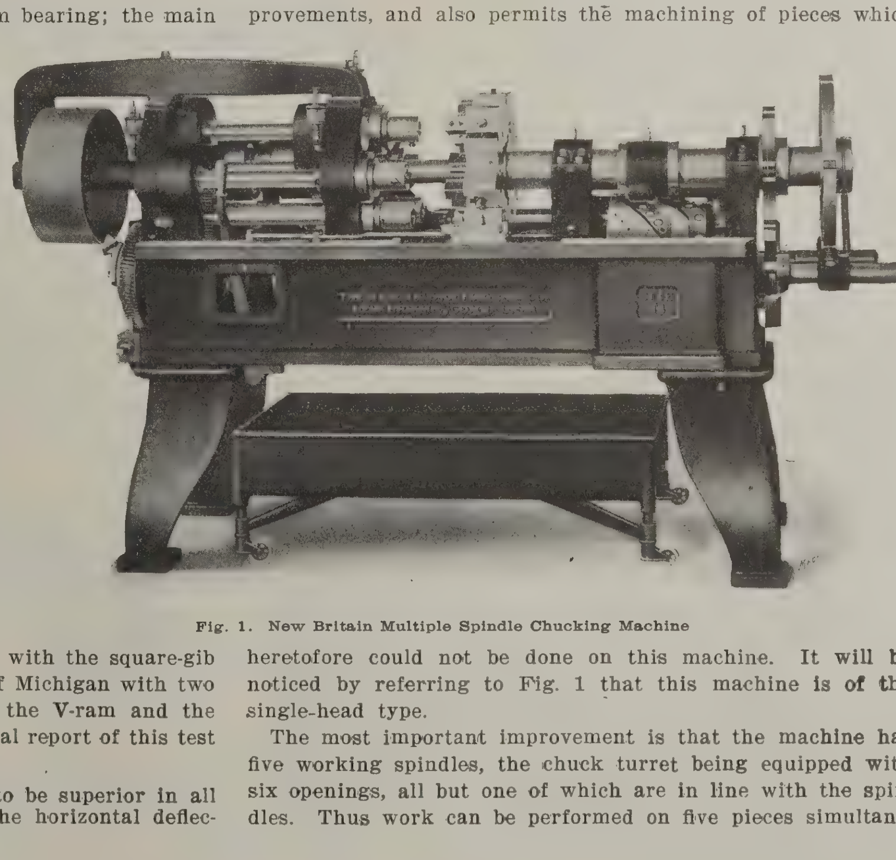


Fig. 1. New Britain Multiple Spindle Chucking Machine

The most important improvement is that the machine has five working spindles, the chuck turret being equipped with six openings, all but one of which are in line with the spindles. Thus work can be performed on five pieces simultane-

ously. If desired, either of the last two spindles can be used plain for reaming, or if fitted with frictions, either or both may be used for threading. As on other machines of this type, the time for completing a piece equals the time required for the longest single operation; and as it is possible to distribute long operations over the different spindles, it will be seen that such operations can be performed in the time required for a comparatively short operation.

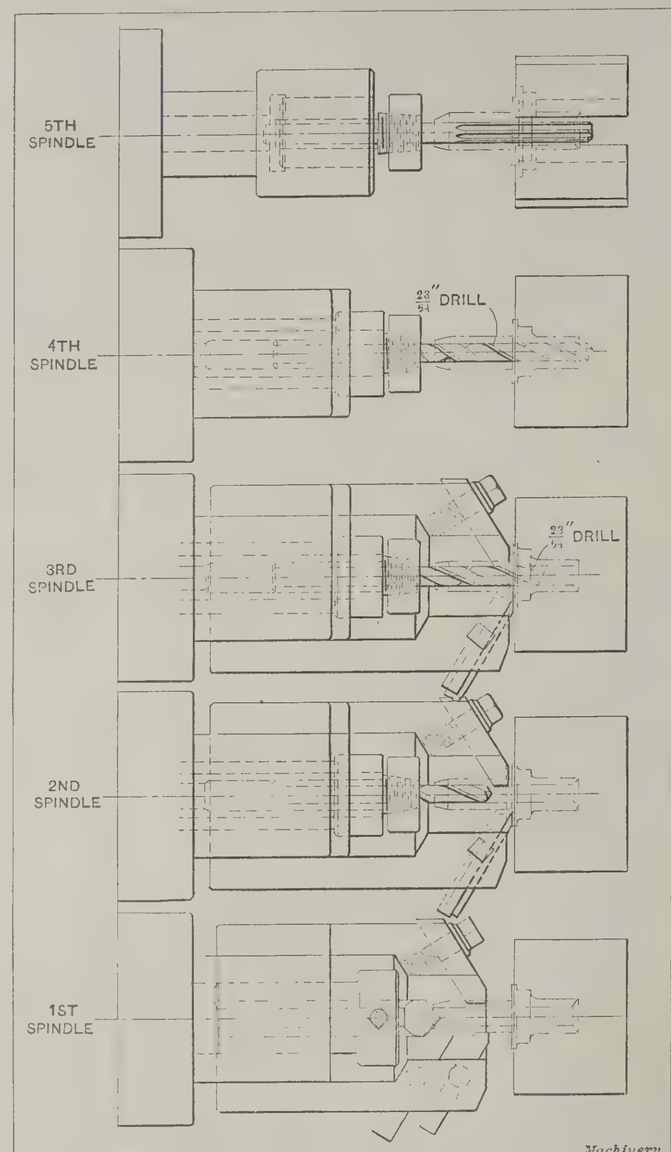


Fig. 2. Example of Work done on New Britain Chucking Machine

On the size 33 machine, an overhead arm has been added which securely ties the two heads together, and, moreover, extends so as to form an outboard bearing for the driving pulley, thus equalizing the belt pull upon both ends of this bearing. It is interesting to note the method used in tying this overhead arm to the two heads, the construction being such that the heads are held rigidly but without subjecting the attaching bolts to a shearing strain. This is done by providing the two bearings of the overhead arm with longitudinal tongues which fit into corresponding slots which have been milled in the two head bearings. In addition, the bolt holes are fitted with hardened steel bushings which extend into the heads and thus protect the attaching bolts from shearing action.

The cam roll yoke which was formerly held in a fixed position on the turret barrel, is now adjustable lengthwise. The yoke runs on a split sleeve which is clamped to the turret barrel by two tangent screws. The advantage of this feature lies in the fact that if it is desired to advance the action of all tools a short distance, it can be done by simply moving the position of the yoke upon the barrel. Formerly it was necessary to move each tool or to change the cam position to secure this result. The size of the turret barrel has been materially increased, thus providing for handling heavier turrets or faceplates with fixtures. The turret bar, or shaft upon which the turret slides as it moves forward, is supported at one end in the head of the machine and at the other in a ground hole in the turret barrel.

A steadyrest of the sliding-key design automatically locks the chuck turret in both directions while the tools are in operation. This steadyrest, which can plainly be seen in Fig. 1, is actuated during indexing by a cam and roll action which is entirely automatic. The faces of the steadyrest are adjustable to compensate for wear, and maintain the accuracy of the machine by supporting the turret chuck near the working position. By supporting the turret at that point, the turret barrel is relieved of all torsional strain and the indexing mechanism from pressure.

The working range of the machine covers pieces requiring a cam stroke of 3¾ inches, and diameters up to 1½ inch can be turned or bored. Larger diameters may be finished when the length of cut is less than the full stroke of the cam.

As an illustration of a typical job which may be handled on the size 33 machine when equipped with high-speed drilling spindles in the No. 2-3-4 spindles, the tool lay-out for a valve stem guide is shown in Fig. 2. These valve stem guides are 3 inches long, the maximum diameter is 1⅜ inch, and they are finished at the rate of 50 per hour. The material is cast iron. It is required to drill and ream a hole 23/64 inch in diameter: chamfer the outside of one end; turn a ⅝-inch diameter for a distance of 1⅜ inch, and face the side of the shoulder adjacent to this turned section. A second chamfering operation is performed on the opposite end of the piece, but this tool lay-out refers simply to the first operation. At the first spindle position, the piece is spot-centered, the end chamfered, and the outside turned for half its length. At the second spindle position, one-third of the length of the hole is drilled, the remainder of the ⅝-inch section is turned and the flange rough-faced. At the third spindle position, another third of the 23/64-inch hole is drilled and the flange is finished-faced. At the fourth spindle position, the remainder of the hole is drilled. At the fifth spindle position, the full length of the hole is reamed thus completing the operations on the piece.

NEW BRITAIN ADJUSTABLE DRAFTING TABLE

The drafting table illustrated herewith is a high-grade design having both vertical and angular adjustments. The front and side views clearly show the construction. The board

New Britain Adjustable Drafting Table

measures 36 by 48 inches and is equipped with a Keuffel & Esser parallel attachment. The board is firmly secured to cast brackets which are pivoted to the vertical supporting mem-

bers. The table is rigidly held in an angular position by tightening the hand lever shown in the view to the right. This lever binds against a segment of the supporting bracket and it is threaded to a long bolt, the head of which clamps the bracket on the opposite side. The table is adjusted vertically by the handwheel shown. This wheel is mounted on a cross shaft having pinions at each end, which engage teeth cut on the supporting legs. This table is a product of the New Britain Machine Co., 64 Bigelow St., New Britain, Conn.

BESLY 53-INCH VERTICAL-SPINDLE DISK GRINDER

A vertical-spindle disk grinder manufactured by Charles H. Besly & Co., Chicago, Ill., is shown in the accompanying illustrations. This machine is intended for "jointing or flatting" such work as stove doors, foundry flasks, meter cases, large gear cases, split shafting bearings, etc., or for other parts which do not have to be ground to a given size or angle. The work is laid on the horizontal disk wheel and is ground by gravity feed. Where work is too light to be ground satisfactorily by its own weight, the practice is to lay on weights. As many parts as the disk wheel will accommodate can be ground simultaneously. As soon as one piece is finished, it is taken off the wheel and immediately replaced by a rough piece. In this way the disk wheel is loaded constantly practically to its limit. When grinding castings for split shaft bearings, as many as thirty five are ground at once, and a laborer attends to the machine.

A hollow exhaust ring extends around the outer edge of the disk wheel for exhausting the grinding dust. This exhaust ring tapers from nothing to about five by five inches at the end where the exhauster is connected. This gradual increase of section is to give a uniform suction all around the disk wheel. The rear view, Fig. 2, shows the exhaust fan and the method of connecting it with the grinder. A removable guard ring which is cast in sections and projects two inches above the grinding face is provided around the disk wheel. This prevents the work from flying off the wheel while being ground, and aids in properly exhausting the grindings. Suitable wooden bars are usually secured to this guard ring as shown, to prevent the work from revolving with the grinding wheel. A section of the exhaust ring twenty-six inches wide, is removable, so that free access may be had to the edge of the disk wheel at this point, for grinding work which may have bosses or lugs projecting beyond the plane of the ground surface. This feature is very desirable, especially on stove work.

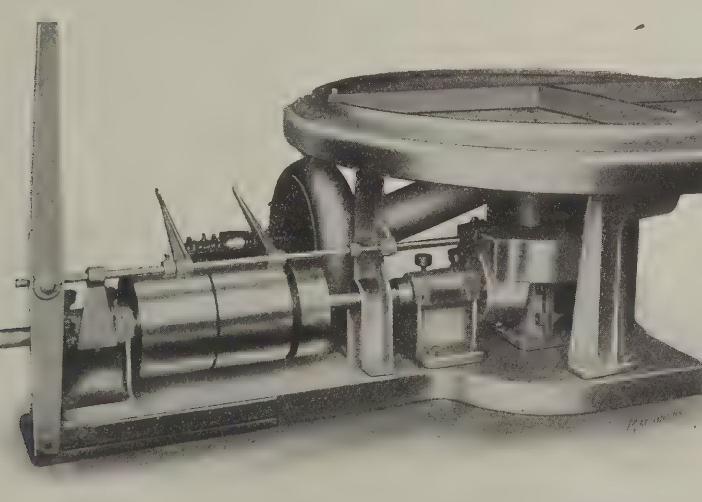


Fig. 1. Besly 53-inch Vertical-spindle Disk Grinder

The disk wheel is of wrought steel, 53 inches diameter by 1¼ inch thick. It is machined on both sides so that both faces of the wheel can be set up with circles. When the circle on one face is worn out, the disk wheel can be turned over and the opposite circle used. The machine is usually furnished with an extra steel disk wheel. A suitable press is also provided so that one wheel can be "set up" while the other is in use on the grinder. In this way the grinder can be operated continuously. The disk wheels weigh 800 pounds each. For convenience in handling, they are drilled and tapped to receive eye-bolts for connecting to a crane or hoist hook. The grinder and press are usually served by a chain hoist suspended from a suitable trolley.

The bevel gears for transmitting power from the horizontal driving shaft to the vertical spindle, are fully enclosed in a cast-iron gear case and run immersed in oil. All bearings are bushed. The tight-and-loose pulleys on the horizontal driving shaft are twelve inches in diameter and take an eight-inch belt. A countershaft is not necessary, as the machine can be driven direct from a lineshaft or motor located above or below it. A suitable pulley for driving the exhauster can be mounted on the horizontal shaft as shown in Fig. 1. The grinder is thirty-four inches high and weighs, complete with two disk wheels and a press, 6000 pounds.

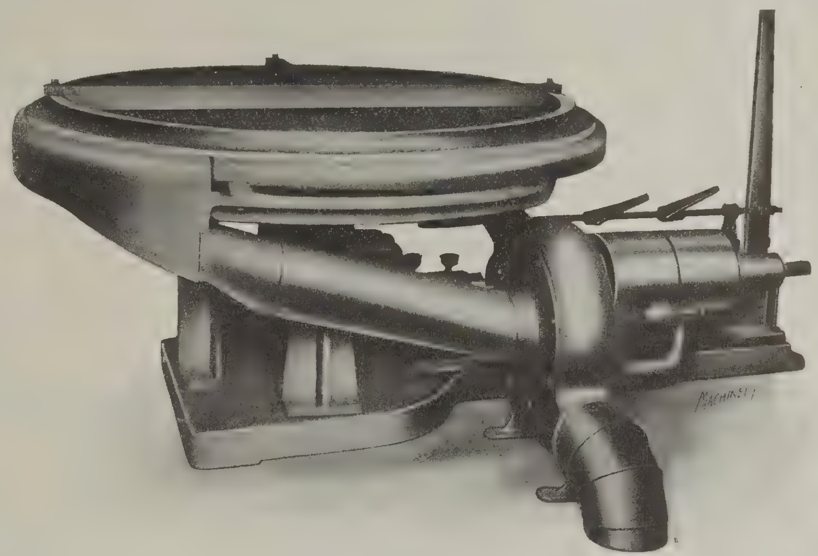


Fig. 2. Rear View of Vertical Disk Grinder, showing Exhaust System

On work for which it is adapted, this grinder is very efficient as is indicated by the following examples. When jointing cast-iron split shaft bearings, this 53-inch grinder does the work six times faster than was accomplished with two milling machines operated by one man. For facing narrow ribs on cast-iron boxes so large that a 53-inch disk wheel accommodates only four boxes at a time, the 53-inch machine does the work twenty times faster than by the profiling process formerly employed. For facing spots on power-pump bedplate castings measuring thirty-three inches by thirty-eight inches and weighing 115 pounds, the vertical disk grinder does the work ten times faster than by the former planing process.

INGERSOLL OPEN-SIDE HORIZONTAL-SPINDLE MILLING MACHINE

The Ingersoll Milling Machine Co., Rockford, Ill., has recently built and installed several open-side horizontal-spindle milling machines of the faceplate drive type. Fig. 2 shows the driving and operating side of this machine, and Fig. 1 is another view showing the machine in operation at the Dean Bros. steam pump works in Indianapolis.

The bed and table of this new design are of the standard planer-type construction. The table has twelve feed changes, and, in addition, a rapid power traverse in either direction, of thirty feet per minute. The feed motion for the table is transmitted through a Sellers rack and worm, the latter being immersed in oil. As the illustration shows, this machine has but

one main upright which is of heavy construction and is further stiffened by the addition of an auxiliary housing placed at right angles.

All the driving and feed gears and also the motor for driving the machine, are assembled upon the main housing. This means that the machine can be entirely controlled from the operator's working position. Perhaps the most interesting mechanical feature of the machine is the saddle. This is an entirely new construction. The main driving gear for the spindle, instead of transmitting the power through the spindle, delivers the full power of the machine directly to the cutter through a hardened steel driving pinion. The function of the spindle, in such a case, is simply that of supporting the driving gear, this being the arrangement when cutters of from 18 to 36

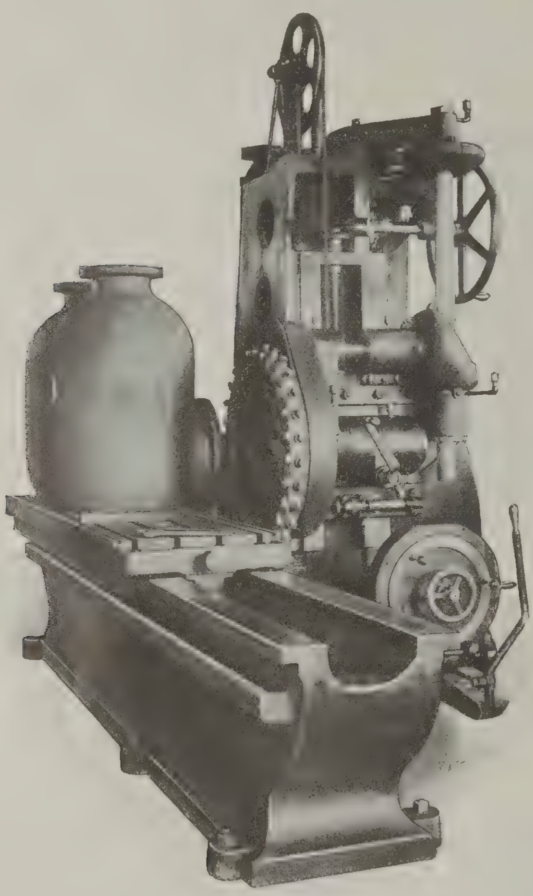


Fig. 1. Ingersoll Machine Milling Flanges of Steam Pump Air Chambers

inches in diameter are used. The cutters of smaller diameter are attached to the spindle by means of a shank and draw-in bolt, and the machine is driven by the main spindle gear.

The saddle has an in-and-out adjustment by hand, and in order to provide a fine adjustment, it is equipped with a patented micrometer stop. This stop gives accurate adjustments for any position within the travel of the saddle, so that cutters as large as 36 inches in diameter can be adjusted to a thousandth of an inch, just as easily as smaller cutters on a small tool-room milling machine.

WINFIELD ELECTRIC WELDING MACHINE

The Winfield Electric Welding Machine Co., of Warren, Ohio, is the manufacturer of the 36-inch spot welder shown herewith. This is a special design particularly adapted to the spot welding of pipe. It has a capacity for stock up to ¼ inch in thickness, and pipes ranging from 3 inches in diameter and up can be welded.

There is a swiveling head and a combination double-pole, non-arcing, automatic switch and circuit cut-out. The one-inch welder points are water cooled. In addition to a hand lever, the machine is equipped with a removable, adjustable foot-treadle having a stop. The transformer has a capacity for 16 kilowatts, and a single-phase alternating current is used. The voltage is regulated by a 10-point, self-contained regulator having an indicating dial at the side of the column, as shown.

Winfield Pipe Spot Welding Machine

This welder has an overhang of 36 inches and a die opening of 3 inches. The distance between the horns is 8 inches. The height from the floor to the center of the dies is 43½ inches. The lower horn is round and has a diameter of 2¾ inches. The welder requires a floor space of 26 by 42 inches, and its net weight is 2100 pounds.

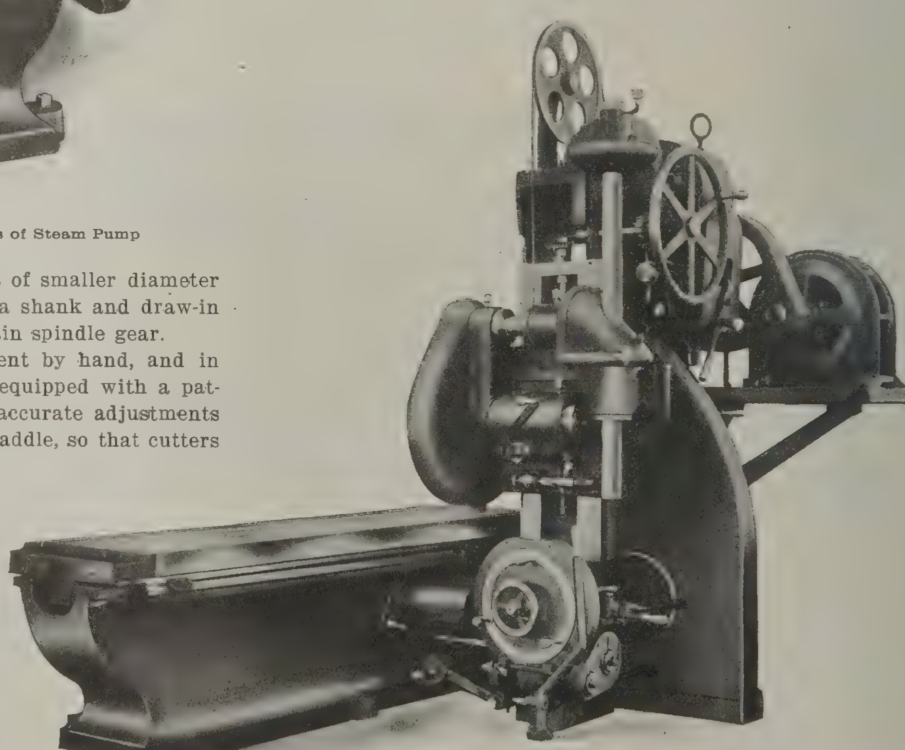


Fig. 2. Ingersoll Open-side Horizontal-spindle Milling Machine

* * *

A hexagon nut should always be used wherever the movement of the wrench is limited.

NEW MACHINERY AND TOOLS NOTES

Die-Stock: J. M. Carpenter Tap & Die Co., Pawtucket, R. I. Die-stock having holes in the handle which act as guides for the work. Twenty-two sizes of dies can be used in one stock.

Spacing Collar: Schuchardt & Schutte, Cedar and West Sts., New York. Adjustable spacing collar intended for spacing straddle mills. It is provided with graduations indicating an endwise movement of 0.002 inch.

Portable Grinder: Chicago Pneumatic Tool Co., Chicago, Ill. Portable pneumatic grinder which weighs 20 pounds and will take an 8 by 1 inch wheel. It is equipped with a grip handle and trigger similar to a pneumatic hammer.

Screw Driver: L. J. Watson, Port Huron, Mich. Screw driver made of spring-tempered steel and having a split end which, when pressed into the slot of a screw, holds the latter firmly while it is being entered into a hole.

Tool-holder: Double Grip Tool Co., Belleville, N. J. Tool-holder in which the cutting tool is held by a set-screw in the usual manner and also by a long gib on the top, which is forced down against the tool by the toolpost screw.

Horizontal Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Special machine for boring chords used in the construction of the new Quebec bridge. These chords have sections as large as 7 feet 10 inches, and weigh from 75 to 100 tons.

Belt Idler: Charles Miller, Industrial Bldg., Syracuse, N. Y. This idler is placed beside the driving pulley and has rollers on its periphery so that the belt can be easily shifted on or off. It is intended for use where a belt is not in continuous operation.

Tool-holder: A. O'Keefe & Sons, 353 Mulberry St., Newark, N. J. Combination tool-holder which will take three sizes of tools made of either round or square stock. The cutting tool can be held straight or tilted to the right or left for angular cutting.

Toolpost Grinder: G. Horvath, 190 Hague Ave., Detroit, Mich. Toolpost grinder consisting of an angle-plate which bolts to the tool-slide and carries the spindle head. The latter has a vertical adjustment, and can be arranged for internal as well as external grinding.

Automatic Planer Stops: Lamb Knitting Machine Co., Chicopee Falls, Mass. Two devices for automatically stopping a planer when the tool has reached a predetermined point. One stop operates by disengaging the feed gear, whereas the other shifts the belt on the countershaft.

Saw Sharpening Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Automatic saw sharpening machine designed for either solid or inserted-tooth saw blades. The latter type are ground with the teeth in the blades, and the machine is so arranged that the rake of the teeth can be varied to suit conditions.

Multiple-Spindle Drilling Machine: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. Multiple-spindle drilling machine designed for drilling bolt holes in steel-tired car wheels. This is an all-geared machine, power being transmitted from the main spindle of the drill through bevel gearing and shafts, instead of universal joints. There are twelve spindles each capable of driving a 1½-inch drill.

Convertible Open-side Planer: Detrick & Harvey Machine Co., Baltimore, Md. Open-side planing machine which may be converted into a double-housing type. The auxiliary housing is attached to the base and also at the cross-rail end by heavy bolts, and it is further secured by pockets in the base and rail end. The auxiliary housing can be quickly removed for work that cannot pass between the two housings.

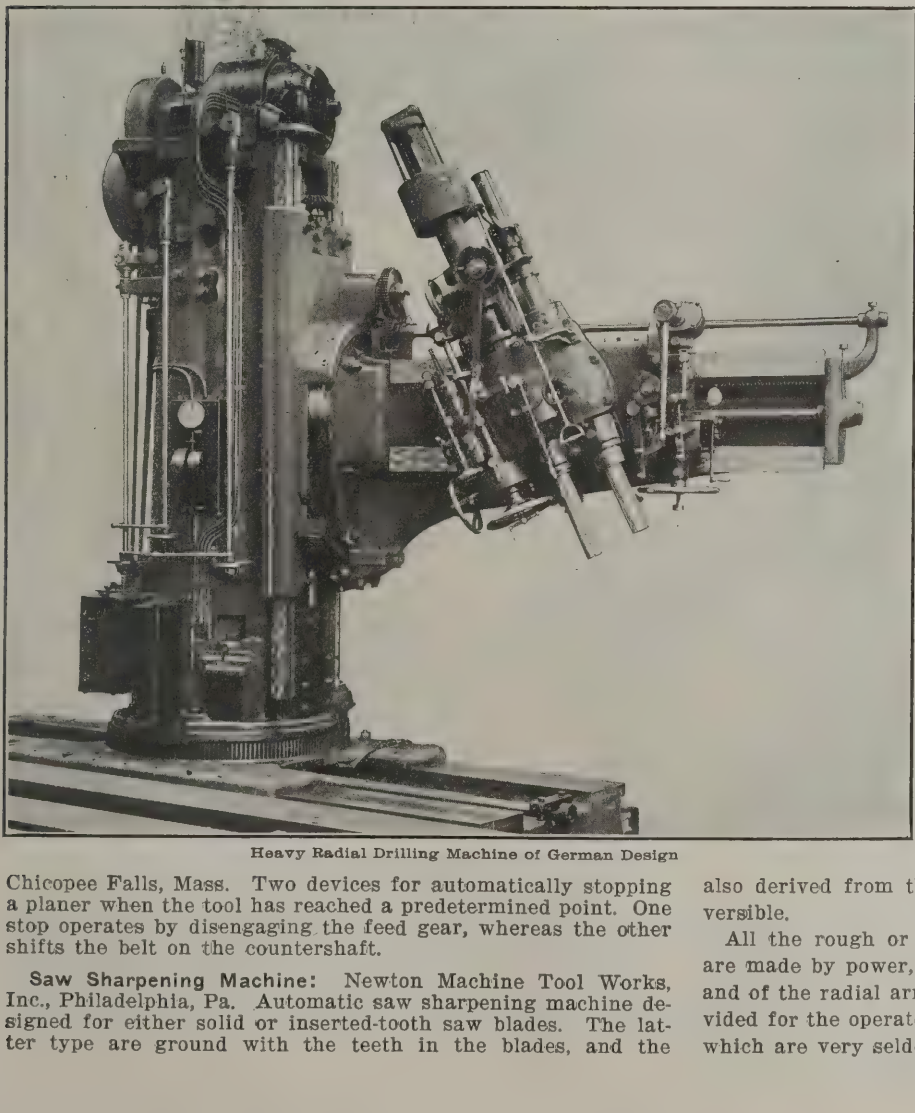
Screw-Plate: A. J. Smart Mfg. Co., Greenfield, Mass. A compact screw-plate which is only about half the size of an ordinary screw-plate of the same capacity. It is known as No. X5 and cuts threads 1/8, 5/32, 3/16, 7/32 and 1/4 inch in diameter. The stock is 5 inches long, and round adjustable dies ⅝ inch in diameter are used. A tap wrench fits into the die-stock, and the entire outfit with a set of plug taps is contained in a neat and compact box.

Cylindrical Boring Machine: Automatic Machine Co., Bridgeport, Conn. Four-spindle vertical boring machine for boring and facing engine cylinders and similar work, ranging from 4 to 10 inches in diameter and having a maximum depth of 24 inches. The time required for boring and facing a cylinder 7½ inches in diameter and 18 inches deep is 1½ hour, but with the four spindles, all of which are in operation part of the time, the actual time per cylinder is less than thirty minutes. The boring is done in four operations, including a roughing cut, a semi-finishing cut and two finishing cuts. This machine was designed for boring cylinders with such precision that grinding would be unnecessary, and also to insure economical production by utilizing the entire time of one operator with a single machine.

* * *

RADIAL DRILLING MACHINE OF GERMAN DESIGN

The accompanying illustration shows a large radial drilling machine built by the firm of Ernst Schiess of Düsseldorf, Germany. It differs in its design considerably from the conventional type of radial drilling machine, it being entirely universal and provided with every possible adjustment; nevertheless, all the operating handwheels and levers remain close to the operator at all times. The main column is mounted on a large base-plate which is provided with ways, about 18 feet in length, on which the column can slide back and forth, this movement being actuated by an electric motor. The inner column of the upright is fixed on the slide and provided with a large spur gear at the bottom which is used for turning the whole machine around. The power for this movement is derived from the main shaft in the horizontal arm. This construction makes it possible to swing the arm through a full circle of 360 degrees.



Heavy Radial Drilling Machine of German Design

An electric motor of 18 horsepower is placed on the top of the upright. This motor is of the variable speed type (400-1200 R.P.M.), the current being carried through a sliding contact in the base-plate. The motor drives, through suitable gearing, a vertical shaft, which, in turn, transmits power to the horizontal shaft located on the arm, both shafts being provided with keyways for their full length. The vertical movement of the slide carrying the radial arm is also derived from the main vertical shaft. The motor is reversible.

All the rough or approximate adjustments of the machine are made by power, while the fine adjustments of the spindle and of the radial arm are made by handwheels and levers provided for the operator on the spindle head. Some adjustments which are very seldom required, like the swinging of the arm

from the vertical plane, or swiveling of the spindle head itself, are effected only by hand through worm and worm-gears.

The spindle is 4 5/16 inches in diameter. From the main spindle a secondary spindle is driven by spur gearing. This is used only for thread cutting. A lever in the front is provided for reversing the motion of this second spindle. The feed is provided for by a gear box giving eight changes. In addition to the power arrangement for swinging the arm around the column, a pawl and ratchet construction is used for obtaining a fine adjustment of the arm. The machine is capable of drilling holes and cutting threads up to 4 inches in diameter in armor plate, using high-speed steel drills. The spindle makes from 2 to 72 revolutions per minute, and the feed varies from 0.0035 to 0.040 inch per revolution of the spindle.

The general dimensions of the machine are as follows: The horizontal movement of the upright along the baseplate, 9 feet 10 inches; maximum height of lower end of spindle over bed, 7 feet 6 inches; minimum height of lower end of spindle, 3 feet 11 inches; maximum distance of spindle from axis of column, 10 feet 4 inches; vertical movement of drill spindle, 22 inches; vertical movement of thread-cutting spindle, 9 inches; distance between spindles, 12 inches; total weight of machine, 45 tons.

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WATSON-STILLMAN CAR COUPLER SHEARING AND RIVETING PRESS

The hydraulic shearing and riveting press shown in Figs. 1 and 2 has been designed by the Watson-Stillman Co., 192

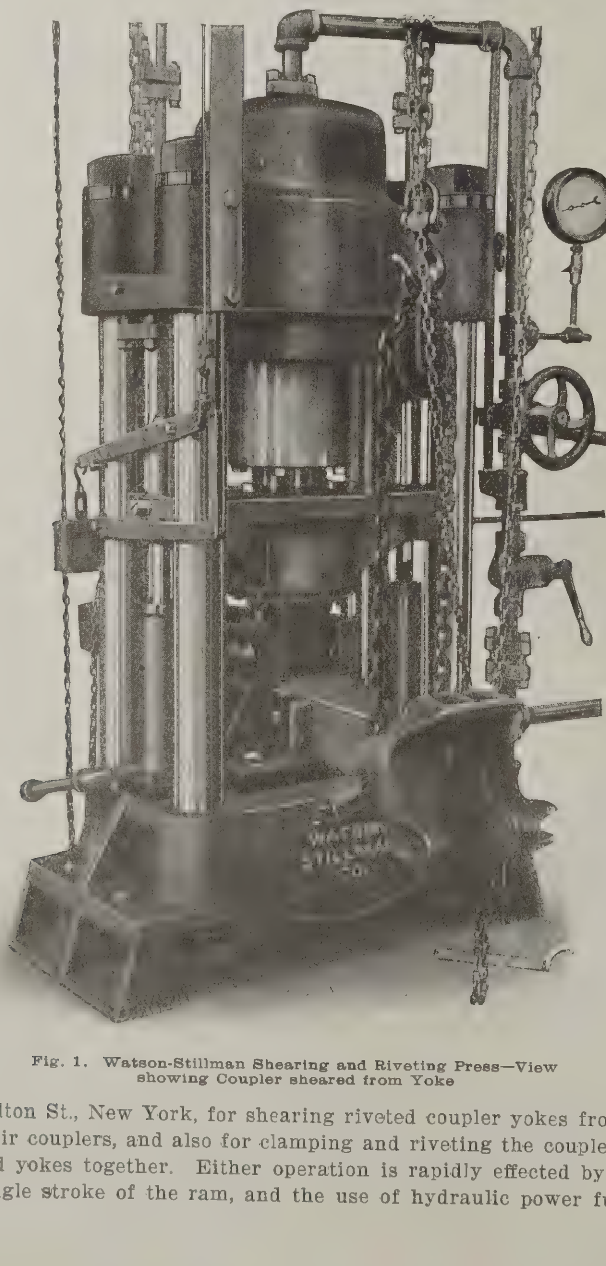


Fig. 1. Watson-Stillman Shearing and Riveting Press—View showing Coupler sheared from Yoke

Fulton St., New York, for shearing riveted coupler yokes from their couplers, and also for clamping and riveting the couplers and yokes together. Either operation is rapidly effected by a single stroke of the ram, and the use of hydraulic power further tends toward economy, as compared with the common practice of doing this work by hand and the pneumatic hammer.

In the operation of the press, the coupler is first sheared from its yoke. The yoke is placed upon supporting blocks which the coupler shank clears, and the ram descends upon the coupler shank, thus forcing it downward and shearing both ends of the rivets. Fig. 1 shows the position of the coupler and yoke after the shearing operation is completed.

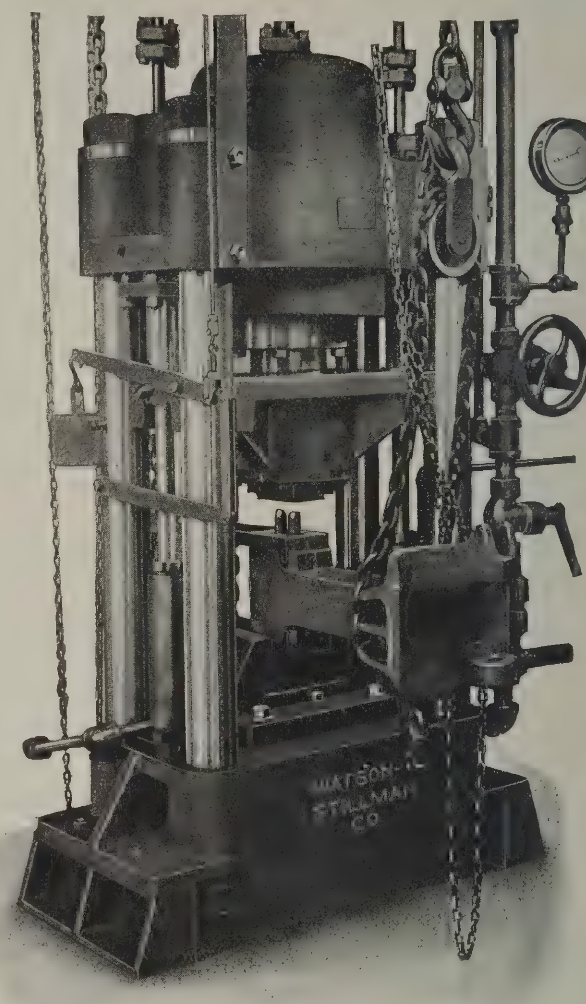


Fig. 2. Coupler and Yoke ready for Riveting

This view also indicates the method of handling the separated parts. Fig. 2 shows the coupler with the yoke and rivets attached and everything in readiness for heading the rivets. The main ram and clamping rams start downward simultaneously, the small rams first clamping the yoke to the coupler shank. The riveting die which is attached to the large ram, then descends upon the rivets and heads them.

This press is built with heavily-ribbed platens and has plenty of room for removing and replacing the work. There are two "push-back" rams for quickly and automatically returning the large ram. The diameter of the main ram is 12 inches and the stroke, 6 inches. The clamping cylinders have 3-inch rams with a 6½-inch stroke, and the push-back cylinders have 1¾-inch rams. The overall height of the press is 6 feet 8 inches; the complete weight 7858 pounds, and the capacity, 200 tons.

* * *

PERSONALS

William L. Wardleigh, formerly superintendent of the Baush Machine Tool Co., Springfield, Mass., is now superintendent of the Electric Goods Mfg. Co., Canton, Ohio.

Lieut.-Col. William S. Peirce of the ordnance department at Washington, D. C., has been appointed commandant of the U. S. Army at Springfield, Mass. Col. Peirce assumes his new duties in September. He succeeds Col. Stanhope E. Blunt.

A. M. Powell, president of the Powell Machine Co., Fitchburg, Mass., left August 6 on the *Franconia* of the Cunard Line from Boston, for an extended trip abroad in the interests of his company, and for the demonstration of the Powell patent high-speed planer.

Albert S. Smith, president of the Smith & Mills Co., Cincinnati, Ohio, shaper manufacturer, returned August 24, having made a trip around the world. Mrs. Smith accompanied him.

Adolph O. Krieger has resigned his position as publicity manager of the Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., with which he had been connected for a number of years, and has opened an office at 916 Victoria Bldg., St. Louis, for the sale of the Tacchella oil burning device.

C. J. Nyquist, superintendent of the Davis-Bournonville Co., was given a dinner by the New York officers and members of the sales force, and employes of the Jersey City shops, at Myers Hotel in Hoboken, July 17, Mr. Nyquist having returned from abroad the previous day. His trip abroad was made in the interests of his employers. He visited several cities in Germany, Denmark and France, investigating the progress being made in oxy-acetylene welding.

* * *

OBITUARIES

Harold R. Walker, secretary of the Union Caliper Co., Orange, Mass., died at his home, July 24.

Emil Von Wyck, of the Von Wyck Machine Tool Co., Cincinnati, Ohio, died suddenly in his office, July 11, aged forty-seven years.

Baxter B. Noyes, senior member of the firm of B. B. Noyes & Son, Greenfield, Mass., manufacturers of hardware specialties, small tools, blacksmiths' machinery and iron castings, died July 22, aged sixty-eight years, as the result of an accident, Mr. Noyes having fallen from a staging in the factory.

Joseph LeConte Davis, engineer in charge of design of direct-current railway type motors in the electric railway department of the Westinghouse Electric & Mfg. Co., recently deceased, was a graduate from the University of South Carolina in 1897 with the degree of electrical engineer. He was professor of physics at Bingham Academy High School, North Carolina from 1897 to 1900, and in 1904 was employed by the General Electric Co., Schenectady, N. Y. He was also at one time in charge of the developments of the National Electric Signalling Co., which embraces the Fessenden wireless system. Since 1904 Mr. Davis was with the Westinghouse Electric & Mfg. Co. He was regarded as one of the brightest and most promising of the younger electrical engineers of the present day. His work in connection with the design of the direct-current motors used on the Pennsylvania terminal electrification in Greater New York and many other large installations brought him into prominence before the electrical profession.

Charles A. Haney, vice-president and general manager of the Sloan & Chace Mfg. Co., Ltd., Newark, N. J., died after a brief illness August 10. Mr. Haney was born in Brooklyn, N. Y., July 27, 1867. He started to learn his trade with George Griswold, New Haven, Conn., at the age of fourteen years. From this time and until he became connected with the Sloan & Chace Mfg. Co. he was employed by a number of different manufacturing concerns as toolmaker, foreman and assistant superintendent. Among these concerns may be mentioned the Yost Typewriter Co., Bridgeport, Conn., the Mergenthaler Linotype Co., Brooklyn, N. Y., and the S. S. White Dental Mfg. Co., Staten Island, N. Y. At one time he was employed by Thomas A. Edison on making the early models of the phonograph. In 1902 he became general manager, vice-president and principal owner of the stock of the Sloan & Chace Mfg. Co. Through Mr. Haney's efforts and untiring energy the plant of this company was remodeled, new machinery replacing the older types, and the business grew considerably in volume, necessitating, in 1906, new and more spacious quarters. Mr. Haney was the inventor of a cyclometer and a typographical numbering machine. His unusually varied experience enabled him to successfully handle all kinds of mechanical problems. He was a member of the National Metal Trades Association, the National Machine Tool Builders' Association, and the Newark Board of Trade, as well as of a number of other organizations. He is survived by a wife and two children.

* * *

COMING EVENTS

September 2-7—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 9-11.—Ninety-third meeting of the National Association of Cotton Manufacturers at the Griswold, Eastern Point, New London, Conn. C. J. H. Woodbury, secretary, Boston, Mass.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

September 30-October 4.—Autumn meeting of the Iron and Steel Institute at Leeds, England. G. C. Lloyd, secretary, 28 Victoria St., London.

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

October 16-18—Annual convention of the National Machine Tool Builders' Association in New York; headquarters, Hotel Astor. James H. Herron, general manager, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

NEWBERRY COLLEGE, Newberry, S. C. Catalogue for 1911-1912, containing 80 pages, 6 by 9 inches, of information relating to the departments and courses of instruction of the college. The catalogue is illustrated with a number of halftones showing the various buildings, as well as interior views.

AMERICAN SOCIETY OF SWEDISH ENGINEERS, 271 Hick St., Brooklyn, N. Y., announces two lectures for its meetings during September. On Sept. 7 at 8:30 P. M., Mr. L. Pelletier, advertising representative of MACHINERY, will speak on "Advertising in Its Relation to Engineering." On September 21, Mr. C. J. Nyquist, superintendent of the Davis-Bournonville Co., will speak on "Oxy-Acetylene Welding and Its Applications." Mr. Nyquist will be assisted by a demonstrator who will show the oxy-acetylene welding and cutting apparatus in action.

NATIONAL METAL TRADES ASSOCIATION, New England Bldg., Cleveland, Ohio. Pamphlet entitled "Industrial Betterment Activities of the National Metal Trades Association." The pamphlet outlines the history of the society and its constructive activities along the lines of industrial education, apprenticeship systems, cooperative profit-sharing plans, safety appliances, hygiene and sanitation, systematic compensation for industrial accidents, legislation, extension of transportation facilities and local branches and employment bureaus. It should be of interest to manufacturers generally, whether members of the association or not.

IOWA STATE COLLEGE, Ames, Iowa, announces that two new scholarships have been established in agricultural engineering, one being founded by the M. Rumely Co., of Laporte, Ind., and the other by the International Harvester Co., of Chicago, Ill. These scholarships are intended for young men qualified to do special research work along the lines of agricultural engineering, and amount to $250 a year each. They were established at the Iowa State College on account of the fact that this college was the first to institute a four-year course in agricultural engineering, and because instruction in this branch of engineering has been most highly developed at this college.

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN, 116 Nassau St., New York, held its regular monthly meeting in the Engineering Societies Building, Thursday, August 15. A paper was read by Mr. W. T. Walters of Chicago, on "Safety Devices—Their Application and Design." Prof. Charles W. Weick of Columbia University spoke on "Practical Perspective," and the question of whether to place dimension figures on drawings perpendicular to the bottom of the drawing or perpendicular to the dimension line was discussed. The general opinion seemed to be that the figures should be placed perpendicular to the dimension line. The American Museum of Safety, which adjoins the society's meeting room, was thrown open for the evening to members and visitors, and an opportunity was afforded to inspect the collection of the museum.

NEW BOOKS AND PAMPHLETS

REPORT OF THE COMMISSIONER OF EDUCATION FOR THE YEAR ENDED JUNE 30, 1911. Volume II. 1407 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

THE PHYSICAL TESTING OF ROCK FOR ROAD BUILDING. By Albert T. Goldbeck and Frank H. Jackson. 96 pages, 6 by 9 inches. Published by the U. S. Department of Agriculture, Washington, D. C.

RAILROAD OPERATING COSTS. By Suffern & Son. Volume II. 144 pages, 8 by 11 inches. Published by Suffern & Sons, New York. Price $2.

This volume includes the reports on the operations of railways for 1911, and comprises a continuation of studies in operating costs of the leading American railroads, undertaken by the authors. The book is divided into eight chapters, of which the first is of a general introductory character; the second deals with the maintenance of way and structures; the third with maintenance of equipment; the fourth with freight car maintenance; the fifth with locomotive maintenance; the sixth with passenger car maintenance; the seventh with transportation expenses; and the eighth with fuel. The last chapter gives exhaustive information about the cost and amount of fuel required under various conditions.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES. 1574 pages, 7½ by 10 inches. Published by S. E. Hendricks Co., New York. Price, $10.

This is the twenty-first annual edition of this most useful book for buyers and sellers in the architectural, mechanical engineering, contracting, electrical, railroad, iron, steel, hardware, mining, milling, quarrying, exporting and kindred industries. The aim of the book is to furnish a complete classification list of manufacturers of various products for the benefit of those who want to buy as well as for those who want to sell. It contains over 350,000 names and addresses of manufacturers and dealers, arranged under nearly 40,000 business classifications. One of the main features of this book is the complete index of classifications included, which covers 122 pages with about 350 classifications on each page. The most important and valuable feature of this commercial register, outside of its unusual completeness, is the simplicity of its classifications, making it possible to locate a manufacturer of any product very quickly. Another valuable feature is that the trade names of all articles classified in the book have been included as far as it has been possible to secure them. These trade names appear in parentheses between the names and addresses of the manufacturers under the classifications where they appear. The new edition has been considerably enlarged, an addition of 155 pages having been made. As there are 230 pages of concellations, etc., omitted from the present edition, there is a total of 385 pages of new matter. The book should prove very useful to any business firm who has dealings with manufacturers or dealers in any of the lines mentioned above.

NEW CATALOGUES AND CIRCULARS

STANDARD MFG. CO., Bridgeport, Conn., manufacturer of gear cutting machines, has issued a new catalogue.

EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Bulletin No. 3711 on laboratory lathes for alternating and direct currents.

TEMCO ELECTRIC MOTOR CO., 99 Sugar St., Leipsic, Ohio. Folder showing applications of the Temco portable electric drill.

L. S. STARRETT CO., Athol, Mass. Booklet descriptive of the Chicago store of the L. S. Starrett Co., illustrated with halftones.

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y. Catalogue describing large photomicrographic apparatus for laboratory work.

BOSCH MAGNETO CO., 223-225 W. 46th St., New York. Catalogue describing the Bosch magneto ignition for one-cylinder motor-cycles.

CONTENTS FOR SEPTEMBER

The first column of page numbers applies to the Engineering and Railway Editions; the second to the Shop Edition.

Kerr Turbine Co., Wellsville, N. Y. Bulletin No. 26 describing the "Economy" steam turbine. Steam consumption curves are shown and size comparisons made.

Fulton Machine & Vise Co., Lowville, N. Y. 1912 catalogue of vises and centrifugal pumps. The catalogue illustrates and describes the Star, Peerless, F. & R., and Fulton types of vises.

Beaudry & Co., 141 Milk St., Boston, Mass. Catalogue of "Beaudry" power hammers comprising the Beaudry Champion, 50- to 500-pound rams, and the Beaudry Peerless, 25- to 200-pound ram.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York. Bulletin No. 902 describing and illustrating Sprague electric grab-bucket cranes, and showing examples of their use.

Gould & Eberhardt, Newark, N. J. Circular illustrating and describing the "Invincible Type" 24 inch shaper, designed to take care of extra heavy work required in steel mills, railroad shops and drop forging die shops.

American Stoker Co., 11 Broadway, New York. Bulletin B-1, entitled "The Class 'E' Stoker," illustrating and describing in detail the devices made by the company for obtaining high efficiency in the burning of coal.

Triumph Electric Co., Cincinnati, Ohio. Bulletin No. 491, describing direct-current steel frame motors. The construction of the various parts is shown in detail, and instructions for starting and operating electric motors are given.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 153 on direct-current lighting and power generators from 200 to 1500 kilowatts; Bulletin No. 154 on oil insulated, self-cooled and water-cooled power transformers from 50 to 5000 KVA.

Gilbert & Barker Mfg. Co., Springfield, Mass. Catalogue B of gas furnaces, showing various types of furnaces built by the company, and giving information regarding the work for which they are adapted and tables of dimensions and capacities.

Autogenous Welding Equipment Co., 41 Bay St., Springfield, Mass. Circular containing a reprint from *The Locomotive* of an article entitled "Autogenous Welding for Repairing Boilers," together with additional material on autogenous welding.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 149, illustrating and describing direct-current motors and generators of 50 horsepower and larger. Details of the magnet frame, bearing brackets, armature laminations, armature and armature core are shown.

Fort Wayne Engineering & Mfg. Co., Fort Wayne, Ind. Catalogue No. 2022 illustrating and describing the "Paul" non-storage system of water supply, pumping water direct from well; Catalogue No. 2023 on "Paul" pneumatic systems of water supply.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin G-5 on Standard high-power small portable electric grinders, including tool-post electric grinders, parallel grinders and bench grinders; Bulletin No. D-6 of Standard high-power ball-bearing electric drills.

American Blower Co., Detroit, Mich. Bulletin No. 324, "The 'A B C' High-pressure Exhaust Fan, Type P"; Bulletin No. 344, "The 'A B C' Cast-iron Blowers and Exhaust Fans, Type V"; Bulletin No. 347, "Unit Heaters," adapted to all types of factory buildings.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 67 of differential recording gages. The bulletin shows the application of the instrument to boilers; reproductions of records made by it are included, as well as a table giving general dimensions of the device.

General Electric Co., Schenectady, N. Y. Lithographic poster in colors showing, full size, all the Edison "Mazda" lamps made by the company. The "Mazda" lamps range in capacity from 5 watts (for signs) to 500 watts (used for street lighting, railway terminals, etc.).

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Data sheets: No. 47A, Thrust Collar Bearings; No. 59A, Driving Clutch Thrust Bearings; No. 82, Ball Bearings in Horse Vehicles; Nos. 83, 84 and 85, Ball Bearing Mountings for Vertical Armature Shafts of Electric Motors.

A. J. Kelting Engineering Works, 459 Carroll St., Brooklyn, N. Y. Catalogue entitled "Positive Pressure Blowers," containing a comparison of the different methods of moving air for high, low and intermediate pressures, and a complete description of the Kelting pressure blowers.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 87 describing and illustrating hydraulic coupler yoke shearing and riveting press. This type of machine shears riveted coupler yokes from their couplers or clamps and rivets the couplers and yokes together with a single stroke of the ram.

Dayton Pump & Mfg. Co., Dayton, Ohio. Bulletin No. 15 illustrating and describing duplex double-acting power pumps and water supply systems for service conditions where the vertical suction lift does not exceed twenty feet. These pumps are built in twelve sizes, with capacities from 3 to 60 gallons per minute.

Eugene Dietzgen Co., 214-220 E. 23rd St., New York. Circular of the "Premier" ellipsograph for drawing ellipses and circles. The instrument is adapted for either pen or pencil work and is useful for draftsmen on cams, wheel spokes, apertures, projections, etc.; also circular of the "Dietzgen" fountain ruling pen.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 8007 illustrating and describing "Little David" pneumatic drills adapted for general drilling, reaming, tapping, flue rolling and wood boring. Illustrations showing the valve action of the drill are included, as well as several halftone illustrations showing the drill in actual use.

Winter Bros. Co., Wrentham, Mass. Catalogue No. 7 of high-speed steel taps and dies. This catalogue contains, in addition to price lists of taps and dies, considerable valuable information relating to tapping and threading, brief, concise paragraphs on such subjects as the size of taps, lead, speed of operation, lubrication, form of cutting edges, etc., being included.

Bullard Machine Tool Co., Bridgeport, Conn. Circular V-21 illustrating and describing the turret head of the Bullard vertical turret lathe. The illustrations show the construction of the turret in detail, giving the names of the various parts and describing the features of the new turret design and its advantages. An interesting record of tests for the accuracy of indexing and registry is included.

Gould & Eberhardt, Newark, N. J. Catalogue of high-duty automatic gear hobbing machines for spur, helical and worm gears. This catalogue contains a complete description of the design and operation of the Gould & Eberhardt automatic gear hobbing machines, as well as illustrations and specifications of the four sizes of machines built, ranging from 12 by 10 inches to 36 by 14 inches capacity.

E. Horton & Son Co., Windsor Locks, Conn. 1912 catalogue of lathe chucks, faceplate jaws, and drill chucks. This catalogue contains illustrations and descriptions of all the chucks designed and made by the S. E. Horton Machine Co., and the E. Horton & Son Co., which are now made by the consolidated company known by the latter name. The catalogue covers a wide line of independent, universal and combination chucks, two jaw chucks, drill chucks, and planer chucks.

Cleveland Hardware Co., Cleveland, Ohio. Safety poster in English and German illustrating hospital room, caring for an emergency case, safety device for trimming presses, danger from carelessly operated trucks, lineshaft dangers; danger to female operators running drill presses, etc. The poster carries blanks to be torn off and filled out by employes whenever defects in machinery or conditions injurious to health are noted; also reports of accidents when workmen are injured.

Ingersoll-Rand Co., 11 Broadway, New York. Catalogue form 75 entitled "Water Lifted by Compressed Air." During recent years considerable progress has been made in the development of compressed air pumping apparatus. The air lift has been found especially useful for asylums, hospitals, plantations, railway water tanks, etc. The catalogue describes the various methods employed for utilizing air for lifting water, and gives figures showing cost of operation of various installations.

New Britain Machine Co., 64 Bigelow St., New Britain, Conn. Catalogue of multiple-spindle automatic chucking machines. This catalogue contains 38 pages, 9 by 12 inches, describing in detail the main features of the New Britain automatic multiple-spindle chucking machines. It is profusely illustrated with both halftones and line engravings and contains specifications and tables of capacities of the various sizes of these machines, as well as illustrations of the work for which these machines are peculiarly adapted.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., Circular No. 1516 illustrating and describing Baldwin-Westinghouse electric locomotives; Circular No. 1524 describing switchboard indicating meters; Leaflet No. 2494 describing synchronous booster rotary converters; Leaflet No. 2499 describing commutating-pole direct-current motors; Leaflet No. 2480 containing rules for the selection of machine tool motors; Leaflet No. 3505, on motors for paper mill service; Leaflets Nos. 2465 to 2471, on various kinds and types of meters.

Whitman & Barnes Mfg. Co., Akron, Ohio. Catalogue No. 82 of twist drills, reamers, drop-forged and screw wrenches, spring cotters, flat spring and riveted keys and drill chucks. This catalogue comprises 170 pages, 6 by 9 inches, and covers completely the extensive

line of machinists' supplies manufactured by the company. Directions for drill grinding are included, as well as a number of useful tables giving speed and feed of carbon and high-speed steel drills, etc. A novel feature of the catalogue is that the prices of carbon and high-speed steel drills are given side by side on the same page, the latter being printed in red.

NEWTON MACHINE TOOL WORKS, INC., 24th and Vine Sts, Philadelphia, Pa. Catalogue No. 47 of cold saw cutting-off machines. This catalogue comprises 95 pages, 6 by 9 inches, devoted exclusively to cold saw cutting-off machines. In addition, a number of pages are inserted showing halftone illustrations of other lines of machine tools built by this company. The catalogue contains information relating to cutting compounds to be used with the machines described, and on the speed and feed to be used for various materials. The types of machines illustrated and described are as follows: Bar type saw; I-beam saws; internal cold saw cutting-off machines: combination type saw; crankshaft saw; girder rail saw; duplex type saw; steel foundry type saw; armor plate saw; and multiple cold saw cutting-off machines. In addition, the catalogue illustrates independent and automatic saw sharpening machines.

TRADE NOTES

AMERICAN EMERY WHEEL WORKS, Providence, R. I. Program of the second annual outing of the employes, held at Emery Park, Auburn, R. I., Saturday, June 22.

WELLS BROS. CO., and WILEY & RUSSELL MFG. CO., Greenfield, Mass. Program of the first annual field day of the employes of these two companies at Island Park, Brattleboro, Vt., Saturday, August 3.

Gisholt Grinder is the name of a publication issued by the employes of the Gisholt Machine Co., Madison, Wis. It is published and edited entirely by the employes of the company, and contains personal items and announcements of interest to those connected with the concern.

J. N. LAPOINTE CO., Marlboro, Mass., builder of broaching machinery, will move to New London, Conn., on October 1. A factory of concrete and brick construction, two stories high, with an ell extension, which will provide a total floor space of 20,000 square feet, is now being built.

VULCAN ENGINEERING SALES CO., Chicago, Ill., has taken the selling agency for the line of structural and plate working machinery, punches, shears, rolls, bulldozers, etc., manufactured by the Rock River Machine Co., Janesville, Wis. In addition to this line, the Vulcan Engineering Sales Co. now controls the product of the Hanna Molding Machine Works, the Mumford Molding Machine Co., and the Q. M. S. Co.

NEW DEPARTURE MFG. CO., Bristol, Conn., is building additions to its factory, which will increase the present floor space by nearly 75,000 square feet. The new additions will be available for use late in the fall of the present year. This increase in manufacturing facilities has been necessitated by the fact that the plant is at present running 127 hours a week in all departments and 152 hours a week in some departments, in order to meet the demands of the market.

DAVIS-BOURNONVILLE CO., 97 West St., New York, used oxy-acetylene cutting torches for cutting away the wrecked steel in the crushed bow of the Fall River Line steamship *Commonwealth*, which has been in dry dock at Hoboken since her recent collision with the United States battleship *New Hampshire* in Long Island Sound. The cutting required the time of several operators for two days but the oxy-acetylene torches made short work of what would otherwise have been a much more difficult task.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

OCTOBER, 1912

SETTING THE WALSCHAERTS VALVE GEAR*†

PRACTICE IN ERECTING DEPARTMENT OF BALDWIN LOCOMOTIVE WORKS

THE advantages of the Walschaerts valve gear, as compared with the Stephenson link motion, are familiar to railway machinists, but comparatively few understand how the Walschaerts gear is set. This may be due to the fact that this gear does not need to be adjusted very often, because it is constructed to "stay put" when the locomotive is assembled, and the shop men have little to do with it afterwards. Furthermore, comparatively little has been written on this type of valve gear, whereas countless articles and many books have been published on the Stephenson motion. This article explains briefly the practice followed at the Baldwin Locomotive Works in setting the Walschaerts gear.

The complete mechanism consists of the following parts: Valve *A*; valve stem *B*; combining lever *C*; crosshead link *D*; radius-rod *E*; reverse shaft *F*; lifting link *G*; reach-rod *H*; reverse lever *K*; reverse link *L*; eccentric rod *M*; and eccentric crank *N*. The motion is of the radial type. Link *L* is trunnioned at its center and is rocked by means of eccentric rod *M* which derives its motion from return-crank *N* secured to the main crankpin. The movement of the link is transmitted to valve stem *B* by radius-rod *E* having a length equal to the link radius. This radius-rod is pinned to a sliding link-block and can be raised or lowered by the reverse lever *K*. When the block is above the link center, the engine runs in one direction, and when it is below the center, the motion of the engine is reversed, as will be explained subsequently.

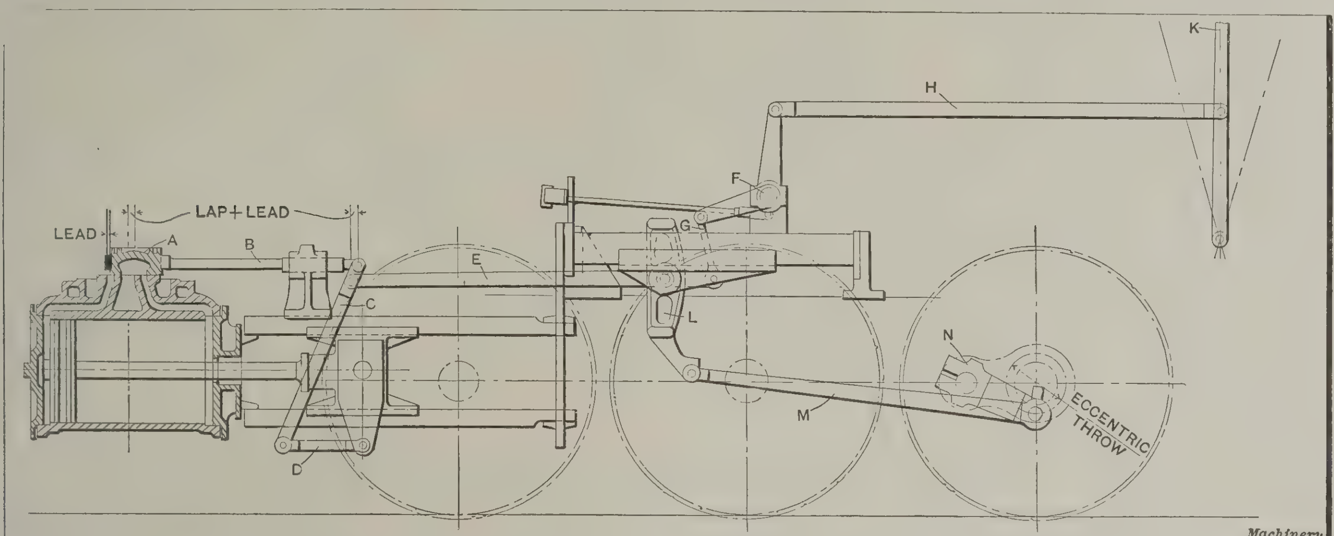


Fig. 1. Diagram showing Arrangement of Walschaerts Valve Gear for Outside-admission Valves

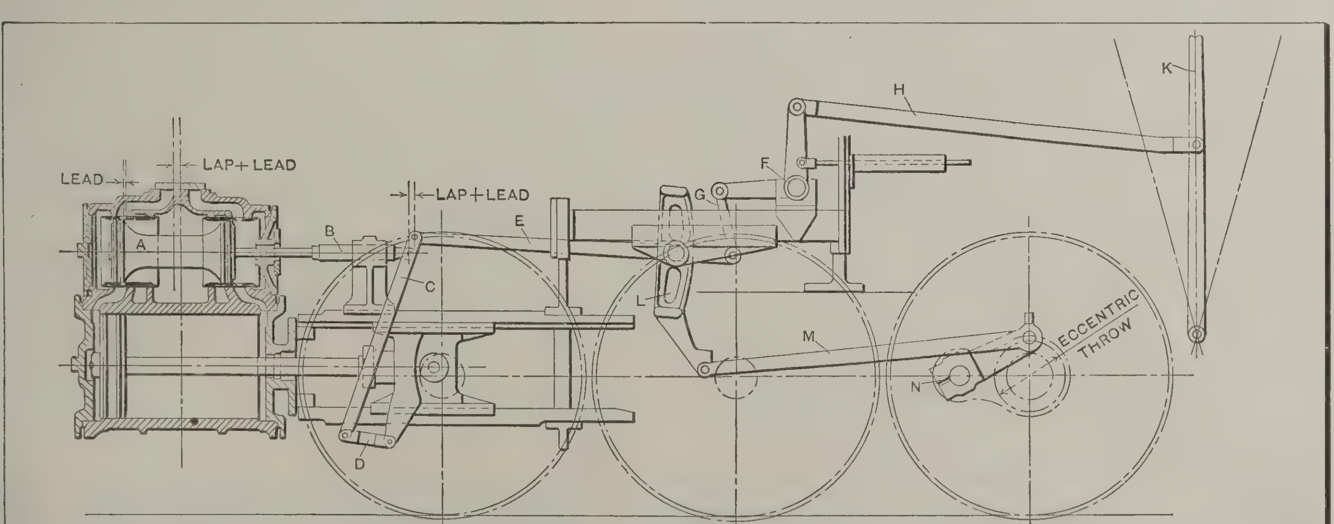


Fig. 2. Walschaerts Valve Gear arranged for Inside-admission Piston Valves

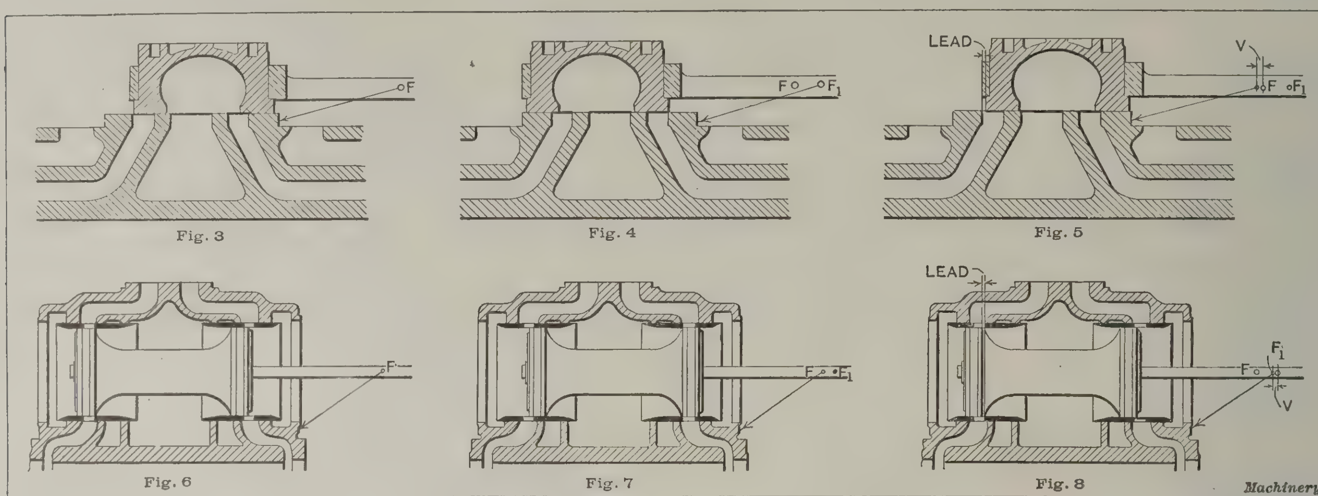
Fig. 1 represents the arrangement of Walschaerts motion as used with outside-admission slide valves, and Fig. 2 illustrates the design used with inside-admission piston valves.

The return crank on the main pin (sometimes known as the eccentric crank) is so set that when the piston is at the extreme end of its stroke, the link *L* stands in its central position. Now if the radius-rod were attached directly to the valve stem, the valve would also be in its central position, but when the piston is at the end of the stroke the valve must be displaced from its middle position by an amount equal to the lap plus the lead. With the Walschaerts

* Abstracted from Record No. 70, "Walschaerts Valve Gear," issued by the Baldwin Locomotive Works, Philadelphia, Pa.

† For additional information on the Walschaerts valve gear see the following articles previously published in MACHINERY, railway edition: "Making Walschaerts Valve Gear Parts"; "Locomotive Building at Altoona," June, 1910; "The Walschaerts *vs.* the Stephenson Valve Gear," October, 1906; "Nomenclature of Walschaerts Valve Gear," September, 1906; "Setting Valves with the Walschaerts Gear," January, 1906; "Setting Valves with Walschaerts Gear," February, 1906; "The Walschaerts Valve Gear," May, 1906.

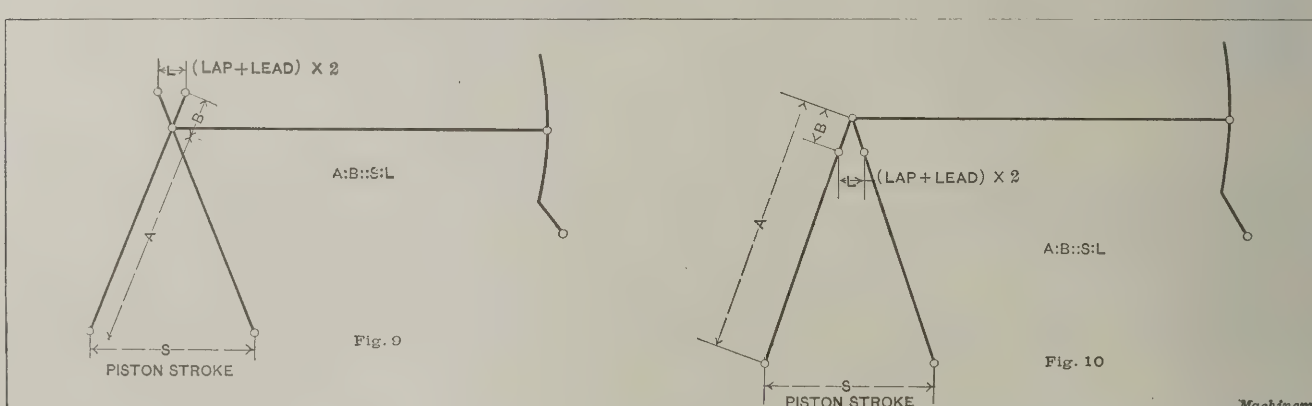
gear the valve is given lead (the amount of port opening when the piston is at the end of the stroke) by combining lever *C*, which is attached to valve stem *B* and radius-rod *E* and is also connected by link *D* with the crosshead. This combining lever is so proportioned that if the point of its connection to the radius-rod is a stationary fulcrum, and the



Figs. 3 and 4. Slide Valve set at Points of Cut-off Front and Back. Fig. 5. Slide Valve set for Lead Opening. Figs. 6 and 7. Inside-admission Piston Valve set at Points of Cut-off Front and Back. Fig. 8. Piston Valve set for Lead Opening

piston is moved a distance equal to the stroke, the valve will be shifted an amount equal to twice the lap plus the lead. Therefore, when the piston is at the end of its stroke, the valve is displaced from its central position a distance equal to the lap plus the lead.

In both Figs. 1 and 2, the main pin is shown on the for-



Figs. 9 and 10. Diagrams showing Proportions of Combining Lever Arms, for Outside and Inside Admission

ward "dead center", and the reverse lever is in its middle position with the link-block in the center of the link. A study of the diagrams shows that with a valve having *outside admission*, the valve rod is connected to the combining lever at a point above the latter's connection to the radius-rod, and, if the block is in the lower half of the link when

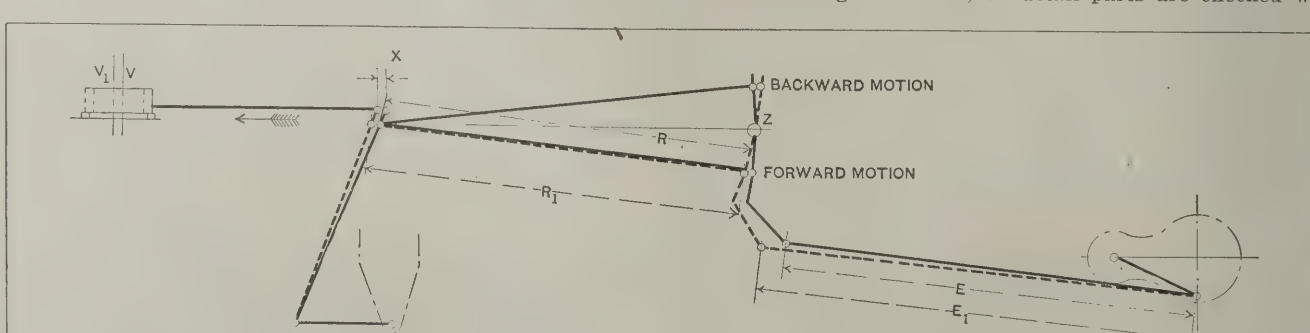


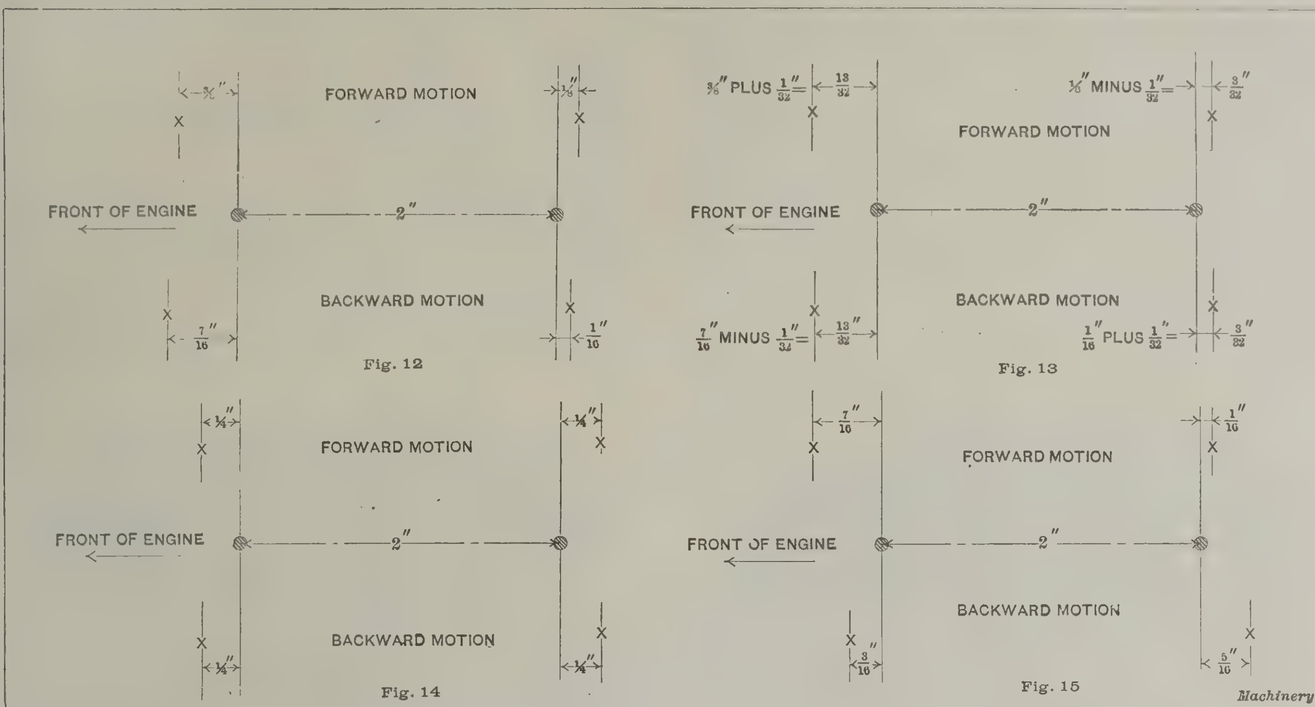
Fig. 11. Diagram showing Movement of Valve effected by Lengthening Eccentric Rod

in the forward gear, the eccentric crank *leads* the main pin. On the other hand, if the block is in the upper half of the link when in the forward gear, the eccentric crank *follows* the main pin. With a valve having *inside admission*, the valve rod is connected to the combining lever at a point below the latter's connection to the radius-rod (as shown in Fig. 2), and if the block is in the lower half of the link when in the forward gear, the eccentric crank *follows* the main pin, whereas if it is in the upper half of the link when in the forward gear the eccentric crank *leads* the main pin.

Inasmuch as the position of the valve when the piston is at the end of its stroke, is dependent upon the combining lever only, it is evident that the lead is the same from all points of cut-off. This is the principal feature which distinguishes the Walschaerts gear from the Stephenson motion, as far as steam distribution is concerned. The former should be correctly laid out to give the lead most desirable for the usual running speed. After the parts have been correctly made, it is impossible to alter the lead without seriously deranging the mechanism. In this respect the Walschaerts gear is less flexible than the Stephenson, but when once set up it is less liable to derangement, and the engine is more easily kept "square."

Before setting the valves, all detail parts are checked with their respective drawings, the main rod is erected and the valve gear connected. The main driving boxes are then blocked up one-half inch above the central position to allow for settling, after which punch marks are located on the main drivers for placing the engine on the dead centers. The method of locating these marks is the one commonly

employed in valve setting. The main crank is placed approximately six or eight inches below, say, the forward dead center, and the position of the crosshead is then marked with a tram held in a punch mark on the guide. A larger tram is also used to scribe a line on the driving wheel tire, from any convenient point on the frame. The wheel is then revolved backward until the crosshead, after passing the dead center, moves back to its first position as shown by the tram. Another line is then scribed on the tire from the same point on the frame. An arc is then drawn through these two lines on the tire and a central point is laid off on the arc to get the dead center position. A dead center mark for the opposite end of the stroke is also located in a similar manner. To place the engine on the dead center, the wheel is simply turned until the tram used for scribing the tire coincides with the punch mark on the frame and the dead center mark on the tire.



Figs. 12 to 15. Examples illustrating Adjustment for Equalizing Valve Travel in Backward and Forward Motion

Setting Outside-admission Valves

The following instructions apply to the setting of valves having outside admission:

1. With the ports exposed, set the valve at the points of cut-off front and back (as illustrated in Figs. 3 and 4) and prick punch the valve stem at points F and F_1 by tramming from any convenient place. The distance between points F and F_1 will be equal to twice the lap of the valve. When the main crankpin is on either dead center, the port should be opened an amount equal to the desired lead, as shown in Fig. 5. If a line is scribed on the valve stem with the valve set for the required lead, the distance V, Fig. 5, between this line and the point of cut-off F will equal the lead. With this statement in mind, proceed as follows:

2. Hook up the gear so that the link-block is in the center of the link; then place the main crank on the forward dead center and tram to the valve stem. Next revolve the wheel to the back dead center and again tram to the valve stem. Measure the distance between the points so obtained and compare with the specifications. This distance should be equal to twice the sum of the lap and lead. Any variation from the specified figures means that an error exists in the combining lever, the upper and lower arms of which should be made, respectively, proportional in length to twice the lap and lead and to the stroke of the piston, as indicated in Figs. 9 and 10. Assuming that the distance L, as trammed on the valve stem, is correct, the procedure is then as follows:

3. Place the gear in the forward motion with the link-block at a point in the link that will give the specified maximum valve travel when the wheels are revolved in the forward direction. This position of the link-block is obtained by experiment.

4. Place the main crank on the forward dead center and again scribe a line on the valve stem, measuring the distance between the point so obtained and the mark F, (Fig. 4). This distance should be exactly equal to the specified lead.

5. Revolve the wheel in a forward direction until the main crank is on the back dead center and again scribe on the valve stem, measuring the distance to punch mark F_1. This distance should also be equal to the specified lead.

6. Place the gear in the backward motion (as instructed in paragraph 3) and test for lead at the front and back, as described in paragraphs 4 and 5, excepting that the wheel should be revolved in a backward direction.

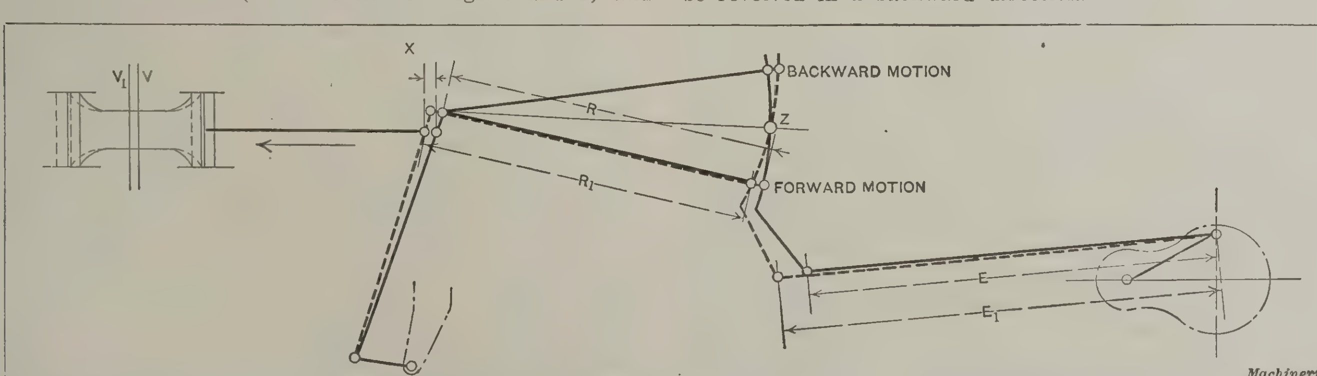


Fig. 16. Diagram of Valve Gear for Inside-admission—Note Change made by lengthening Eccentric Rod

7. If all the measurements conform to the specifications, the valves are set "square." A check should now be made by placing the piston on the forward dead center and moving the link-block through its entire travel in the link. This should in no way disturb the position of the valve. With the gear set for the full stroke forward and the full stroke backward, the maximum valve travel should also be noted when the piston is at half stroke.

In marking the forward and backward gear positions on the reverse quadrant of a "cold engine," an allowance toward the front of the quadrant must be made on each end, to correct for expansion when the engine is under steam. This al-

lowance is largely a matter of judgment, but from ¼ to ⅜ inch is sufficient for the ordinary standard gage locomotives.

If, on trial, the lead is found to be unequal, the following examples will serve to explain the corrections that should be made: Suppose the specification calls for a maximum valve travel of 5½ inches, an eccentric throw of 11 inches, a constant lead of ¼ inch, an outside lap for the valve of 1 inch, and the link-block below the center in the forward gear. It is very important that the following dimensions check exactly with the drawings:

1. Length of combining lever between the central fulcrum and the upper and lower arm centers (see dimensions *A* and *B*, Figs. 9 and 10). 2. The eccentric crank throw and length of the crank arm.

A change in the length of the eccentric rod changes the position of the valve approximately in proportion to the eccentric throw and valve travel. In this case the proportion is as 11 to 5½ or as 2 to 1; in other words, a change of ¼ inch in the length of the eccentric rod will move the valve approximately ⅛ inch when the link-block is in full gear and the main crank is on the dead center. The effect of the eccentric rod changes upon the position of the valve will be seen by referring to Fig. 11. If the eccentric rod E is lengthened to E_1, then the radius-rod R will be moved ahead to position R_1, and the valve stem will be moved a distance X in the direction of the arrow, thus displacing the valve from position V to position V_1.

The following rules can thus be formulated: If the link-block is below the link center when running ahead, then, in the *forward motion* if the eccentric rod is lengthened, the valve is moved ahead; whereas, if the eccentric rod is shortened, the valve is moved back. For the *backward motion*, if the eccentric rod is lengthened, the valve is moved back, and by shortening the eccentric rod, the valve is moved ahead. If the link-block is above the center when running ahead, then, in each case, the valve will be moved in the direction opposite to that given in the foregoing.

Changes made in the length of the link radius-rod will have approximately full effect on the movement of the valve. In other words, any variation in the radius-rod will produce about the same variation in the movement of the valve. In either forward or backward motion, the valve is moved ahead by lengthening the radius-rod the amount desired, and to move the valve back, the radius-rod is shortened. This holds good whether the link-block is above or below the link center in the forward gear. With these facts in mind, two examples will be considered:

Example No. 1: Let it be assumed that, on tramming to the valve stem with the main crank on the dead center, we find irregularities in the lead as shown by the diagram Fig. 12. The dots on the diagram represent the prick punch marks F and F_1 (Fig. 4), and the crosses represent the irregularities in the lead. First, the error between the forward and backward motion should be divided as follows:

The error in the forward motion at the front equals ⅜ — ¼ inch lead = ⅛ inch error. At the back, ¼ inch lead — ⅛ = ⅛ inch error. Therefore, to square or equalize the lead, the valve must be moved ahead ⅛ inch. The error in the backward motion at the front equals, 7/16 — ¼ inch lead = 3/16 inch error. At the back, 1/4 inch lead — 1/16 = 3/16 inch error. To equalize the lead, the valve must be moved ahead 3/16 inch.

As the errors in the two motions are in the same direction, it follows that one partially neutralizes the effect of the other, and that the combined or average error would be the difference between the two, or 3/16 — 1/8 = 1/16 inch error. To divide this error of 1/16 inch, it will be necessary to move the valve one-half of this amount, or 1/32 inch back in the forward motion. In order to do this, the eccentric rod must be shortened 1/16 inch, according to the rule previously given. When this has been done, the tram lines will be located as shown by Fig. 13. The errors at the front, in the forward and backward motions, are now 13/32 inch, and at the back, 3/32 inch, and it only remains to equalize the lead at the front and back for both motions. The position of the valve as shown by Fig. 13 is 5/32 inch too far back. Thus, 13/32 — 1/4 inch lead = 5/32 inch error front, and 1/4 inch lead — 3/32 = 5/32 inch error back.

As the effect of adjusting the radius-rod is direct, it follows that by lengthening this rod 5/32 inch, the valve travel will be equalized, thus giving a lead of 1/4 inch at the front and back for both motions, as indicated by the diagram, Fig. 14. The required changes, then, for Example No. 1, are as follows: Eccentric rod shortened 1/16 inch; link radius-rod lengthened 5/32 inch. A final trial of the valve and cut-off, etc., can now be made, as previously described.

Example No. 2: As another illustration, let it be assumed that, when tramming for lead, the results indicated by Fig. 15 are obtained. In this instance, the error in the forward motion at the front equals, 7/16 — 1/4 inch lead = 3/16 inch error; and at the back, 1/4 inch lead — 1/16 = 3/16 inch error.

To square the lead, the valve must be moved ahead 3/16 inch. The error in the backward motion at the front equals, 1/4 inch lead — 3/16 = 1/16 inch error; and at the back, 5/16 — 1/4 inch lead = 1/16 inch error. In this case the valve must be moved back 1/16 inch.

As the errors in the two motions are in opposite directions,

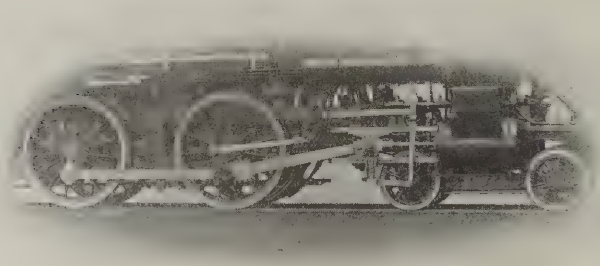


Fig. 17. Walschaerts Gear applied to American Type Locomotive

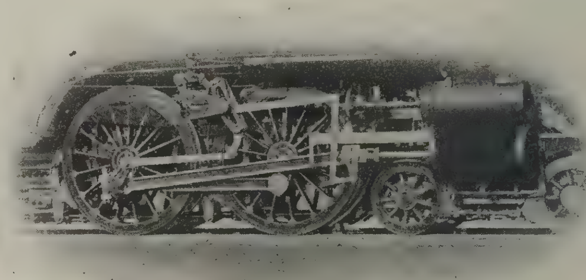


Fig. 18. Atlantic Type Equipped with Walschaerts Gear

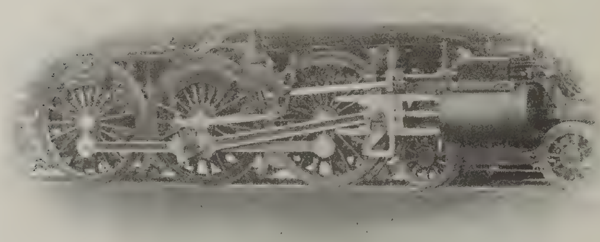


Fig. 19. Walschaerts Gear on Pacific Type Locomotive

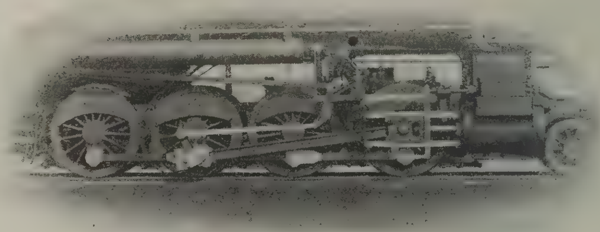


Fig. 20. Consolidation Locomotive having Walschaerts Gear

the combined or average error will be the sum of the two, or $3/16 + 1/16 = 1/4$ inch. To divide this error, it will be necessary to move the valve one-half the amount, or 1/8 inch ahead in the forward motion. To do this, the eccentric rod must be lengthened ¼ inch, which will give a lead of 5/16 inch at the front for both the forward and backward motions, and 3/16 inch at the back. The valve is now 1/16 inch too far back to equalize the lead. Therefore, the radius-rod must be lengthened 1/16 inch, which will give the results indicated by the diagram Fig. 14. The necessary adjustments, then, for Example No. 2, are, to lengthen the eccentric rod ¼ inch and the radius-rod 1/16 inch.

From the foregoing, it is evident that the errors in the forward and backward motions are made to correspond at the front and also at the back, by changing the length of the eccentric rod, after which the lead is equalized by changing the length of the radius-rod. Theoretically, the radius-rod should not be changed, but the necessary adjustment is so slight that it makes practically no difference in the movement of the valve. In special cases it may be desirable to equalize the valve travel when the gear is hooked up to give the cut-off which is most frequently used when the engine is in service. Thus, on a passenger locomotive, the most satisfactory results may be secured when the valve travel is equalized for a one-third or one-half stroke cut-off. In such a case, a slight irregularity at full stroke may be unavoidable but not detrimental.

Setting Inside-admission Piston Valves

The method of setting inside-admission piston valves is very similar to that described in the foregoing. It must be remembered, however, that to perform corresponding functions, such a valve moves in an opposite direction to that of a slide valve. When setting piston valves, the steam chest heads should be removed, for the sake of convenience, and the cut-off positions of the valve are determined by observation through peep holes provided for that purpose. In this way the points F and F_1 are located on the valve stem, as indicated in Figs. 6 and 7, by tramming from any convenient point in the back wall of the steam chest. The test for lead is made as previously described for outside-admission valves.

To illustrate the method of correcting errors with the inside-admission type, suppose we have the following specifications: Maximum valve travel, 5¾ inches; eccentric crank throw, 15½ inches; constant lead, ¼ inch; steam lap of valve, 1 inch; and link-block below the center in forward gear.

The effect of eccentric rod changes is indicated by the diagram Fig. 16. If eccentric rod E is lengthened to E_1, then radius-rod R would be moved ahead to position R_1, and the valve stem will be moved a distance X, thus displacing the valve from position V to position V_1. Therefore, the rules previously given for outside-admission valves also apply to this type. In any case, regardless of whether the gear is in the forward or backward motion, lengthen the radius-rod to move the valve ahead, and shorten it to move the valve back. It must be remembered that with an inside-admission valve, the front port opening is increased when the valve is moved ahead, and the rear port opening is increased when the valve is moved back. Bearing this in mind, an example of valve adjustment will be given.

Let us assume that, when tramming a valve, the irregularities indicated by the diagram Fig. 12 are found. First the error in the forward motion is found. As this is 1/8 inch, the valve must be moved back 1/8 inch. The error in the backward motion is 3/16 inch, so that the valve must be moved back 3/16 inch. As these errors are in the same direction, the difference between the two is found. This equals $3/16 - 1/8 = 1/16$ inch. To divide this error, it will be necessary to move the valve 1/32 inch ahead in the forward motion. As the eccentric crank throw in this instance is 15½ inches and the valve travel 5¾ inches, the ratio of the eccentric throw to valve travel is approximately 2.7 to 1. Therefore, the eccentric rod must be lengthened $2.7 \times 1/32$ inch, or approximately 5/64 inch, to move the valve ahead 1/32 inch. The valve will now tram as shown by Fig. 13. As it is 5/32 inch too far ahead, the radius-rod should be shortened this amount in order to equalize the lead. The adjustments, then, are as follows: Eccentric rod lengthened 5/64 inch; radius-rod shortened 5/32 inch.

When setting outside-admission piston valves, the method described for slide valves is followed, as the arrangement of the valve gear is the same. The cut-off position of the valve, however, must be observed through peep holes, the same as with inside-admission piston valves.

Fig. 17 shows the Walschaerts gear applied to an American type locomotive having slide valves. The link and reverse shaft bearings are bolted to a crosstie placed just ahead of the main driving wheels. A bracket bolted to the upper guide-bar supports the valve rod. As the radius-rod is down when running ahead, the eccentric crank leads the main pin. Fig. 18 shows an arrangement used on an Atlantic type locomotive. A cast-steel bearer placed between the two pairs of driving wheels, supports the link and reverse-shaft bearings. The valve is of the piston type with inside admission, and, as the radius-rod is down in the forward gear, the eccentric crank follows the main pin. Fig. 19 shows an arrangement used on a Pacific type locomotive with slide valves. A rocker is used to transmit the motion from the plane of the link to that of the valve stem, and the rocker-box is bolted to the guide yoke. Fig. 20 shows this motion applied to a consolidation type locomotive with slide valves. In this case the reach-rod of the reverse lever, is attached to an arm extending down from the reverse shaft, in order to have the block below the link center when running ahead. Fig. 21 shows a heavy consolidation locomotive of the Mallet type. The valves of the rear engine are arranged for inside admission and those of the front engine for outside admission, and the necessary arrangement of the eccentric cranks and combining levers is clearly shown. Both valve motions are controlled simultaneously by a power reverse mechanism, the reverse shafts being connected by a jointed reach-rod. The different gears referred to are typical of modern practice, but by no means represent all the modifications in successful use. The general design of the engine affects to a great extent the arrangement of the motion.

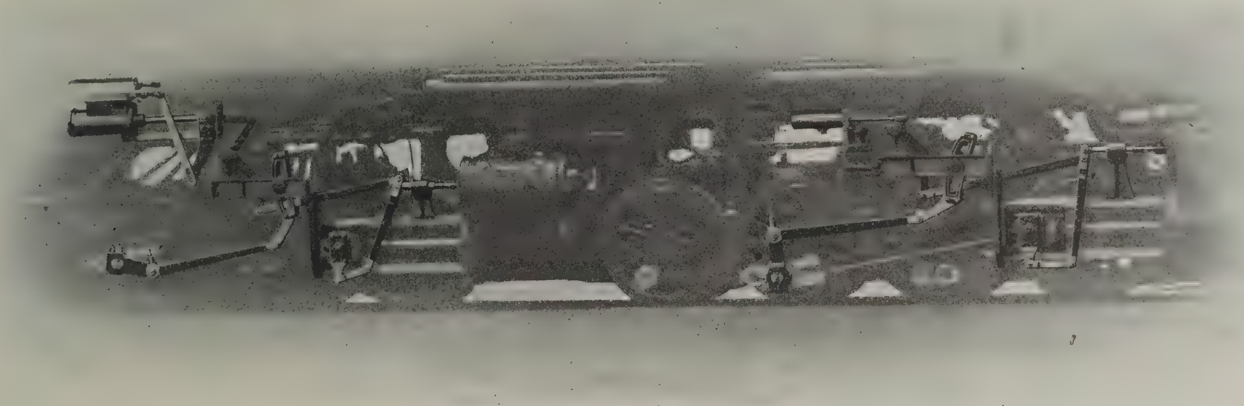


Fig. 21. Consolidation Mallet Type with Inside-admission Valves for Rear Engine and Outside-admission Valves for Front Engine

AN EXHIBITION OF SAFETY DEVICE MODELS

The illustration presented herewith shows a collection of models of different safety devices which were exhibited by the New York Central Lines at the session of the International Congress of Hygiene and Demography in Washington, D. C., from September 16 to October 5, under the general charge of Mr. George Bradshaw, general safety agent of the New York Central Lines. The following list shows the models which were on exhibition:

Lathe guard for end gears; two emery wheel guards; two water glass gage guards; shaker bar; protector for electric welder operator; two electric switch guards; four models showing exposed and correct method of applying set-screws; model of gasoline turntable motor; two models showing exposed and correct method of guarding set-screws in drill press; two models showing joiner guards; two models showing rip saw and guard; model of car bridge with spurs to prevent slipping; goggles used for emery wheel grinders; clamps and nozzle for sprinkler hose; and truck for handling driving wheel tire.

New York Central Lines Exhibit of Safety Device Models

Besides the models the exhibition included photographs of a great variety of safety devices, photographs of safe and unsafe methods of work, and samples of safety educational literature which is being distributed by the safety department of the New York Central Lines.

* * *

Experiments undertaken by the Hungarian State Railway authorities show that an alloy of 78 parts of lead, 17 parts of antimony, and 5 parts of tin constitutes an excellent journal-bearing metal. Five thousand cars were fitted with this metal in order to test its efficiency, and after a usage of three years, the results are pronounced satisfactory. This metal will now be adopted for all journal bearings on the Hungarian State Railways.

WHAT A MAN CAN DO WHEN HE GETS MAD

BY A. P. PRESS

I saw an incident the other day that showed what a man can do when he gets provoked good and proper.

It happened in the toolroom; one of the toolmakers had a fuse tip die to make. The blank was ⅞ inch thick and the fuse tip was about 1 inch long, round at one end and square at the other, with a wing-like projection on each side. The toolmaker was a good man, all right—in fact one of the very best that ever filed a die—but I guess it must have been the "morning after". He had laid out the die all right and had drilled and roughed out most of the stock when it dawned on him that he had made it left-handed, that is, he had laid the templet on the die blank wrong side up. While the die was all right, it, at the same time, was all wrong, or at least the work from it would not fold up so as to bring the burr edge of the metal together.

What did he do? He slapped that piece of work into the scrap-box, took another blank (they were all machined out ready for the templet) and in two hours and twenty minutes he had drilled out his die, roughed out the stock and finished it up ready to harden.

I have seen quick work, but never did I see the same amount of hand work performed in the same length of time as in this case. It pays to get mad once in a while.

* * *

It has been found unprofitable to use old tin cans in the process of detinning for recovering the tin. The cost of collecting, transportation and inability to dispose of the black iron plate are responsible for the cans not being utilized. This information was recently published by the United States Geological Survey which investigated the subject.—*Brass World.*

DIES FOR DROP-FORGING A CRANK-SHAFT

BY J. W. JOHNSON*

The dies for drop-forging the crankshaft shown in Fig. 1 comprise an interesting set of tools, especially to those unaccustomed to crankshaft diemaking. The principal interest of these dies lies in the fact that they were made to forge the collars, pin and adjacent parts of the crankshaft only, the remainder of the ends of the crankshaft being forged under an ordinary trip hammer. The advantages to be gained in forging the crankshaft in short dies are that on account of the

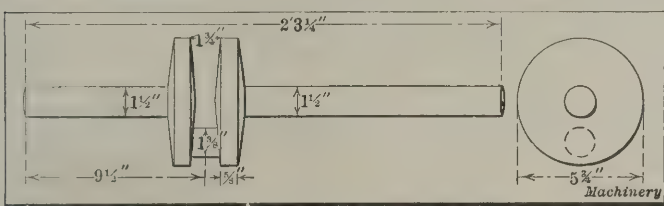


Fig. 1. The Drop-forged Crankshaft

small amount of stock being acted upon, the forging can be thus made under a lighter hammer and stock of smaller dimensions may be used, for it can be worked up by passing it back and forth from the break-down to the impression. Another important advantage in forging this job in short dies is that there is less liability of the forging sticking in the dies while being forged. If long dies were used there would

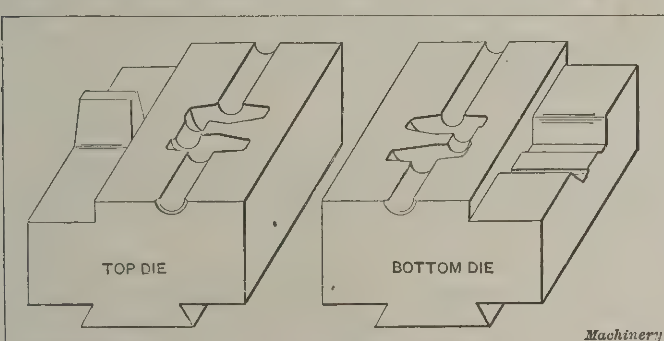


Fig. 2. Forming Dies for Forging a Crankshaft

be more or less trouble from this source. Moreover, when the forgings stick in a long die it is harder to free them than it is from short dies. Short dies are also much easier to keep lined up than long ones; in fact dies long enough to forge this entire crankshaft would give constant trouble by working out of alignment.

Fig. 2 shows the drop-forging dies for forming the forging,

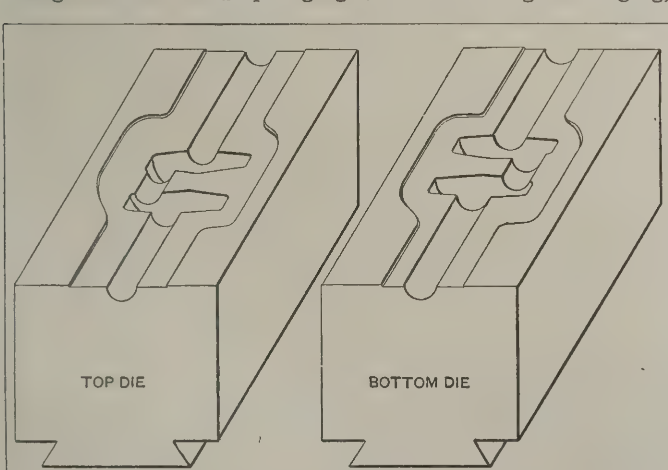


Fig. 3. Finishing Dies

the finishing being done in a separate pair of dies. It will be noticed that the break-down is of unusual width, which is necessary on account of the spreading of the stock. All corners in the forming impressions were well rounded to prevent cold shuts. In making the top die for the forming operation, the projecting piece on the break-down was made by dovetailing a separate piece into the side of the die. If this were not done, a great deal of superfluous labor would have to be done in shaping away the rest of the face of the die. The finishing dies are illustrated in Fig. 3, and, of course, the impressions are like those in the forming dies, except that the corners are not rounded as much and are flashed. It is obvious that no break-down or anvil was required on the finishing dies.

The trimming die and punch for this forging are shown in Fig. 4, and it will be noticed that the die is made in halves and left open at the front for hot-trimming. The punch was milled out to receive the forging for trimming so that it would not bend during the trimming operation.

The stock used for forging this crankshaft was nine inches long and four inches square. The first operation consisted of forging a tong-hold on one end. The piece was then put back in the fire, heated all over to a good forging heat, and

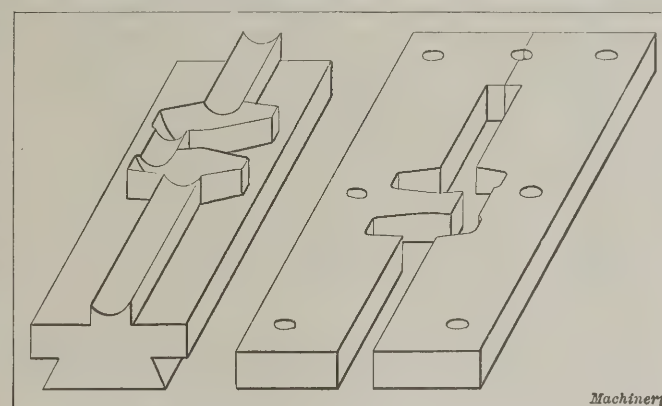


Fig. 4. Trimming Dies

the first blow of the hammer given the piece when in the break-down. Care was necessary in locating the piece in the die for the first blow, for this crankshaft is longer on one side of the collars than on the other. The stock worked up very rapidly, as it drew from the smaller sections and flowed into the collars. Quite a number of blows were necessary to draw enough stock from the ends to get the collars full.

After distributing the stock by means of the forming dies, a few blows in the finishing die brought the corners up and sized the forging, after which it was hot-trimmed in the ordinary manner in the trimming dies shown in Fig. 4.

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* * *

The statistics compiled by the *Archiv für Eisenbahnwesen* give the total mileage of the world's railways in 1910 as 640,158 miles; the total increase in the last year was 14,460 miles and in the last decade, 149,092 miles. This increase in mileage had been exceeded by but one previous decade, that between 1880 and 1890, when 152,179 miles of railway were built. Of all the railways in Europe more than 50 per cent are owned by the respective governments: 60 per cent of the railways in Africa, nearly 60 per cent of those in Asia and about 95 per cent of those in Australia are owned and operated by the State. It is interesting to note that while Great Britain has no state railways, and Canada only 1718 miles out of a total of 24,731 miles, this form of administration prevails almost exclusively in the British possessions of Asia, Africa and Australia.

It is also of interest to record the growth of the world's railway system from the time of its beginning. In 1840 there were about 4800 miles of railway in the world; in 1850, 24,000; in 1860, 67,000; in 1870, 130,000; in 1880, 231,000; in 1890, 383,000; in 1900, 490,000; and in 1910, as mentioned, 640,000 miles.

* * *

At a recent meeting of the Society of German Engineers, Herr Hammer, after having reviewed the improvements in the locomotives shown at the recent Turin exposition in Italy, stated that the following lines of development are being followed: A high steam pressure; the use of steam more highly superheated; valve gear improvements; utilization of the heat of the waste gases now escaping through the smokestacks; and the purification and pre-heating of the feed water.

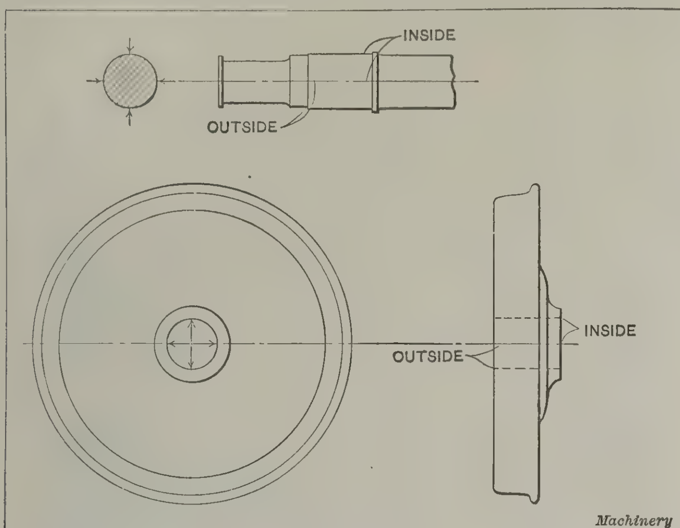
TABLE OF WHEEL AND AXLE PRESS FITS

Axle										Wheel											General Remarks
Size of Journal, Inches	Diameter, Wheel Fit		Condition of Finish	Cutting Speed, Feet per Min.	Depth of Cut, Inches	Feed, Inches	Make of Lathe	Condition of Lathe	Diameter, Inches	Material	Diameter of Bore		Condition of Bore	Cutting Speed, Feet per Min.	Feed, Inches	Cuts per Wheel	Pressure for Fit, Tons	Service of Wheel	Make of Mill	Condition of Mill	
	Outside End, Inches	Inside End, Inches									Outside End, Inches	Inside End, Inches									
5 x 9	6.345 6.343	6.349 6.349	G	40	1/32	1/8	Bridgeford	G	33	C. I.	6.339 6.337	6.336 6.337	G	25	3/16	2	50	T T	Putnam	G	Gage used, Niles Lubricant, Paint
4¼ x 8	5.708 5.704	5.706 5.704	G	40	1/32	1/8	Bridgeford	G	33	C. I.	5.700 5.702	5.700 5.702	G	25	3/16	2	50	T T	Putnam	G	
3¾ x 7	5.341 5.341	5.345 5.345	G	40	1/32	1/8	Bridgeford	G	33	C. I.	5.332 5.332	5.336 5.331	G	25	5/16	2	65	T T	Putnam	G	
3¾ x 7	5.339 5.339	5.338 5.338	G	40	1/32	1/8	Bridgeford	G	33	C. I.	5.333 5.333	5.333 5.333	G	25	5/16	2	40	T T	Putnam	G	
5½ x 10	5.480 5.480	5.480 5.480	G	25	1/32	1/8	Bement-Miles	G	30	S. T.	5.469 5.467	5.465 5.470	G	25	3/16	2	75*	E T	Putnam	G	
5½ x 10	6.802 6.802	6.803 6.803	G	40	1/32	1/8	Bridgeford	G	33	S.	6.802 6.802	6.802 6.802	V G	25	3/16	2	32*	T T	Putnam	G	
4¼ x 8	5.766 5.762	5.764 5.760	V F	50	1/32	1/16	Bridgeford	G	33	C. I.	5.744 5.744	5.743 5.743	G	18	1/8	2	75*	Fr	Niles-Bement	G	Gage used, Crosby Lubricant, Paint
4¼ x 8	5 763 5.763	5.761 5.763	P	50	1/32	1/16	Bridgeford	G	33	C. I.	5.7445 5.7445	5.743 5.743	G	18	1/8	2	61	Fr	Niles-Bement	G	
4¼ x 8	5.769 5.775	5.770 5.769	V F	50	1/32	1/16	Bridgeford	G	33	C. I.	5.756 5.756	5.7545 5.7545	F	18	1/8	2	62	Fr	Niles-Bement	G	
5½ x 10	6.873 6.8715	6.872 6.869	P	50	1/32	1/16	Bridgeford	G	33	C. I.	6.851 6.851	6.851 6.851	G	18	1/8	2	75	Fr	Niles-Bement	G	
5½ x 10	6.969 6.969	6.972 6.971	V G	50	1/32	1/16	Bridgeford	G	33	C. I.	6.956 6.956	6.9545 6.9545	G	18	1/8	2	75	Fr	Niles-Bement	G	
5½ x 10	6.912 6 912	6.912 6.912	G	50	1/32	1/16	Bridgeford	G	33	C. I.	6.898 6.896	6.900 6.898	V F	18	1/8	2	62	Fr	Niles-Bement	G	
4¼ x 8	5.746 5.749	5.752 5.751	P	25	1/32	3/32	Niles	F	36	C. I.	5.740 5.740	5.738 5.738	V G	16	9/16	2	80	Pa	Putnam	G	Gage used, Niles Lubricant, Paint
4¼ x 8	5.748 5.743	5.749 5.749	V F	25	1/32	3/32	Niles	F	36	C. I.	5.740 5.740	5.740 5.740	G	16	9/16	2	57	Pa	Putnam	G	
5 x 9	6.371 6.371	6.380 6.382	G	25	1/32	3/32	Niles	F	33	C. I.	6.362 6.362	6.362 6.362	G	18	9/16	2	65	T T	Niles	G	
3¾ x 7	5.355 5.355	5.356 5.359	V F	25	1/32	3/32	Niles	F	33	C. I.	5.352 5.352	5.348 5.348	V F	18	3/32	1	60	T T	Niles	G	
3¾ x 7	5.388 5.390	5.395 5.398	G	25	1/32	3/32	Niles	F	33	C. I.	5.383 5.383	5.383 5.383	G	18	9/16	2	60	T T	Niles	G	
3¾ x 7	5.260 5.257	5.257 5.256	G	25	1/32	3/32	Niles	F	33	C. I.	5.252 5.252	5.250 5.250	V F	18	9/16	2	32	T T	Niles	G	
4¼ x 8	5.763 5.762	5.763 5.762	G	30	1/32	1/8	Bement & Son	V G	33	C. I.	5.753 5.753	5.752 5.752	G	24	1/8	2	52†	Fr	Bement-Miles	G	Gage used, Bristol Lubricant, White Lead and Oil
4¼ x 8	5.787 5.783	5.797 5.792	G	35	1/32	5/32	Bement-Miles	G	36	S.	5.785 5.785	5.785 5.785	G	18	1/16	2	119*	Pa	Niles	V G	
4¼ x 8	5.774 5.774	5.777 5.776	V F	35	1/32	5/32	Bement Miles	G	36	S.	5.767 5.771	5.775 5.776	V F	18	1/16	2	51	Pa	Niles	V G	
5 x 9	6.436 6.438	6.432 6.433	P	35	1/32	5/32	Bement-Miles	G	33	C. I.	6.401 6.404	6.412 6.410	V G	24	1/8	2	85	Fr	Bement-Miles	G	
3¾ x 7	5.336 5.345	5.341 5.345	V F	35	1/32	5/32	Bement-Miles	G	33	C. I.	5 333 5.333	5.337 5.337	V F	24	1/8	2	64	Fr	Bement-Miles	G	
4¼ x 8	5.768 5.765	5.776 5.773	V F	25	1/32	5/32	Bement-Miles	V G	36	C. I.	5.7125 5.7125	5.7115 5.7115	G	18	1/8	2	Wheels not pressed on	Pa	Niles	V G	....
4¼ x 8	5.7765 5.778	5.780 5.780	G	35	1/32	5/32	Bement-Miles	G	36	C. I.	5.728 5.729	5.728 5.729	G	18	1/8	2		Pa	Niles	V G	
4¼ x 8	5.781 5.781	5.7865 5.788	V G	35	1/32	5/32	Bement-Miles	G	33	C. I.	5 729 5.729	5.729 5.729	G	18	1/8	2		Pa	Niles	V G	

V G = very good; G = good; V F = very fair; F = fair; P = poor.—C. I. = cast iron; S. T. = steel-tired; S = steel.—TT = tender truck; E. T. = engine truck; Fr = freight car; Pa = passenger car.
* Taken off. † Taken off before pressed full distance.

WHEEL AND AXLE PRESS FITS

The accompanying table gives data for wheel and axle press fits, as used in different railroad shops. The data given in the tables requires no further explanation, as it merely records the practice followed in various shops. The writer had the opportunity of obtaining this data during the carrying out of a systematic investigation covering the points recorded. He believes that a great deal of interest is attached to this



Illustrations showing where Dimensions given in the Accompanying Table are measured

subject, as he found that in all the railroad shops visited the men were very much interested in the methods followed in other shops. It will be seen that the practice differs considerably in the various places, both as regards the speeds and feeds used in wheel and axle turning and as regards the allowances for fits. Five shops are represented in the table, the data from each being grouped together as indicated. Two dimensions are given for each axle or bore diameter, these being measured in two directions at right angles to each other as indicated in the accompanying illustration. H.

* * *

CHECKING LIST FOR DRAWINGS

BY E. E. MINARD*

The questions are sometimes asked, "Why is it necessary to check drawings? Why cannot the draftsman be depended upon to make them right in the first place?" As a matter of fact, however, draftsmen are no more infallible than other men, although probably no less so. There are few who can make a drawing with the average amount of detail without some error or omission being found by a competent checker. The errors in design or dimensions are apt to be quite costly if not discovered before the parts are machined or assembled. It has been the experience of the writer that the most costly errors occur where they are least expected, and particularly with regard to matters which it has not been considered necessary to check. If the drawings cover simple and inexpensive parts, the checking might cost more than an occasional spoiled piece, and, in that case, it might be dispensed with, but when the drawings cover expensive parts, like tool work, careful checking is imperative.

It is often claimed that draftsmen are apt to be careless when they know that their work is to be checked afterwards. This may be true if the discipline is lax and the checker is inefficient, but if a standard checking list, such as given in this article, is handed to the draftsman with the understanding that his work must conform to its requirements, a marked increase in the efficiency of the draftsmen will, in most cases, be noted. The checking list submitted herewith is given as an example for one special class of work. Different lists should be prepared for different classes of work. In making up such a list, one should guard against the mistake of trying to make this standard checking list as complete as an instruction book. To make it efficient and useful, it must be brief in every item, and must be used simply as a supplement to other necessary instructions. The sole object should be to instantly call to the mind of the draftsman the requirements of the standard practice. The list given below is for punch and die work drawings, and will, of course, vary according to the practice and working conditions of different drafting-rooms.

* Address: 722 Saginaw St., W., Lansing, Mich.

Standard Checking List—Punches and Dies

Design Approval:
1. Authorization, requisition, memorandum, blueprint, sketch or sample.
2. Yearly requirements.
3. Grade of tool.
4. Method of operation.
5. General and specific requirements of departments.
6. Harmony in design, compared with other up-to-date tools.
7. General design.

Assembly:
1. Views and projections.
2. Work to be easily placed in die.
3. Work to be easily removed from die.
4. Same gaging points on succeeding operations.
5. Parts to be readily machined and assembled.
6. Interference of moving parts, slides, etc.
7. Burr side of blank in proper relation.
8. Provision for grinding.
9. Stripping and knockout devices to be adequate.
10. Clearance for slugs and burrs.
11. Setting pins.
12. Safety pins for unsymmetrical blanks.
13. Punch height to clear work during forming operation.
14. Size of punch shank to be standard.
15. Relation of shut height to available presses.
16. Size of dowel pins and standard screws.

Details:
1. Views and projections.
2. Views of details placed in same relative positions as assembly.
3. Detail to check with assembly.
4. Easily machined.
5. Easily assembled.
6. Easily hardened without liability to check.
7. How fastened in place.
8. Scaling and calculating of dimensions.
9. Intermediate dimensions.
10. Overall dimensions.
11. Limits.
12. Size and location of holes.
13. Finish marks.
14. Grinding marks.
15. Detail number.
16. Name.
17. Number of pieces required.
18. Material.
19. Hardened.
20. Ground.
21. Forging.

Title:
1. Class and type of punch and die.
2. Part number.
3. Model number.
4. Scale.
5. Initials.
6. Drawing number.
7. Date drawn.
8. Date traced.

General Requirements:
1. Neatness and clearness.
2. Crowding of views, details and notes.
3. Lettering.
4. Lines.
5. Section-lining.

The different men in the drafting-room use all or part of this list, as required. The designer uses the section on "Assembly." The head of the division or department uses the sections under the headings "Design Approval," and "Assembly." The detailer uses the portion under the headings "Details," "Title," and "General Requirements." The tracer need pay attention only to the section of "General Requirements," after which the checker uses the complete list with the exception of "Design Approval." It is understood that before a list of this kind can be used successfully, detailed instructions in separate form must be given to the draftsmen, covering all the parts to which attention is called in this list.

* * *

Men who are absolutely convinced of the accuracy of their opinions will never take the pains of examining the foundation on which they are based.—*Buckle.*

RELATIVE FIELDS OF THE BOARD AND STEAM DROP HAMMERS

BY H. TERHUNE*

It has been suggested that the steam drop hammer is rapidly replacing the board drop hammer. The writer wishes to state that after visiting practically all of the drop-forge plants and manufacturing plants making drop forgings, he is not of the opinion that the steam drop is replacing the board drop on the same class of work, but that the nature of the work at the present time has outgrown the limits of the board drop, which, even from a mechanical point of view, has always been placed at 3000 pounds falling weight.

In the Middle West and along the Lakes, where the bulk of heavy forging is done, drop hammers of from 2000 to 16,000 pounds falling weight are required. Here we find, perhaps, one and one-half board drop to every steam drop hammer, with a total falling weight much in favor of the steam drop; but from the western borders of Pennsylvania and New York to the Atlantic coast the conditions change almost as abruptly as does standard time, and we find about twelve and one-half board drop hammers to every one steam drop. The bulk of the board drops are from 800 to 1500 pounds and the steam drops from 2000 to 5000 pounds. Generally speaking, it is as difficult to convince people in New England of the merits of the steam drops as it is to do the same thing with relation to the board drops in the Detroit and Cleveland districts.

Each hammer has its advantages. The managers of the drop-forge shops say that a certain class of accurate work can be done more economically on a board drop than on a steam drop, provided that it does not require a hammer larger than from 1500 to 2000 pounds, and a number of plants that have been provided with all steam drop hammers have recently put in board drops to take care of this class of work. However, there are four or five drop-forge shops in the Middle West where nothing is considered except steam drop hammers for all classes of work.

Nearly everyone admits that the cost of operation and repairs is greater on the steam drop hammers, but at the same time about one-third more work can be done on these. The writer has failed, however, to obtain exact data as to the relative cost of operation and upkeep of the two types of machines. Some claim that these items are about double for the steam drop hammers, but this seems rather high.

The power required for board drop hammers varies considerably with the nature of the work. Very little power is required at the point of "pick-up" if the work is practically "die to die." A great deal more power is required when the work is very soft and there is no rebound; this is largely due to the small amount of kinetic energy in the driving pulleys, the rolls thus having to pick up a dead load from rest. When there is a good rebound, with the knock-off properly timed, the board will have practically the same upward velocity as have the rolls when they come together, and the ram is simply continued on its upward stroke by the rolls. Heavy flywheels would be an advantage, but makers of drop hammers would hardly consider them on account of the danger of the heavy overhanging weight on the end of the driving shaft. In several shops, however, they have been used for years without an accident, and in these places the manufacturers will consider no other construction.

It is rather difficult to find a better machine than the board drop hammer on certain classes of work, at least in cases, for example, where hammers of from 500 to 1500 pounds (or even up to 2000 pounds) are used, and the shop is driven by water power or natural gas at 12 cents per 1000 cubic feet, or even electric current at from one to one and one-half cents per kilowatt-hour, especially when coal is as high as in New England.

When the work is heavy and requires a great deal of breaking down, and there is considerable drawing and bosses to be forged, and even when light work is to be done having thin sections that cool quickly, such as gear blanks with thin webs, I-sections, etc., requiring quick sharp blows, the steam drop will make the best showing in nearly all cases.

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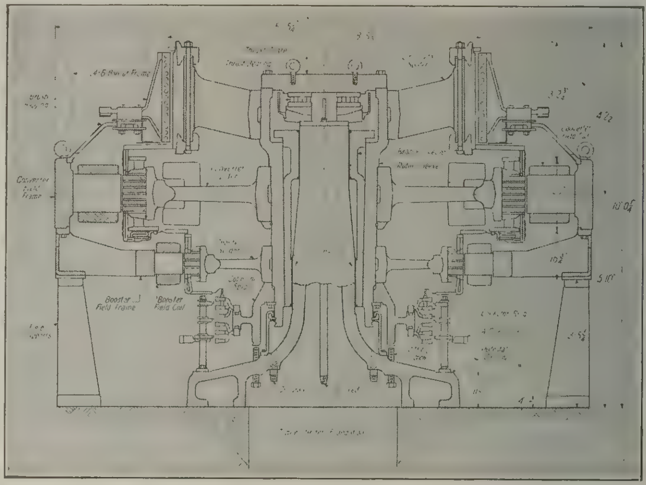
At the present time the waste heat boiler mounted on the top of each heating furnace is receiving considerable attention. This boiler generates the steam for the hammer with little or no extra fuel other than that required for heating the work being forged. If the waste heat of each furnace were sufficient and could be utilized to generate enough steam for its own drop hammer, regardless of size, the board drop hammer would become obsolete on account of the superior economy of the steam hammer. At present, the relative advantages of each, however, depend, as we have seen, on many conditions, some of which are purely local in their character.

* * *

LARGE VERTICAL ROTARY CONVERTERS

Two 3000 K. W. vertical rotary converters have recently been built by the Westinghouse Electric & Mfg. Co. in its East Pittsburg works. These machines are of especial interest because they are the largest rotary vertical converters ever constructed. They were built for the New York Edison Co. The accompanying illustration shows a sectional drawing of these converters, some of the mechanical features of which are rather interesting and different from those hitherto used on ordinary electrical machines. The pedestal on which the armature rotates is made in one piece from a hollow steel



Section through Large Westinghouse Rotary Converters

casting. A much more rigid construction is possible in this way than with a steel pedestal provided with a flange on its lower end bolted to a cast-iron base. A roller thrust bearing is arranged at the top of the pedestal to take the weight of the revolving element. This bearing rests on the plate having a spherical seat carried on the pedestal, so that perfect alignment is possible. The roller bearing can be easily taken out by removing the top plate of the machine. When it is necessary to remove the top plate, the weight of the rotating parts is carried by six $1\frac{3}{4}$-inch bolts which pass through the flange at the base of the pedestal. When the top plate is taken off these bolts are screwed up until they raise the rotating element a trifle and assume its weight.

* * *

ARTIFICIAL RUBBER

A consular report states that a factory for producing artificial rubber has been established at Ymuiden, in Holland. It is stated that the company that has started this factory has succeeded in producing a substance having the qualities of rubber, and in addition, some advantages over genuine rubber. The principal ingredients of the product are said to be fresh sea fish with about 15 per cent of natural rubber, the resulting substance being as flexible and as elastic as rubber, but costing but one-sixth of real rubber. The low price of the product is caused partly by the use of the by-products, which can be employed as artificial fertilizers. It is stated that this artificial rubber can be vulcanized, that it is benzine-proof and that it can resist the effect of heat. The substance much resembles real rubber, but the slightly fishy smell betrays the chief ingredient. It is explained that this will be prevented by extracting the fat from the fish used. The development certainly is interesting, providing the claims, too, are not "fishy."

WATCH MOVEMENT MANUFACTURE—4

METHODS, MACHINES AND SPECIAL TOOLS USED BY THE SOUTH BEND WATCH CO., SOUTH BEND, IND.

BY DOUGLAS T. HAMILTON*

The final operations on a watch movement, such as jeweling, stem fitting, banking, dialing, balance truing, over-coiling, spring truing, finishing, timing and adjusting, are necessarily hand operations which require the attention of experienced workmen. The assembling operations are, of course, also accomplished by hand. Before the winding wheels, plates, bridges or other exposed portions of the movement are ready to be assembled, they are usually decorated by means of a tortoise shell lap charged with carborundum, held in a damaskeening machine. In addition to the operations mentioned, the methods used in making the dials will be dealt with in the following.

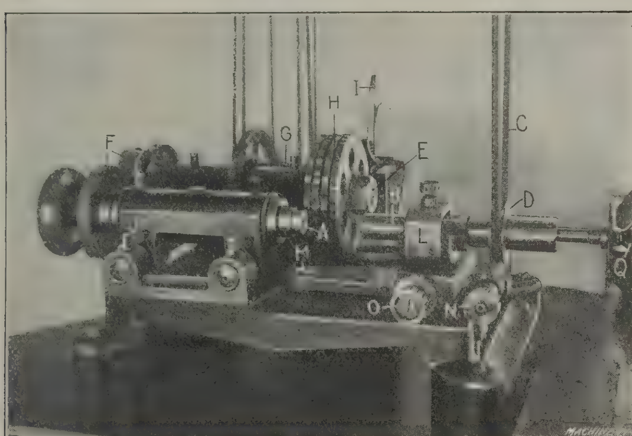


Fig. 40. Machine used in Damaskeening Winding Wheels, etc.

Decorating Watch Movement Parts

To produce the decorations on the winding wheels, etc., the parts are held in the spring chuck *A* of the damaskeening machine shown in Fig. 40. The tortoise shell lap, which for the steel parts is charged with diamond dust, is held in the spindle *B*, the latter being rotated by a belt *C* running on pulley *D*. The work is rotated by the cam-shaft *E* through change gearing *F*, the former receiving power from grooved pulleys *G*, through a worm and worm-wheel.

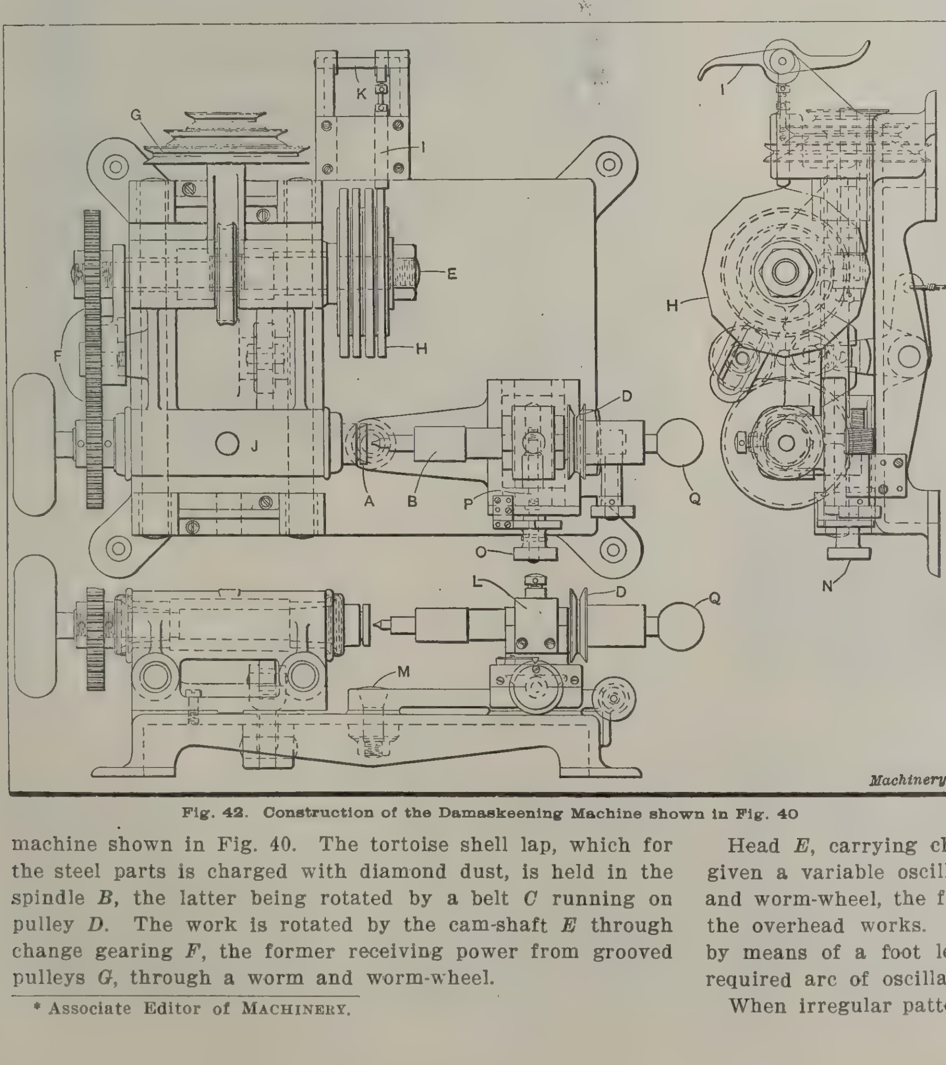


Fig. 42. Construction of the Damaskeening Machine shown in Fig. 40

The oscillating movements of the work required to produce the desired decorations are obtained from irregular faced cams *H*, which, through an adjustable pawl *I* transmit the required oscillating movement to the head *J*. As is shown in Fig. 42, this pawl can be slid back and forth on pin *K*, and thus be brought in contact with the irregular faces of the various cams. The entire head which carries the change gears and work is thus moved back and forth while the work is being rotated.

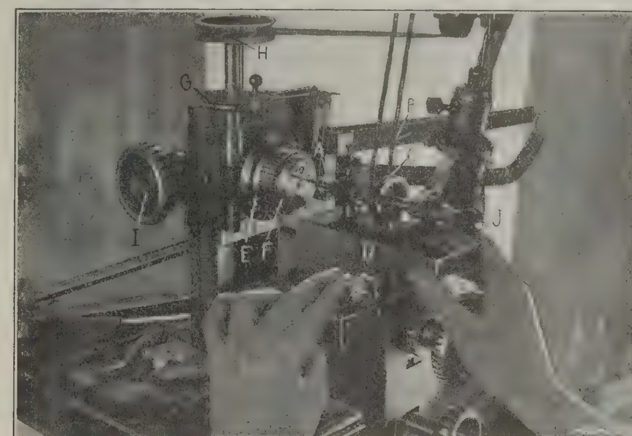


Fig. 41. Damaskeening Machine of the Upright Type for Decorating Bridges, Plates, etc.

The head *L* carrying the spindle in which the diamond-charged lap is held is pivoted at a point *M*, and is made to move through an arc by operating knob *N*, which has a worm formed on its forward end meshing in a rack cut in the base of the holder. This adjustment of the spindle is necessary to change the angular position of the face of the lap in reference to the work, so that fine or wide "wavy" decorations can be produced. The head carrying the lap can also be adjusted laterally to conform to the diameter of the required circle by means of a knob *O* and screw *P*. The lap is kept in contact with the work by the operator pressing on knob *Q*.

Damaskeening Bridges and Plates

The bridges and plates are decorated in a machine which differs in construction to a considerable extent from that shown in Figs. 40 and 42. This machine is shown in Fig. 41 at work on the rear watch plate. As before, the decorating is accomplished with a tortoise shell lap, which in this case, however, is charged with carborundum. The lap is held in a spindle *A*, which is rotated at a high rate of speed by means of a belt *B* and pulley *C*. The table *D* on which the lap spindle is held can be tilted to an angular position, so as to change the width of the decoration. For large work, the table can be moved back and forth, and is provided with an index, so that all lines can be spaced the same distance apart.

Head *E*, carrying chuck *F*, which holds the work, can be given a variable oscillating movement by means of a worm and worm-wheel, the former being driven by a pulley *G* from the overhead works. The belt driving the worm is shifted by means of a foot lever, stops being provided to give the required arc of oscillation.

When irregular patterns are desired, irregularly-faced cam-

* Associate Editor of MACHINERY.

strips retained on the rear of the machine are brought into play. These cams, through the medium of a follower, impart a forward and backward movement to the head, the latter being raised and lowered automatically by means of pulley *H*. This pulley is driven by a round belt from the overhead works, and by means of stops which shift the driving belt, its direction of rotation is changed to raise and lower the head. The head can also be moved back and forth by means of knob *I*.

The variety of patterns which can be produced on this simple machine is very great. By using any one of the irregularly-faced cams, the outline of the pattern is altered, and by using the same cam, but changing the angle of inclination of the lap spindle, an entirely different pattern is produced. Various combinations of patterns can in this way be produced without special attachments. The lap, of course, is kept in

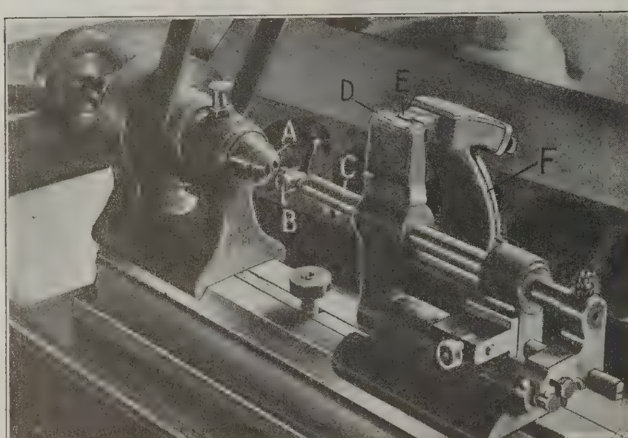


Fig. 43. Jewel "Letting-in" Machine and Caliper Rest for governing Diameter of Hole for Jewel

contact with the work by the operator, who presses on the knob *J* with the palm of her hand.

Fitting Jewel Settings and Jewels

The jewels, which act as bearings for the staffs, are not in all cases set directly in the plates and bridges, but are located in settings, the latter being retained in the plates and bridges. The machine used for producing the holes in the settings for the jewels is shown in Fig. 43. The setting is held in a spring collet *A*, and the boring tool in a holder *B*, provided with a shank fitting in spindle *C*.

A device called a "caliper rest" is used in connection with this machine for determining the diameter of the hole for the

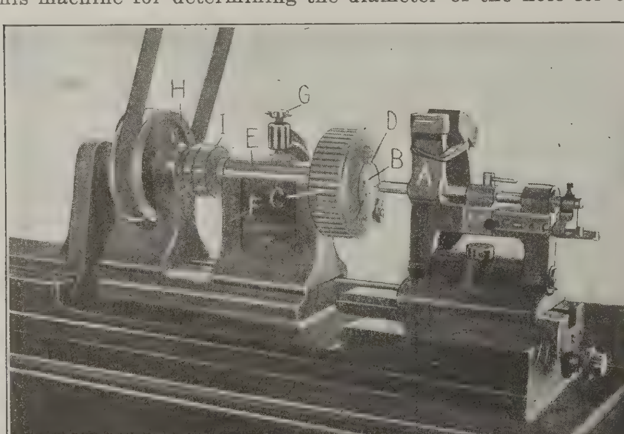


Fig. 44. "Cutting-in" Machine for Jewel Settings

jewel. This caliper rest is shown in detail in Fig. 45. The jewel is placed between the two jaws *D* and *E*, and as arm *F* is cast rigid with the base, it follows that (when the jaws are together) arm *H*, which is pivoted at a point *G*, must be deflected when the jewel is placed between the jaws. As radius *R* is twice *r*, the spindle *C* of the machine which fits in the bushings *I* is moved out a distance equal to the radius of the jewel. Then, as the cutter is set directly on the center line or axis of the machine spindle, it will produce a hole (when cutting on one side only) equal to the diameter of the jewel.

The plate or bridge in which the setting is retained is bored out in the "cutting-in" machine shown in Fig. 44. This machine is also provided with a caliper rest *A* similar in construction to that shown in Fig. 45. The work is held in the quill chuck *B*, which is tightened onto the work by turning the corrugated ring *C*. This ring, in turn, operates a ring having cam grooves which draw in the dogs *D* to grip the

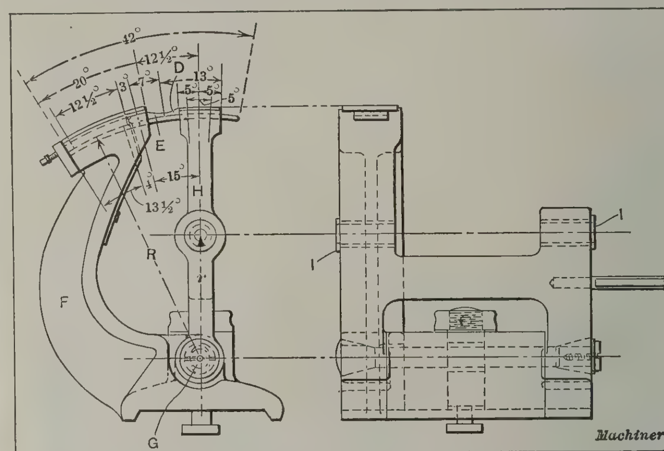


Fig. 45. Construction of the Caliper Rest shown in Figs. 43 and 44

work. This chuck is provided with a quill in which the spindle of the chuck rotates. The quill *E* is held by a clamp screw *G* in a U-shaped groove cut in the rest *F*. The spindle of the chuck is driven from pulley *H* by means of a clutch *I*. This method of holding and driving the chuck is conducive to greater accuracy, because vibration and wear are practically

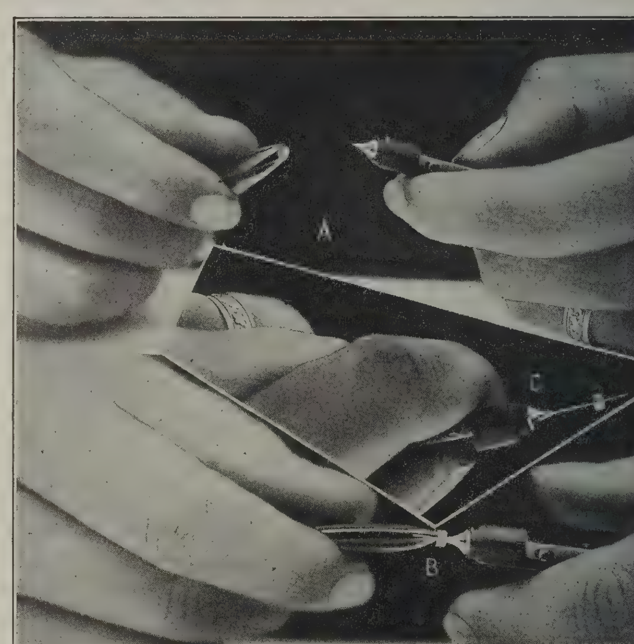


Fig. 46. Gaging the Holes in Jewels by Means of a Needle Gage

eliminated. The pull of the belt does not affect the alignment of the spindle, and the latter is free to rotate in the quill which is clamped rigidly in the rest.

Another good feature of the quill chuck is that it can be removed from the machine and replaced with the assurance that it will always run true and be in perfect alignment. A chuck is also made for every different part, and is used only for that part, thus insuring interchangeability—one of the chief objects sought in modern manufacturing.

Polishing and Gaging Jewels

The jewels used for bearings in watches are obtained from Switzerland already drilled. It is necessary, however, to lap the holes and round the corners (making what is called an "olive" hole), so the staff will rotate in it with as little friction as possible. The jewel is held in a small speed lathe, the spindle of which is rotated at about 150,000 R. P. M. The polishing is accomplished by a lap made from peg wood—the same class of wood as is used for pegging shoes—charged with No. 6 diamond powder.

After lapping, the holes are gaged by means of a "needle" gage in the manner illustrated in Fig. 46. At *A* the gage is shown in position for inserting it into the jewel; at *B* the operator has forced the needle into the jewel, and is obtaining the correct reading on the scale; and at *C* the needle is forced out to the limit. The needle is slightly tapered and is set in a holder, and its position with reference to the scale gives the diameter of the hole in the jewel. It is absolutely necessary that the jewel be placed on the needle in the manner illustrated at *A* in Fig. 46, because of the slenderness of the needle. If it were attempted to put the jewel on the needle when the latter was in the position shown at *B* or *C*, a broken needle would be the result.

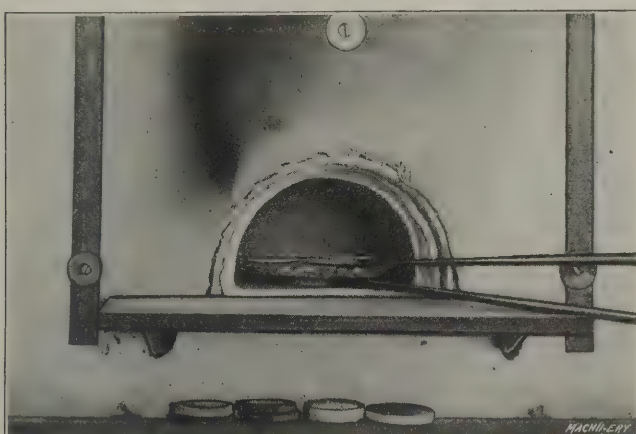


Fig. 47. Furnace for "Baking" the Enamel on the Watch Dials

Making Watch Dials

A watch dial consists of a copper disk or base upon which three or more layers of enamel are deposited. The first coat —known as the grip coat—is much harder than the top or last coat. The enamel used for watch dials comes from Germany. It is received in the form of lumps, which are broken up and put in a grinding barrel provided with a wedgewood lining. The grinding is accomplished by porcelain balls, which are put in the barrel with the lumps of enamel. After the enamel is ground it is sifted through bolting cloth—the same as that used in flour mills—two meshes of this cloth being used. The finely powdered enamel is used on the back of the dial—it being absolutely necessary that the enamel used on the front of the dial be of a uniform size of grain.

After the copper bases have been blanked out in the punch press, the dial feet are riveted in. Small rings are then soldered around the base of these dial feet so that they will be held securely. In soldering the dial feet into the copper blank, the latter is bent out of shape, so it is necessary to flatten it on an ordinary flat die.

When the dials or bases have been prepared in the manner described, the copper bases are laid flat in a sieve tray, after they have been cleaned in acid, washed and dried. The tray containing the copper blanks is then taken to a sifting device which holds the ground enamel, the latter being sifted over the dials by means of a knocker, producing a slight vibratory movement of the container, thus spraying the enamel evenly over the copper blanks. After an even deposit of enamel has been sprayed on the copper disks, they are dried over a gas fire. Both the back and front of the copper disks are treated in this way. Then the front of the dial receives a second coat of a uniform thickness. After applying this coat, the enamel is fused in the gas furnace shown in Fig. 47, where the dials remain for about one minute. They are then taken out and allowed to cool off gradually.

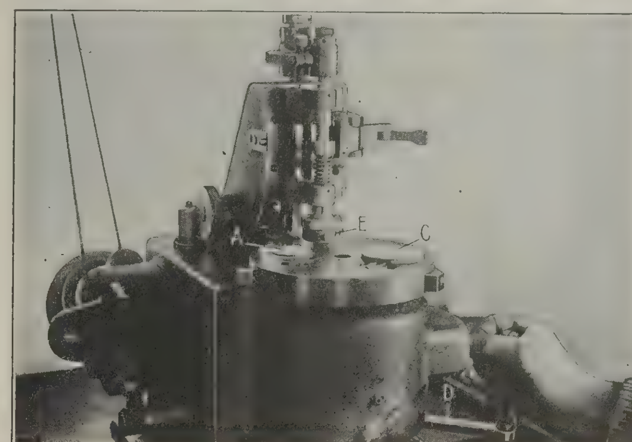


Fig. 48. Dial Printing Machine

The dials used on expensive watches are as a rule double sunk, that is, they are composed of various sized disks soldered together, that portion of the dial around the second hand usually being depressed. In such a case the enamel-coated disk is taken to a small grinding machine where that portion of the dial to be sunk is removed by means of a copper arbor coated with flour of emery, and located by means of a pilot fitting a punched hole in the dial. This emery charged arbor grinds away the enamel down to the copper on each side of the dial. The dials are now coated with paraffine wax, and an aluminum cup is placed around the ground ring in the enamel; then this is luted in place with wax. This aluminum cup is now filled with pure nitric acid, which eats or burns through the copper in about ten minutes.

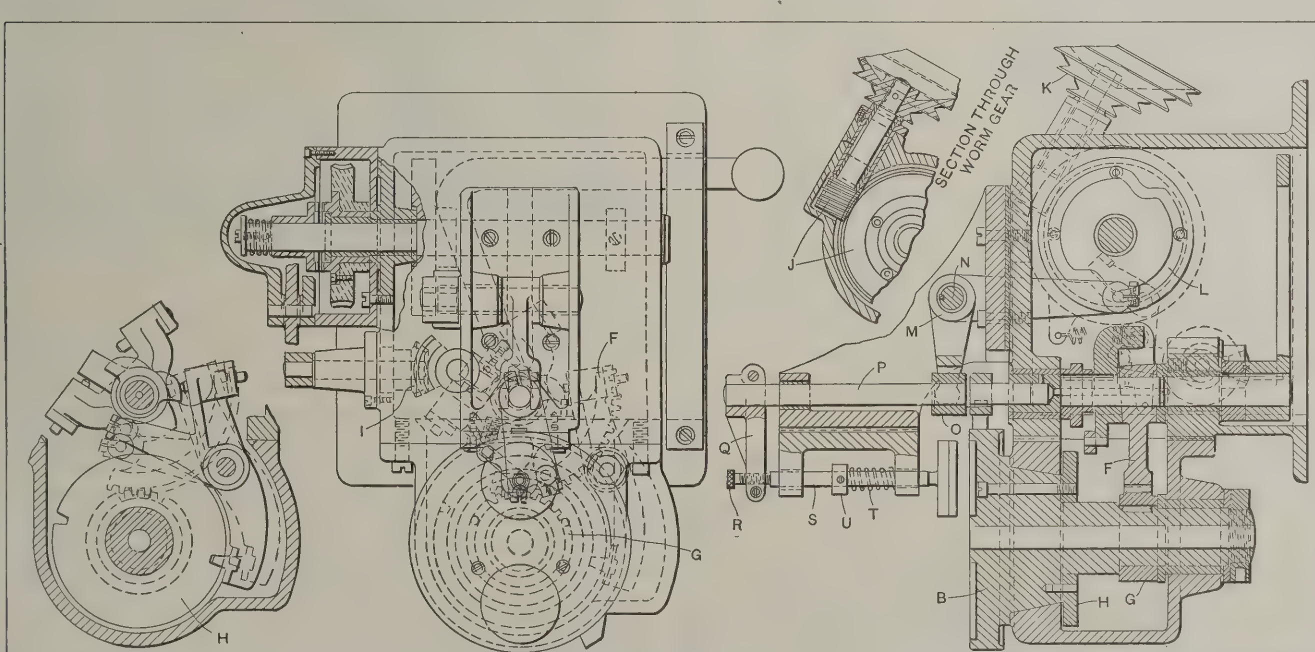


Fig. 49. Construction of the Dial Printing Machine shown in Fig. 48

While eating out the small copper disks with nitric acid, the dials are placed in a box-shaped container, provided with a rather ingenious arrangement to carry away the fumes of the acid. As is well known, nitric acid fumes, if in the vicinity of steel parts, will soon cause oxidation. Now, as the dial house is in close proximity to the factory in which the steel parts are made, the fumes of the acid would be carried to the other manufacturing departments and cause an endless amount of trouble. The device about to be described,

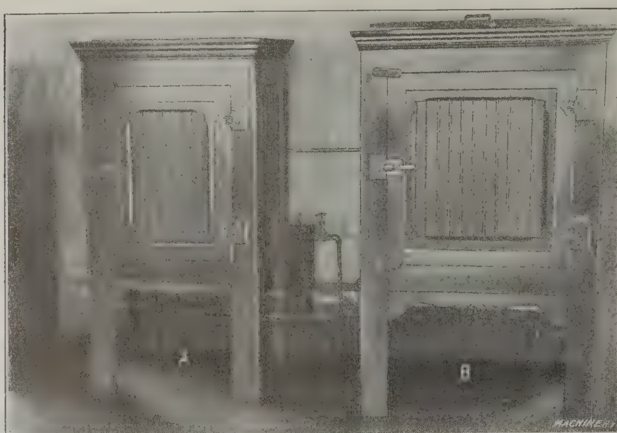


Fig. 50. Temperature Adjusting Cabinets

which was devised by Mr. Charles T. Higginbotham, consulting superintendent, takes care of these acid fumes in a satisfactory manner.

The arrangement consists of a funnel-shaped box through which the acid fumes are blown by means of an electric fan. This funnel-shaped box terminates in another box, where the fumes meet with a fine spray of water which descends in the

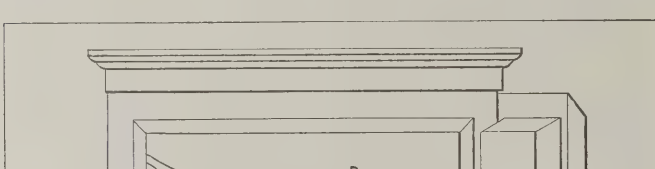


Fig. 51. Interior Arrangement of the Temperature Adjusting Cabinet shown at A in Fig. 50. Fig. 52. Temperature Regulator

shape of a fog, absorbing the nitric acid fumes and carrying them to the sewer.

After burning out a portion of the copper disk, the hole is lapped with a copper lap coated with a putty powder made from oxide of tin. The sunken portion of the dial is then cemented in place with gum arabic and the parts are soldered together. The dials are next coated with shellac varnish to obviate scratching. There are a number of other minor operations on the dials before they are ready to have the characters stamped onto them, such as beveling the edge, drilling cross holes through the dial-foot pins, etc.

Printing the Characters on Watch Dials

The characters which were formerly painted on watch dials by artists are now put on by means of a transfer method, using a steel stamp in a dial printing machine. This machine is shown in Fig. 48, and in detail in Fig. 49. The dial to be printed is placed in a nest *A* held in the table of the machine. The steel stamp *C* fastened to the table has the characters cut in it (not in relief). This stamp is coated with fondant and the excess material removed, leaving the characters filled with the "paint." The operator, by means of handle *D*, now throws in the clutch, indexing the table to bring the steel stamp under the rubber transfer pad *E*, the latter being brought in contact with the stamp by means of a cam. The table is again indexed, bringing the dial under the rubber transfer pad, and the characters are stamped on.

The mixture used as a paint for printing the characters on the dial is composed of black enamel, which has been ground extremely fine and then mixed with oil of thyme. After the dials have been stamped they are coated with "under-glacé" and the dials black-fired. Before this latter operation, however, the dial has received two impressions in the dial print-

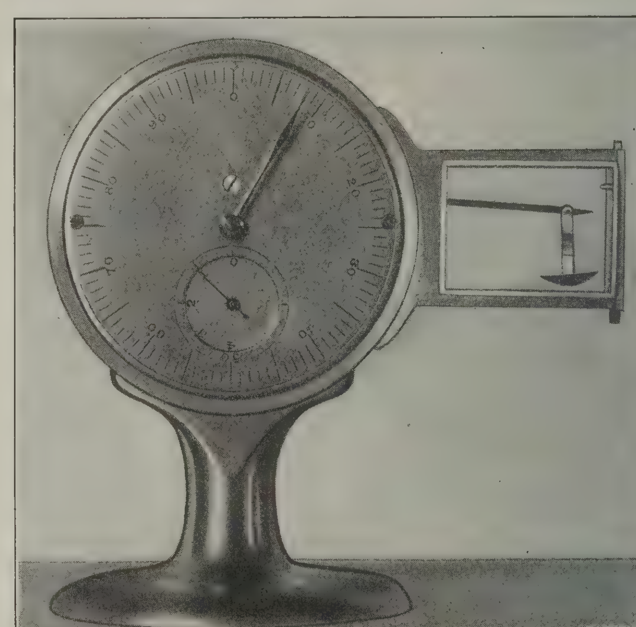


Fig. 53. Scales for Weighing Balance Screws

ing machine, the first impression being allowed to dry before th second one is applied. The black-firing takes place in the gas furnace shown in Fig. 47.

The machine used for printing the characters on the dial has some interesting mechanical features. It consists essentially of a table *B* on which the work and stamp are held. (See Fig. 49). This table is indexed or rotated by means of a sector gear *F* meshing with a pinion *G* keyed to the spindle of the table. An indexing dial *H*, provided with two notches in which an indexing finger fits, locates the table in the two positions. The sector gear receives its motion through bevel gears *I* and a worm and worm-wheel *J*, the latter being driven by pulley *K* belted to the overhead works.

The rubber transfer pad is operated by means of a cam *L* and bell-crank lever *M*, the latter being fulcrumed at *N*. The upper arm of this lever straddles a sleeve *O* which butts against a shoulder on spindle *P*. This spindle has an arm *Q* fastened to its top end carrying an adjustable screw *R* which comes in contact with the upper end of the spindle carrying the rubber pad. Spindle *S* is returned to the "up position" by means of a spring *T* working against collar *U* which is fastened by a set-screw to the spindle.

Assembling and Finishing Operations on Watch Movements

Upon completion, all of the small parts are turned into the stock-room from which they are sent out when needed. When

the jewels have been burnished into their settings, the settings are put into the plates and bridges, and the latter are ready to be assembled with the various parts of the movement. Following this, the hair spring is trued, over-coiled and vibrated for strength. The balance is also trued up and fitted to the staff. Probably one of the most interesting operations performed on a watch movement in its final stages of completion, however, is that of temperature adjustment. After the watch movement has been completely assembled and tested, it is placed in the oven shown at *A* in Fig. 50. This is provided with a water jacket having a capacity of 40 gallons, and is heated by two 4-candlepower bulbs, which keep the water at a temperature of 90 degrees. The water jacket is used as a precautionary measure so that in case the electric current is turned off for a short time there will be no difference in the temperature.

The device used for heating this cabinet and keeping it at a uniform temperature is shown in Figs. 51 and 52. The door is made to fit closely and is provided with a door jamb set at an angle. The electric bulb *B* is wired to the electric circuit and also to the temperature controlling mechanism. This, as shown in Fig. 52, consists of a wooden base *C*, to which a block *D* is fastened to hold the lamp socket. Two bi-metallic bars *E* and *F* are let into a wooden block *G*. These bars are made from a strip of brass ½ inch wide by 0.060 inch thick by 12 inches long, to which a strip of steel 0.040 inch thick is soldered. The wires *L* and *M* lead from the switch of the electric wiring, while wire *O* connects the bar *E* with the lamp. The brass strips on these bars face each other. Contact is made by a platinum tipped adjusting screw *P* that comes in contact with the platinum facing *R* on bar *E*.

This device works on the same principle as a compensated balance. Heat expands the brass strips to a greater extent than it does the steel strips, thus bending the bars outward and breaking the electric circuit by separating the platinum faces. Screw *P* is used to adjust the contact at the proper point, so as to regulate the temperature. A thermometer *Q* is suspended with its bulb near the watches to be tested, so that a true temperature will be recorded. The watch movements are kept in this cabinet at a temperature of 90 degrees F. for 24 hours.

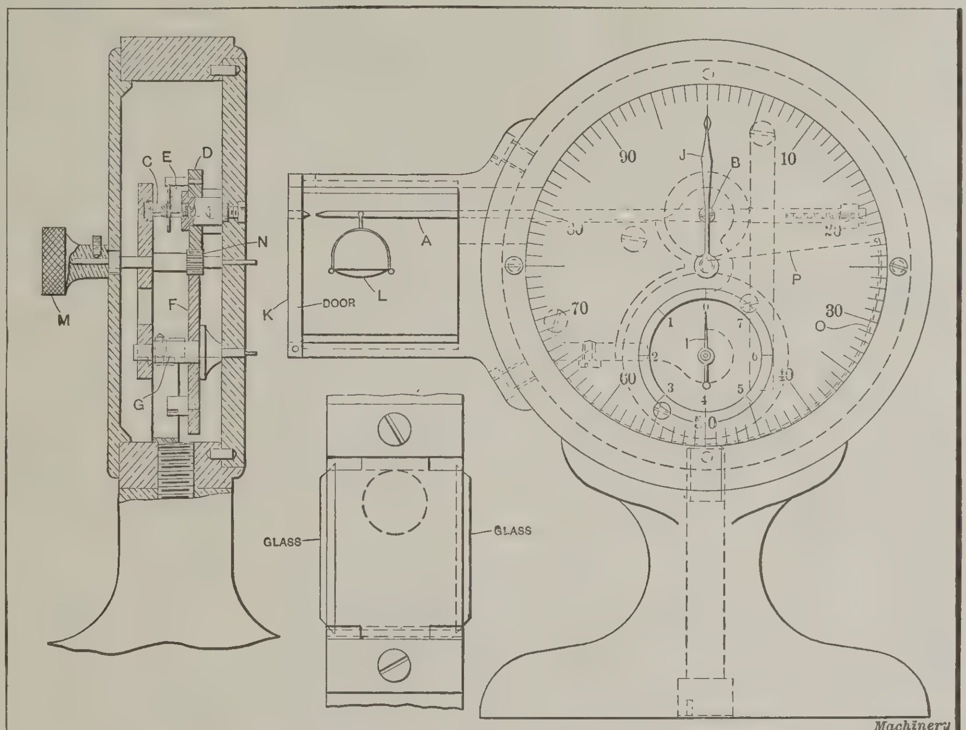


Fig. 54. Construction of the Balance-screw Scale shown in Fig. 53

After the movements have been removed from cabinet *A*, Fig. 50, they are placed in the ice box shown at *B*. Here they are left for 24 hours at a temperature of 45 degrees F. They are taken out and the change in time noted. The adjustment for temperature is accomplished by changing the weight of the balance screws, and also their location in the rim, so as to equalize the expansion and contraction of the balance.

Weighing Balance Screws

The scales used for weighing the balance screws are shown in Fig. 53 and in detail in Fig. 54. The dial is provided with 100 graduations, each graduation equaling one ten-millionth of a pound avoirdupois. The lower dial hand registers 1 when the larger hand makes one complete revolution of the dial.

Referring to Fig. 54, it will be seen that this scale consists of a beam *A* pivoted at point *B* on a balance staff *C*, the pivots of which run in jewels. Attached to the staff *C* and to a pin in wheel *D* is a watch hair spring *E*. The main wheel *F* held on arbor *G* rotates the small needle *I*, which makes one complete revolution to every eight revolutions of the large hand *J*.

To weigh a balance screw, the glass door *K* is swung back and the screw deposited in pan *L*. Then the door is closed and the hair spring *E* wound up by means of knurled thumbscrew *M* and pinion *N*, until the tension of the hair spring overcomes the weight of the screw. The screw is then removed from the pan and the door closed, when the hands register the weight of the screw on the dial in ten-millionths of a pound avoirdupois. Flat spring *O* and thread *P* take up the back-lash in the gearing. So sensitive is this scale that the amount of lead deposited on a piece of paper when writing a name with a lead pencil is clearly registered on the dial.

A difference in weight in a pair of screws, located in the rim of the balance, of one ten-millionth of a pound equals a variation of one second an hour in a watch.

Final Inspection

In the making of the South Bend watch movement parts, over twelve thousand separate and distinct operations are required. Over one hundred operations are performed on the dial alone, while the completed watch has passed through four hundred and eleven inspections. After the watch movements have been accurately adjusted and timed they are, as a final test, run for six days in order to insure uniformity of rate. Even after a watch movement has passed through all of these inspections and has been packed ready for shipment it goes to a final inspector, who unpacks the movements and puts them through a final examination for the purpose of reducing to a minimum the chance of any defect.

* * *

A bill framed as a committee measure by the Patents Committee of Congress, and which covers the features of all the different bills that have been brought in during the present session of Congress relating to patent monopolies, contains the following features of special importance: It provides for compulsory licenses, which, however, will not apply to the original inventor, but only to those persons or corporations who acquire patents by purchase, and who in the past have often done so for the purpose of suppressing competition. It also provides that no purchaser, licensee or lessee of a patented article shall be liable for action for infringement of the patent because of breach of any contract of sale or license. The bill does not propose to take away any right of action, so far as the contract is concerned, but it does take away the rights that may now exist to bring an infringement suit growing out of a contract with regard to the use or sale of a patented article. It also proposes to so amend the Sherman anti-trust law as to make it clearly applicable to combinations and trusts in restraint of trade where patents are involved in the monopoly.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

OCTOBER, 1912

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THE REVIVAL OF BUSINESS

The fall season has opened with a heavy increase of business in iron and steel products, machine tools, accessories and kindred lines required in manufacturing, which makes the outlook bright; but the tendency to mark up prices higher than conditions warrant is a mistaken policy that will inevitably result in a setback.

The crops are large and the railroads have more freight than they can move, and there is already a car shortage which is likely to increase to serious proportions. So marked a revival of trade in a presidential election year is a phenomenon almost unequaled. The common notion that business must be dull every four years apparently has been exploded, and we sincerely hope that the quadrennial scare incident to the presidential election has been dispelled.

America's resources are too great and its business is based on too solid a foundation to be seriously disturbed by possible or impending changes in the political complexion of the government. Changes in economic policy are inevitable, and whatever the coming readjustment of the tariff schedule may be—for readjustment there will be, in some respects, whoever is elected—these changes will be made conservatively and with due regard to the welfare of the great industries that have developed during the past fifty years under a protective tariff.

* * *

THE TESTING OF MATERIALS

When speaking of the testing of materials for construction, one generally understands merely the testing, by suitable machines or other means, of the various qualities of a material. The scope of the work of the International Association for Testing Materials, however, is much greater than implied by this narrow definition of the testing of materials. It is recognized that it would be of little or no use, though we were ever so expert in the mere testing of materials, if we did not at the same time know exactly what was required of certain materials for certain service. We may, for example, be able to test the tensile strength, elastic limit, hardness, elongation etc., of the material entering into steel rails, but the information thus obtained would be of comparatively little value did we not at the same time know, with certainty, the requirements necessary for steel rails that have to stand the pounding of heavy engines on a sharp curve at high speeds. It is the object of the men interested in the testing of materials not only to devise means for carrying out the required tests, but also to settle upon the necessary specifications for materials to be used for different purposes and to aid the makers of these materials, if possible, in obtaining the required qualities in them. The scope of the International Association for Testing Materials, therefore, is a very wide one. It embraces in its final analysis not only that part of the engineering science which deals directly with the study of materials, but also that which enters into the fields of design and manufacture. The work of the association is highly important to the engineering world, and the sixth congress of the association, held in New York City during the early part of September, tended to emphasize this fact. The great number of papers presented indicated the activity of the members, and the engineering world, in general, is to be congratulated upon the effective work being done.

* * *

MECHANICAL EFFICIENCY

The theory of the efficiency of machines is one of the simplest in applied mechanics, but it nevertheless seems to be one very often misunderstood and misapplied. The hundreds of inventors of perpetual motion machines are notorious examples of those who misunderstand it and the great principle of conservation of energy, but they may be classed as impractical men of little or no importance in the machine building world. There is another large class, however, whose ideas are embodied in machines built, sold and used with various degrees of satisfaction who are more or less hazy on certain fundamental principles. It is important that this class thoroughly understand the general principles which conserve power, reduce wear, and tend generally to promote the life and efficiency of machines.

A machine may be effective without being mechanically efficient, and again it may be mechanically efficient without being effective. This is an apparent paradox generally understood and appreciated. A worm-gear, as ordinarily made, is effective but not efficient, and on the other hand if highly efficient it fails to be effective as a brake—a most important consideration in some machines. In the case of machine tools, mechanical efficiency is ordinarily regarded as a minor matter, while accuracy, convenience of operation, adaptability, safety and pleasing lines are of paramount importance. But mechanical efficiency, aside from power saving, is important, nevertheless, as a mechanically inefficient machine wears rapidly and requires more lubrication to do its work than the efficient machine.

The efficiency of a machine is measured by the percentage of useful work available after transformation in the machine. The percentage of useful work is always less than one-hundred, is rarely over ninety-five in the simplest mechanisms, and is often less than ten. Efficiency is expressed by the formula: $E = \frac{W - w}{W}$, in which E is efficiency; W, the work put in; and w, the work delivered.

A stiff machine in which the train of mechanism is well supported is more efficient, other things being equal, than one having a weak and flexible train. Work is lost in bending the parts, especially when the action is intermittent. A reciprocating motion may be transmitted, for example, through a lever so weak and flexible that all the work put into the machine is lost in deflecting this member, thus producing molecular distortion and heat. Take, for example, a compressed air riveting machine of the alligator type. The stiffness of the levers is an important factor in its efficiency. A riveter having ample cylinder capacity might, nevertheless, be so weak in the levers that the toggle action would fail to produce the squeeze necessary to upset the rivets. The work that should be expended on the rivets is lost in friction of the pivots and in springing the levers which yield at the critical position so much that the necessary force to upset them is not developed. This machine would use as much compressed air as another of the same size but with stiffer mechanism which would effectively set the rivets. One is efficient and the other is totally inefficient.

Hence mechanical efficiency, while meaning the percentage of power available in terms of the power expended on a machine, should also mean that the machine is so designed that its parts are subjected to minimum wear, that a minimum amount of oil is required for lubrication and that no part is subjected to such high bending stresses at any point that it bends appreciably when transmitting the load required to do its work effectively.

* * *

SQUARE AND HEXAGON SOCKETS

The analysis of the stresses acting in square and hexagon socket safety set-screws by Mr. Myers in another part of this number, is an excellent example of practical application of mathematics to design. This is a case in which the strength of two members should be equal, if possible, but the proportions necessary for equal strength cannot be determined by simply adding here and taking off there. While the analysis is not rigid, it is sufficiently complete to answer practical requirements. It shows how the wrench socket may be so proportioned as to secure the maximum strength for both the wrench and the screw. Of paramount importance is the matter of durability when the hollow screw is employed for lathe chucks and other parts requiring constant manipulation. While it is shown that for pulley hubs and other machine parts the hexagon socket set-screw is best, as it can be so proportioned as to have greater strength than square socket set-screws of the same size, it is also shown that the square socket is better adapted for those situations in which it is subjected to daily use. Hence for lathe chucks, drill chucks, lathe dogs, etc., the square socket is preferable.

The superiority of this method of determining proportions of machine parts over mere guesswork and numerous tests is obvious. Tests, of course, are necessary to verify conclusions and make certain that the minor factors neglected in calculations are not of greater importance than assumed, but a comparatively small number of tests will suffice to verify a rational design; whereas, with rule-of-thumb or guesswork design those proportions necessary for maximum strength and efficiency are usually found only by a slow and costly process.

* * *

TABLES AND DIAGRAMS

There is considerable difference of opinion among mechanical men regarding the relative advantages and uses of tables and diagrams for recording data. Some engineers seem to prefer to tabulate all data coming under their observation, which may be useful in their practice, regardless of the fact that much of this information could be more conveniently shown in diagrams. Others have what might be called the diagram hobby, and apparently believe that all mechanical data that can possibly be given in diagram form should be put in that shape.

Both of these extreme types show a lack of appreciation of the true uses of tables and diagrams. There is, in general, a fairly well-defined field for each, and engineering data should be recorded partly by tables and partly by diagrams, according to which form best meets the requirements of the practical man. Whenever the matter dealt with has to do with parts, devices and objects made in certain specified sizes, once standardized, a table is most convenient. As an example, may be mentioned data relating to tap drills and other dimensions required in the use of pipe taps. Here a diagram is of little or no value, as there are but comparatively few standard pipe tap sizes, and all the dimensions relating to each of these sizes can be easily and conveniently tabulated with much greater exactitude than they could be put in diagram form; at the same time the chance of error in using a table is far less than in reading off a dimension from a diagram. The diagram, again, is most useful in cases where an indefinite number of combinations of values may exist, and where curves may be used to indicate the values to be found for any combination. An example of this kind is a horsepower diagram from which the horsepower that may be transmitted by gearing of different pitches and velocities may be found. In this case, tables would be entirely too voluminous, and could hardly contain all the possible combinations covered by a diagram of comparatively simple construction.

In a general way, therefore, the proper place for a table is where certain definite data are known and fixed and the values to be found corresponding to them can be conveniently put in plain figures. The diagram should be used instead in all cases where a great number of different combinations of two or more initial values are given, and where a tabulation would be entirely too voluminous to be practicable, both because of the time required for compilation and the inconvenience incident to its use. The diagram has in some cases another advantage—a curve may show the trend of certain functions, indicating the rising or falling values under certain conditions, etc. In this case, the diagram is especially useful in investigating work, when making tests, or when comparing the relative efficiency of mechanisms.

* * *

THE ONE HE GOT FROM HOME

BY A. P. PRESS

Bill was a first-class toolmaker, one of the very best we had in the shop, and the only fault we had to find with him was that nothing he ever did or saw us do—in fact, nothing in the shop or even in the whole country was so good as what they did "back home." What they did "back home" according to Bill's tell was certainly a wonder.

One day he got to talking to the boss patternmaker about extension bits.

"I tell you what, the extension bits we have 'back home' are way ahead of anything that you can get in this country, and the next time any of the boys go 'home' I am going to send and get one for you. I'm willing to pay for the bit, just to show you what they make over there."

Two weeks after that one of the boys in the shop made up his mind to take a trip to the old country, and when he came into the shop, after he got his ticket, Bill put it up to him to get him (Bill) an extension bit.

"Buy me the very best extension bit you can find, no matter what you pay for it, or who makes it, and bring it back when you come, and I will make it right with you."

"All right," and off he went.

Two months passed by, and one day he came in and asked for his old job, and as he was a "crackerjack" good man, we were glad to get him, and told him to come in in the morning.

When he came in the next day he brought in Bill's extension bit. It was in a box the same as they make "back home," and what it said on the label we are unable to tell as we only read and speak one language.

"There," said Bill, as he proudly took it out of the case, "there's a bit that is a bit. Look at that finish, and look at the way the blade is held in on the end."

"Say, but that is pretty good," said the boss patternmaker, "but at the same time it looks kind of familiar. What name is that on the shank? Hold on a minute. I can read that. Why that was made by the S. S. & S. Co., right up here in the next town."

"Well, Bill," said the boss patternmaker, "I want to thank you for that bit. Never mind if it was made only ten miles away, it has been to the old country and back again, and that is more than I ever expect to do, and I shall treasure it all the more for that."

This was the last of anything that we ever heard about "back home."

* * *

According to *The Foundry*, experiments have been made by the Crane Co., Chicago, Ill., which have shown that if iron borings are used in place of a portion of the gravel mixed in concrete, floors of this material can be successfully used in certain portions of foundries. Many foundrymen are interested in the use of concrete floors, but have generally found them unsatisfactory because molten iron will not lie on concrete on account of its porous and, therefore, generally moist condition. The mixture recommended consists of one part cement, three parts sand, four parts gravel, and one part of iron borings. It is stated that floors made from this mixture are perfectly safe.

CASEHARDENING AND CASEHARDENING PRACTICE*

A REVIEW OF METHODS IN THE BICYCLE, AUTOMOBILE BUILDING AND ALLIED TRADES

BY ROBERT H. GRANT†

A great improvement has been made in casehardening processes during the last few years. The advance was begun with the development of the bicycle industry, and the necessity for casehardened parts of the highest quality in automobile manufacture has been the cause of still further improvements in this field.

As an example of what can be accomplished by proper methods, consider the transmission gearing of an automobile. Who would think of throwing in the back-gears of a lathe or any other machine tool without first stopping the machine? In an automobile, however, this very thing is actually done, perhaps a hundred times a day, by a person who gives little thought to what he is really doing. Yet the gears stand up under this treatment because of being manufactured from special steels developed during comparatively recent years, and because of being heat-treated and casehardened by improved methods.

Principles of Casehardening

Casehardening is actually only an improvement on the old cementation process used in times past for making steel from wrought-iron. This process consisted of rolling the wrought-iron into thin strips and then placing it in boxes with some material containing a fair portion of carbon. These boxes were then heated to a very high temperature and the carbon was gradually absorbed by the iron.

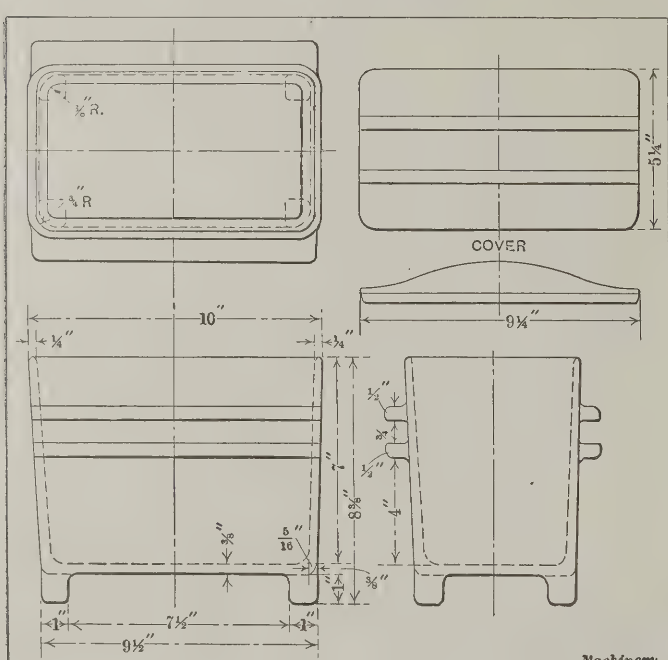

Fig. 1. Box for Casehardening, of Approved Design

In modern casehardening there are a number of different questions that must be taken into consideration. In the first place, the steel or material to be used must be considered. Another most essential thing is the casehardening furnace which must give a uniform heat. As oil has almost wholly superseded coal for heating casehardening furnaces, the changes in furnace construction have, of late, been considerable. The box constitutes another item which must be considered, as well as the material used in packing the parts to be casehardened. The methods used for hardening the parts after they have been carbonized is another question that must be dealt with.

Steel to be used for Casehardened Parts

As the casehardening process consists in adding carbon to the steel, it is necessary to use a material which will absorb the carbon without necessitating overheating or burning. The effect of carbon on steel is, in general, it may be said, to make it dense, and the denser the steel, the higher the heat necessary to open the pores through which it must absorb the carbon. A low carbon steel containing say from 0.15 to 0.20 per cent of carbon is, therefore, most suitable for casehardening. It should also be borne in mind when selecting the material that the casehardening process does not eliminate any of the impurities ordinarily found in iron, such as sulphur, phosphorus, etc., and hence a material as free as possible from these impurities should be selected.

Furnaces for Casehardening

In building or constructing a furnace for casehardening, the size of the work to be hardened should be the first consideration. It is far better to use a small furnace with a small box whenever possible. If the work varies in size, different sizes of furnaces may be used. Small furnaces require less fuel, and small work must be placed in small boxes as otherwise the pieces packed near the sides will be overheated while those in the center will not reach the required temperature. The furnaces should be made right- and left-hand so that they can be placed close together. Thick walls should be used to retain the heat. These walls should be supported by a substantial concrete foundation, so that they will retain their position and shape, even when subjected to a high heat. Large flues should be provided to carry away the smoke and gases.

The furnace should also be so constructed that as much as possible of the heat of the combustion gases may be extracted before they are discharged. The flues and all parts of the furnace should be easily accessible, and a door, the full width of the oven, should be provided so that the tiles can be taken out and the flues cleaned. A pressure blower with a light oil should be used with all the pipes accessible and placed, preferably, above the furnace. If, however, they are placed below ground, they should be arranged in compartments which can be easily reached if repairs are required.

The blower pipes should be run through the furnace so as to preheat the air used; if cold air is used directly it will reduce the heat in the furnace. The furnace fronts should be made in several parts to prevent cracking, with the door properly balanced and lined. A shelf should be provided, projecting at the front, for holding the boxes when they are taken out or put into the furnace. The smokestack should be made of sufficient height to produce a good draft.

Burners should be placed both at the front and rear of the oven and should be arranged in separate compartments, so that the heat will be uniform in the oven. The hot gases will then pass over the top of the compartment wall and strike the boxes on the top, after which they pass out through small openings in the corner of the furnace. They then take a zigzag course under the tiles and pass from there through a flue to the rear of the furnace. A large conduit should be provided just below the ground which will catch all the soot. This conduit should be provided with iron covers which can easily be taken off to remove the accumulation of soot.

The furnace should not be heated too quickly, as this is apt to crack the brickwork. The cooling should also be done gradually. After the work has been taken out and the heat shut off for the day, all the dampers should be closed to hold the heat. In this way the furnace will cool slowly and cracking or bulging out of shape will be prevented. In addition, it will be easier to heat the furnace the next morning, as it will have retained some of the heat.

When work is to be annealed, it should be placed in the furnace after the work to be hardened has been removed, and then the furnace brought to the proper heat. The ma-

* See also the following articles previously published in MACHINERY: "Casehardening," August, 1905, engineering edition; "The Casehardening Furnace," June, 1907, engineering edition, and the articles there referred to; "Casehardening Practice at the Juniata Shops of the Pennsylvania Railroad," July, 1910, engineering edition; "New Casehardening Methods," February, 1912, engineering edition; "Casehardening Temperatures," July, 1912, engineering edition. See also MACHINERY'S Reference Book No. 63, "Heat Treatment of Steel."

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terial to be annealed can then remain in the furnace until the next morning with the furnace closed up and the burners turned off.

A light oil should be used. It should have a high heating value and be comparatively free from carbon deposits, etc.

Boxes for Casehardening

The boxes for casehardening should not be made larger than necessary for the class of work being handled. They should be made from a malleable iron, as ordinary cast-iron boxes are not suitable on account of the fact that they are very porous and absorb the carbon of the carbonizing material. The boxes should also be provided with feet, as shown in Fig. 1, so that the heat can circulate all around them. The covers should be provided with ribs on the top to prevent excessive warping, and the sides should be ribbed so that a

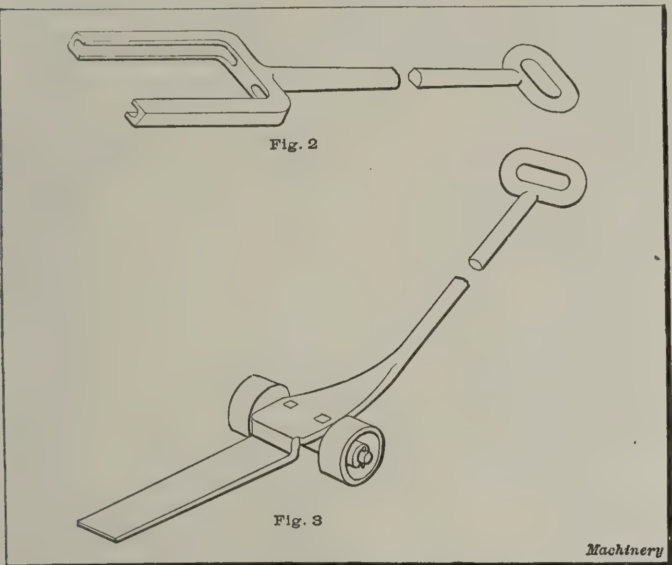


Fig. 2. Grapple Iron or Fork used for Handling Casehardening Boxes. Fig. 3. Truck for Handling Heavy Boxes

fork or grapple iron, as shown in Fig. 2, can be used for handling the boxes. The sides of the boxes should taper slightly towards the bottom so that the contents can be easily dumped out of them; they are also easier to cast when made in that way.

When very large boxes are required, they should, if possible, be provided with a hole through the center so that the heat can reach the contents from the inside, as well as from the outside. A box of this kind is shown in Fig. 4. For long work, such as shafts, tubing, etc., a wrought-iron pipe with a cap on each end provides an ideal box.

Local Hardening

In many cases it is essential that the piece of work be hardened at a certain place and that other parts be left soft. There are three ways in which this can be accomplished: First, by copper-plating and enameling; second, by covering the part which is not to be hardened by fire clay; and third, by using a bushing or collar to cover the part to be left soft.

In the first case the article should be painted with enamel where it is to be hardened, the enamel being baked after having been applied. The remainder of the piece that is to be left soft is copper-plated. In the second case, if the article to be hardened has a recess, such as a hole, slot, etc., this may be filled with clay. The third method is used when a shaft, for example, is only to be left soft for a short distance. A collar is then placed on the shaft, and this provides the easiest and least expensive means for accomplishing the purpose.

In the case where enamel and copper-plating is used, the enamel will burn away and allow the surface covered by it to absorb carbon and, hence, to be hardened, whereas the copper will stand a very high heat and prevent hardening of those portions that are covered by it. If the copper is burned off, it is an indication that the work has been overheated. The clay prevents the hardening of a portion of the work in the same way as does the copper. It is also of advantage when dipping the work, as it prevents the formation of steam pockets which are apt to warp or distort the piece. When a sleeve or collar is used, this should be made about one-half inch longer than the part which is to be left soft, so as to prevent carbonization near the ends of the collar.

Packing for Hardening

The packing room should, if possible, be separate from the room containing the furnaces, so that the packing can be done without the discomfort of the heat and dust. Tables on wheels, or trucks, provided with shelves of the same height as the shelf in front of the furnace and large enough to hold the required number of boxes for one furnace, should be provided, so that the packed boxes can be easily moved to the furnace and quickly placed in it. The work to be hardened should be classified according to its size and the percentage of carbon required, as it will take a higher heat for larger work, as well as for pieces which are required to absorb a higher percentage of carbon.

There are a great many different kinds of hardening materials, but the old-fashioned method of using ground bone can always be relied upon to give satisfactory results. During the last few years, however, the use of bone in various manufactures has increased so that the price of ground bone for casehardening purposes is almost prohibitive. Leather has become very extensively used for this purpose, it being first burned and then ground and graded.

A mixing bin is a great advantage in connection with the handling of the casehardening material. Some partly used bone and some new is then used to make a mixture suitable for the size of the pieces to be hardened. Large pieces require a richer material than smaller ones, as during the higher heat required for the larger pieces and the longer application of the heat, more of the carbonizing material will burn away.

When packing a box, first put a layer of the casehardening material on the bottom, the thickness of this layer depend-

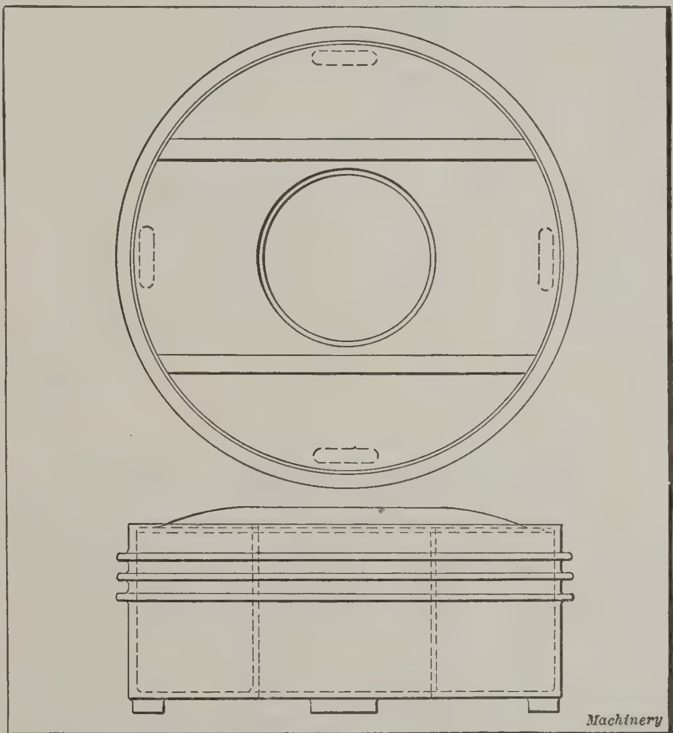


Fig. 4. Large Circular Box with Hole in Center for the Circulation of the Gases of Combustion

ing upon the size of the pieces to be hardened. If the articles are heavy, they do not require such great care in packing, but if they are thin or long, or have a peculiar shape, greater care is required. It has frequently been stated that one piece should never be permitted to touch another when packing, but it has been found that this precaution is not necessary. If a box is properly sealed, the parts can touch each other without injury. Thin long pieces should, if possible, be placed in an upright position to prevent their sagging out of shape. Between each layer of pieces, casehardening material is packed according to the size of the pieces to be hardened. It has been found from experience that if there is not enough

of the carbonizing material in the box, the work is liable to have soft spots.

About two inches from the top of the box, sheet steel strips about 1/16 inch thick should be laid and these should be covered with a layer of about one inch or more of powdered charcoal. Then the cover is placed on the box and the edges are sealed with fire clay. If there is any doubt about the length of time required for heating the pieces to obtain a certain depth of case, wire a couple of pieces together, allowing the wire to project out of the box. These pieces can then be taken out quickly and hardened, and, in this way, it can be ascertained whether the parts have been sufficiently carbonized. In casehardening very small work, it is advisable to wire the pieces together so that they can be taken out of the box at once; otherwise, they would have to be picked out with small tongs, as it is impossible to sift very small work in a screen because the mesh would have to be so fine that it would take a long time to do the sifting and the work would become too cold for hardening. If it is desirable to color the work, from one-third to one-half of the carbonizing material should be burnt leather.

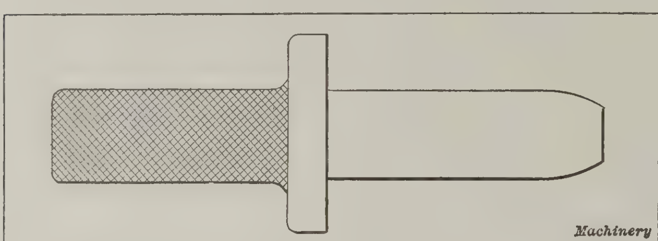


Fig. 5. Mandrel used when Hardening Collars, etc., on the Outside

The boxes should never be put into the furnace under a high heat, but should be placed in it when its temperature is from 800 to 900 degrees F. Then the heat should be slowly brought up to from 1500 to 1800 degrees F. In placing the boxes in the furnace, great care should be taken that the hot gases have an opportunity to circulate all around them. A pyrometer should be put in some convenient place and properly wired so that the heat in the furnace can be readily ascertained at any time. If there is a great deal of night work to be done, a recording pyrometer should be used as it gives the man in charge a record of the heats during the night.

By the aid of the pyrometer it has been found that it is necessary to have an expansion tank in order to get a constant air pressure, otherwise the pulsation from the blower will affect the heat in the furnace. This expansion tank should be situated so that the blower is connected directly with one end while the discharge pipe is connected at the opposite end. This will then act as a reservoir, producing a constant pressure. When oil is used for the heating, it is preferable to pump it from the storage tank in the ground to a stand pipe, which will insure a constant flow of the oil. The intermittent action of the pump, should the oil be used directly as it comes from it, is objectionable. There is also another advantage, in case the pump should have to be shut down on account of break-down. In that case, the furnaces could still continue to operate, as the stand pipe should hold a supply of oil sufficient for several hours. At night and on holidays the oil should be drained back into the storage tank in order to minimize the danger incident to its use.

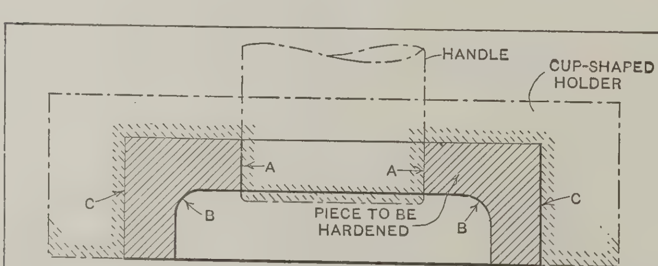


Fig. 6. Holder for Parts which are to be hardened locally

The supply pipe for the air should come from the outside and should be so arranged that the air passes through a fine wire netting, so as to prevent foreign substances from entering the blower.

On the outside of each furnace a card should be placed telling the kind of work that is in the furnace, when the work was put in, the heat required for it, and when it is to be removed. These cards can be kept as a record which will be of value when comparison is made with the depth of case obtained under any specific conditions.

Carbonizing, Reheating and Hardening

The heat required for casehardening is a great deal higher than that required for ordinary hardening. If, for example, the material to be casehardened was heated only to 1375 degrees F., which would be sufficient for the hardening of ordinary tool steel, the result would be very unsatisfactory. In fact, there would be no result at all. Small parts must be heated to at least 1575 degrees F., in which case sufficient depth of carbonized surface will be obtained in from six to eight hours. The time recorded as the correct one for casehardening should be taken from the time the boxes are heated clear through.

The correct way in which to caseharden is first to carbonize the material and then to allow the boxes to cool down with the work in them, after which they are reheated and hardened in water. The reheating refines the grain of the steel and prevents the formation of a distinct line between the outer hardened case and the soft core. If there is a distinct line between these two sections, the case is liable to flake off when the hardened part is subjected to severe stresses.

A still more refined method of casehardening is to repack the work, after it has been carbonized, in old bone, and after heating for two or three hours take it out and dip the pieces in the hardening tank directly as they come from the boxes. This will produce a very fine grain and in many cases prevent warping. If the work is large and it is required to toughen the inner core, it should be reheated to a higher heat than otherwise; then, after dipping, reheat again to 1500 or 1600 degrees F. according to the size of the work, and redip.

However, if the work to be hardened consists of bolts, nuts, screws, etc., it is satisfactory to dump them into water directly from the furnaces, without any reheating. A regular iron wheelbarrow with two pieces of flat iron placed across it lengthwise should be provided. On top of these bars is placed a sieve made from 1/8-inch wire with 1/4-inch mesh, about 18 inches square by 6 inches deep. This sieve should have a handle 6 feet long and 5/8 inch in diameter. The boxes are emptied into this sieve, and after sifting, the heated material is dumped into a tank of cold water which should be of sufficient size to prevent the water from heating too quickly. Care should also be taken in emptying the contents of the boxes into the water that they are not all dumped in one place, but scattered about in the tank. A constant flow of water should be available while the work is being hardened. The work should under no circumstances be removed from the furnace until the heat has been lowered, as the steel should be treated as tool steel after it is carbonized, and it would be injurious to the steel to harden it at the high carbonizing heat.

Gears and other parts which should be tough, but not glass hard, should preferably be hardened in an oil bath. There is then less liability of warping the work, and the hardened product will stand shocks and severe stresses without breakage. Cotton-seed oil is the best hardening medium to be used in this case.

After the work has been properly carbonized, the next operation in the case of all parts, except those mentioned as exceptions above, is to reheat. This may be done either as already explained, or it may be done in a regular muffle gas furnace in which the work can be put in rows on the tile. In this way the work can be heated very slowly, a new piece being put into the furnace to take the place of each piece as it is removed. Collars, etc., which are required to be hardened on the outside, but ought to be left soft on the inside, should be hardened on a mandrel, such as shown in Fig. 5, the diameter of the mandrel being from 0.001 to 0.003 inch smaller than the hole in the piece to be hardened. If the

inside of the piece only needs to be hardened and the outside should be left soft, a cup-shaped holder, such as shown by the dash-dotted lines in Fig. 6, may be used. In this case the work will harden at B while it is left soft at A and C.

The hardening tank should be about 30 inches in diameter and 36 inches deep and have a constant flow of water from a pipe in the center about 6 inches below the surface.

Straightening the Work after Hardening

On account of the manner in which steel is rolled, drawn or forged, the density varies in different parts of the steel, and no matter whether the material is heat-treated or not, it will warp more or less when hardened. It is, therefore, necessary to provide apparatus for straightening the work. In straightening, it is necessary to bend the work about twice as much as would be required to merely keep it straight while the pressure is applied, as, on account of its elasticity, it will have a tendency to work back to its original form. Small rollers and shafts can best be straightened in a vise by having a three-point contact on the jaws. For large diameters a special straightener will be required. A surface plate placed to the height of a man's eye, and at a slight angle towards the light, provides the easiest means for testing work of this character while being straightened.

When there is a large quantity of rings to be straightened or trued up, a surface plate can be readily rigged up in the following manner: A solid strap is provided on one side and a compound lever on the other, adjustable to any place along the plate by means of a slot in the latter. By a slight movement of the lever the ring can be trued up. An indicator should be placed at the front of the plate so that the operator can try a ring to see at which points the ring is out, and also the amount necessary for making it round. In straightening washers or flat pieces of any kind, the hydraulic press provides the best possible means. It might be well to mention that washers or flat pieces should be ground by taking a small amount off each side alternately, as, otherwise, they will return to their original warped shape. Another precaution, relating to the grinding of cylindrical surfaces, is to use a copious supply of water, as otherwise the heat of the grinding operation will draw the surface, producing soft spots. These will appear to have been caused by improper casehardening, but as a matter of fact, they are wholly produced during the grinding operation.

* * *

ITALIAN NATIONAL AERO LEAGUE

A national "Aero League" has been formed in Italy and the raising of funds by public voluntary subscriptions has been started to build an aerial fleet of one hundred aeroplanes for the Italian government. A similar movement for collecting, by voluntary subscriptions, funds for the building of military airships has also been started in France; and the extent to which the military craze carries some of the European countries is further exemplified by the fact that in Sweden voluntary subscriptions are now being solicited for the building of battleships. A curious thing is that these movements meet with enthusiastic response, and that in Sweden, for example, millions of dollars have been collected within the space of a few months.

* * *

LIMITS ON GEARING

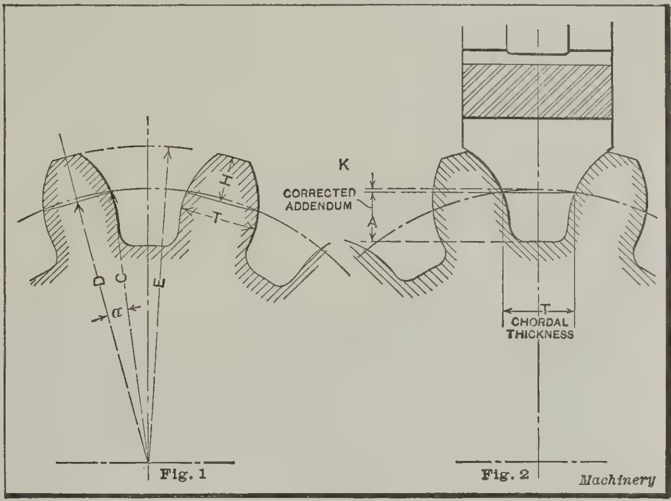
In an article in the *Machine Tool Engineer*, a supplement to the *Practical Engineer* (London, England), Mr. Francis W. Shaw gives the following table for allowable limits for spur gearing, the limits being based on the pitch of the gears:

Pitch	Center Distance	Pitch Diameter	Blanks, Outside Diameter
16	±0.002	−0.003 to −0.005	0.000 to −0.005
14	±0.003	−0.004 to −0.006	0.000 to −0.005
12	±0.0035	−0.0045 to −0.007	0.000 to −0.006
10	±0.004	−0.005 to −0.008	0.000 to −0.006
8	±0.005	−0.006 to −0.009	0.000 to −0.007
6	±0.006	−0.007 to −0.010	0.000 to −0.008
5	±0.007	−0.008 to −0.011	0.000 to −0.010
4	±0.008	−0.009 to −0.012	0.000 to −0.015

CHORDAL THICKNESSES AND ADDENDA FOR GEAR TEETH AND GEAR CUTTERS*

In measuring the thickness of gear teeth and gear cutters, it is necessary to make allowance for the curve of the pitch circle of the gear. In the ordinary 14½-degree involute system, eight cutters to a set are used, the cutters being laid out as follows: No. 1, for 135 teeth; No. 2, for 55 teeth; No. 3, for 35 teeth; No. 4, for 26 teeth; No. 5, for 21 teeth; No. 6, for 17 teeth; No. 7, for 14 teeth, and No. 8, for 12 teeth.

In the following article will be given formulas for finding the chordal thicknesses and what is called the "corrected" addenda, that is, the perpendicular distance from the chord at the pitch circle to the outside diameter of the gear as indicated at H, in Fig. 1. In the accompanying Data Sheet



Figs. 1 and 2. Notation used in Formulas for Chordal Thicknesses and Addenda of Gear Teeth and Cutters

Supplement, tables are given for the chordal thicknesses and the corrected addenda for gear teeth and gear cutters. Let,

a = half the angle subtended from the center of the gear by one gear tooth (see Fig. 1),
N = number of teeth in gear,
T = chordal thickness of tooth at pitch line,
D = perpendicular distance from chord T to center of gear,
H = perpendicular distance from chord to outside circumference of gear,
C = radius of gear at pitch line,
E = outside radius of gear.

The formulas are as follows:

$$a = \frac{90^\circ}{N};\quad T = 2\,C \times \sin a;$$

$$D = \sqrt{C^2 - (\tfrac{1}{2}\,T)^2};\quad H = E - D.$$

In the case of the gear cutter (see Fig. 2), the chordal thickness is the same as that for the gear, but the corrected addendum of the gear cutter is different from the corrected addendum of the gear. The two dimensions, however, added together must equal the total depth of the gear tooth. To obtain the corrected addendum A of the gear cutter, we can, therefore, either subtract the dimension H, as found by the previous formulas, from the dimension for the total depth of the tooth, or we can take the dedendum for the particular pitch required from any standard table of gear tooth parts and subtract the dimension K, Fig. 2, which is found by the formula:

$$K = C\ (1 - \cos a).$$

The values thus found are given in the tables entitled "Chordal Thicknesses and Addenda for Gear Cutters" in the accompanying Data Sheet Supplement. As these tables are calculated for both diametral and circular pitch and for all commonly occurring pitches in either system, they should prove of considerable value to persons engaged in gear cutting or in the making of gear cutters.

* * *

Rivets should never be used in direct tension, but bolts and nuts should be used instead.

* With Data Sheet Supplement.

PRE-HEATING METALS TO BE WELDED BY OXY-ACETYLENE PROCESS*†

OBJECT OF PRE-HEATING, AND METHODS AND APPLIANCES USED IN THIS WORK

BY J. F. SPRINGER‡

The use of the oxy-acetylene torch for heating the work from the ordinary open-air or room temperature to that of, say, red heat, is a rather wasteful method. It is frequently more economical to do this pre-heating by some cheaper method and then to complete the heating with the torch. Various methods are used for pre-heating; as a rule these methods are comparatively simple. A number of examples will be described in the following.

In pre-heating a large cast-iron kettle, a charcoal fire was employed. The kettle weighed about 18,000 pounds and the metal around the crack, which was about two feet long, was several inches thick. The crack was in the bottom and so the kettle was overturned in order to make the crack more easily accessible. The pre-heating was then done from within the kettle, and, in this case, was not only economical but probably essential, as it would have been difficult to obtain the required amount of heat by the torch flame alone. Asbestos sheeting was employed to protect the operator from the heat radiation.

In repairing a break in a locomotive cylinder, Fig. 1, the pre-heating was also done with charcoal, a temporary oven having been built up of loosely laid bricks, as shown in Fig. 2. The fire was kept going for two and one-half hours, at which time a dull red heat was secured. This condition was maintained for six hours longer during the welding operation. It is often possible to use an ordinary blacksmith's forge for the pre-heating, and if a great many similar parts are to be handled, a special forge and bellows may be found of advantage. In addition to the use of charcoal, torches using illuminating, producer, or natural gas, oil, or gasoline, may be employed; in fact, any method for obtaining a large amount of heat, but not necessarily a high temperature, can be employed. In one case, in welding a break in a locomotive engine frame, a gasoline torch was employed for the pre-heating, the torch being applied throughout the welding operation. In cases of repetition work, special pipes and burners may be used.

In one plant in Europe, where tubing is manufactured with the aid of power-driven gas-welding machines, provision is made for the rolled but unwelded tube to pass through a muffle just before reaching the torch, so that the tube is bright red when passing under the torch. Sometimes the outer flame of the torch itself may be used for pre-heating. Thus the Edison Storage Battery Co. employs a machine (see MACHINERY, September, 1911, engineering edition, "Oxy-acetylene Welding and the Edison Storage Battery Can") in welding a straight seam on the containing cans of their batteries. The torch, the work, and the clamping devices are so arranged that the outer flame of the oxy-acetylene jet is divided into two long streamers. One of these impinges upon the seam several inches ahead of the place where it is reached by the working flame. It is possible that this arrangement was not provided with a view to pre-heating, but that is the effect, and a consequent economy in gas consumption is the result.

The use of the outer flame for pre-heating may come to be quite an important factor. A large quantity of heat is generated by this flame. In the machine referred to, the clamps arranged along the sides of the seam are beveled to afford access to the torch, the bevels being quite steep—about 60 degrees. The writer would suggest that similar clamping bars be formed in connection with regular hand-welding work, so as to provide a canyon-like working groove. In hand-welding larger sizes of tubing, it would also be practicable to provide a series of gas jets on a single supply pipe beneath the joint. In this way the edges could be pre-heated with cheap gas.

Pre-heating is often resorted to for reasons other than those of economy of gas consumption. It is used where the effects of expansion and contraction are objectionable. The rise of 2000 degrees in the temperature of a metallic body occasions considerable expansion in every direction. For example, a 12-inch steel bar will lengthen about 5/32 inch. It is easily seen that the sudden swelling and resultant shrinking of only a small part of the work may, at times, have disastrous results. Take as an example the spoke of a fly-wheel with a piece broken out. This piece just fits into its place. If we repair this by making the required grooves and then filling them with new metal, thus producing an apparently good weld, we will find that, upon cooling, a break will frequently occur in the weld or at some other point, due to the contraction. A similar case is met with in a crack in a casting. It is chipped out in order to obtain beveled edges for the flame, the faces are heated, and new molten material filled in. When the weld cools off, however, the new material is likely to shrink away from the walls of the crack.

Now what can be done to meet this condition? If we could uniformly heat the whole work within as well as without, we should probably have an ideal solution, but one of the great objects in oxy-acetylene welding is to localize the heating. We can, however, pre-heat a larger portion of the whole body than is required for the welding alone, and in this way distribute the stresses. In the case of the flywheel, the broken spoke, the adjacent spokes, and the intervening rim may be heated

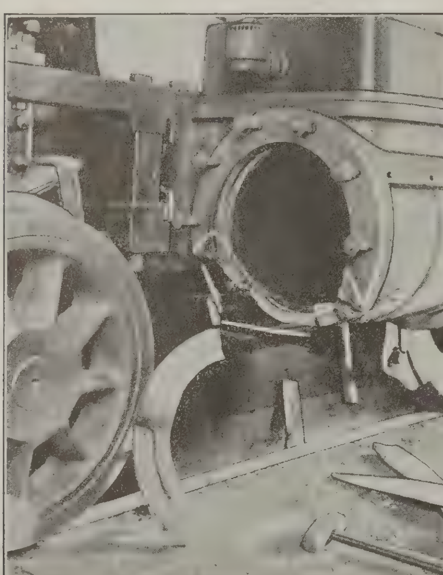


Fig. 1. The Broken Cylinder

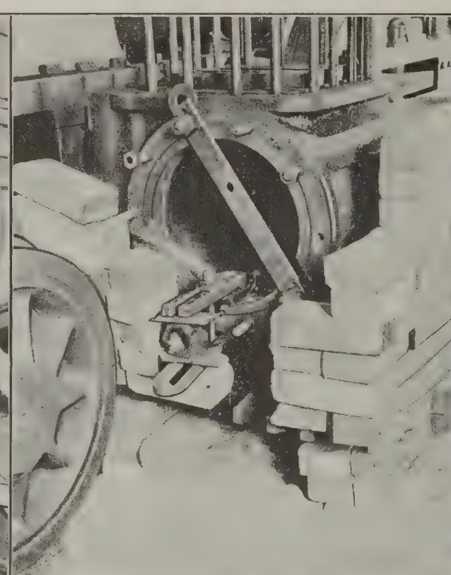


Fig. 2. Arrangement for Pre-heating

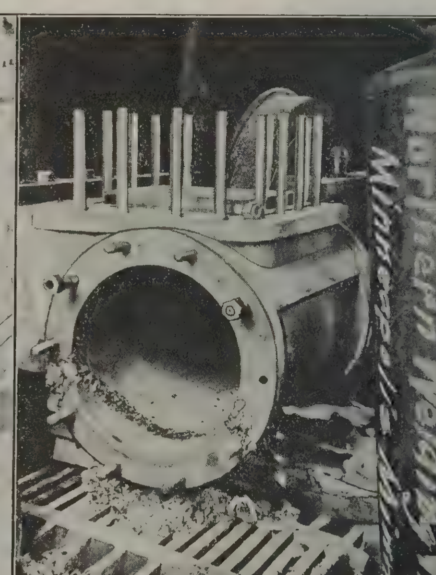


Fig. 3. After Welding, before Cleaning Weld

* For further information on autogenous welding, see "Modern Welding Methods," MACHINERY, December, 1911, and the previously published articles there referred to.

† This article has been prepared with the cooperation of the Davis-Bournonville Co., New York, and is a chapter from a forthcoming book: "Oxy-acetylene Torch Practice."

‡ Address: 608 West 140th St., New York.

to a red heat, gradually diminishing toward the other parts of the wheel, so that the pre-heating itself does not introduce new stresses. When the new material for making the joints is filled in, the spoke is naturally longer than it will be at ordinary temperatures, and while there is a local contraction of the weld, there is also a general contraction of the whole spoke and those adjacent, which diminishes the effect. In the case of a cracked cylinder casting, the pre-heating of the metal beyond each end of the crack, if properly done, will ordinarily open up the crack so that when it is filled with new metal, the amount which is used will be sufficient, when the cylinder

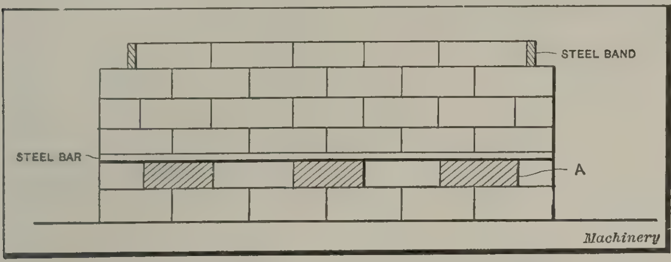


Fig. 4. Arrangement of Temporary Brick Furnace

cools off, to fill the original space. Ordinarily, the walls of the crack should be held apart until the weld is completed, so that the width of the crack and the new metal will contract together. If the crack runs from a point within the periphery all the way to the edge it may be opened up by heating at a point a little further in than the beginning of the crack. The welding is begun at the inner end of the crack, working toward the edge.

The pre-heating should ordinarily be done rather slowly so as not to introduce sudden temperature changes and stresses. Slow heating is especially to be advised when there is a combination of thin and heavy parts. Similar remarks apply to the cooling, which should be slow to be safe; the cooling may be retarded by the use of asbestos sheeting or by packing the object in heated ashes or heated slacked lime.

When it is possible to pre-heat the entire casting, this seems to be the best way of taking care of expansions and contractions. Castings the size of which makes necessary special arrangements may be placed on a bed of fire-brick ar-

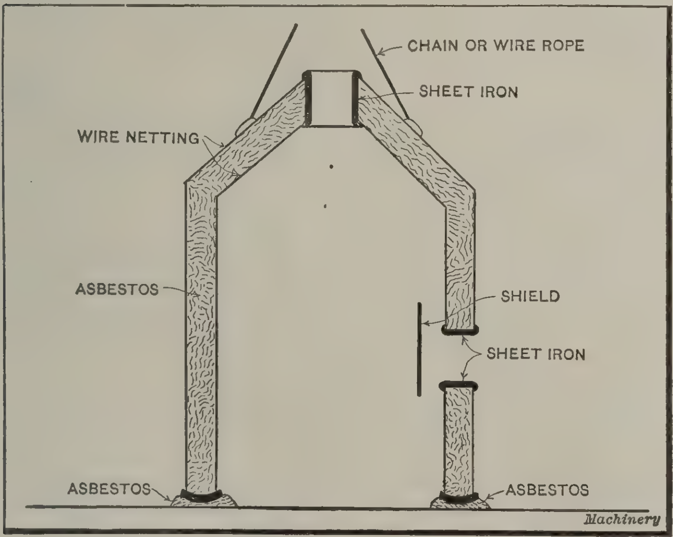


Fig. 5. Hood used for the Pre-heating Operation

ranged with spaces between them. A temporary wall or furnace is then built around the whole, fire-brick being used for this also. These are arranged, of course, without the use of mortar, with very narrow openings between them, one method of constructing such a wall being shown in Fig. 4.

Flat steel bars may be employed just above the separated course of bricks *A*. The top course may be held in place by a steel band. The object of the open spaces is to provide a draft. Charcoal is now filled in between the casting and the wall and the fire started. A sheet of asbestos is used as a cover. This cover should contain a number of holes so as to provide an exit for the gases.

Another method is to make a hood of a material that is a poor conductor of heat. Such a hood is shown in vertical section in Fig. 5. The walls consist of two sheets of wire netting with an intervening space filled with asbestos. A hole, the wall of which is made of sheet iron, is provided at the top. Another aperture also lined with sheet iron is provided on one side of the vertical cylindrical wall. The bottom of the hood is furnished with an annular base ring of sheet iron, the netting and sheet iron being joined by welding. Provision should be made for lifting and lowering the hood, so that it can be let down over the casting which is to be pre-heated. To make a tight joint with the floor, some loose asbestos may be used as a foundation for the hood. A kerosene or other torch may now be inserted through the aperture in the side. Some kind of shield may be used just inside of the side opening to divide the flame, so that, as far as possible, the casting will be encircled by it. Sometimes it is advisable to use auxiliary fires on shelves above the main fire at the bottom. This is especially to be recommended for tall castings, so that there will be no severe concentration of heat at one point. As already mentioned, the heating should be done slowly, the fires being started in a moderate way and gradually increasing in intensity. During the welding the hood must, of course, be raised, and when the welding is completed the hood may again be lowered into position in order to retard the cooling. The oil torch should be brought into service again for a short period. It may then be shut off and the openings of the hood covered. In this way, slow and even cooling is assured.

In general, after a welding operation, the casting should be reheated as soon as the welding is completed, and then covered with asbestos wool or scrap asbestos. The casting may also be buried in any of the materials ordinarily used for retarding the cooling of steel which is to be annealed. If the casting is of such a shape that it is not likely to crack, it may be cooled in the bed of charcoal in which it has been heated.

Cast iron may be pre-heated to about 700 or 1000 degrees F. Generally speaking, the higher the temperature of pre-heating, the less the danger of cracking when cooling. Aluminum castings should be pre-heated to about 600 or 700 degrees F., the heat if possible being maintained during the entire time of welding. To accomplish this, it is often advisable to cover the casting with asbestos and to leave only the working area exposed. Asbestos sheeting will be found satisfactory for keeping any class of work hot during the welding.

It may be of interest to refer to a specific case of welding performed by the Pullman Co. of Chicago. The bed of a hydraulic press was cracked; the casting weighed about 10 tons, and the crack was about 10 inches long and 26 inches deep. The material of the bed was cast steel. The casting was placed on supports of brick about 14 inches high and a fire of wood and charcoal was maintained during the night, with the result that when the welding was begun the metal was at a red heat. A No. 10 Davis-Bournonville tip was used with a soft steel welding rod, two workmen carrying out the work. The time consumed for the welding operation was about five hours. The necessary enlargement of the crack was made by the oxy-acetylene flame. The expense was estimated at $19.16, and the result of the welding was very satisfactory. As the gas cost of the Pullman Co. is extraordinarily low, for ordinary conditions the expense would, perhaps, be as follows:

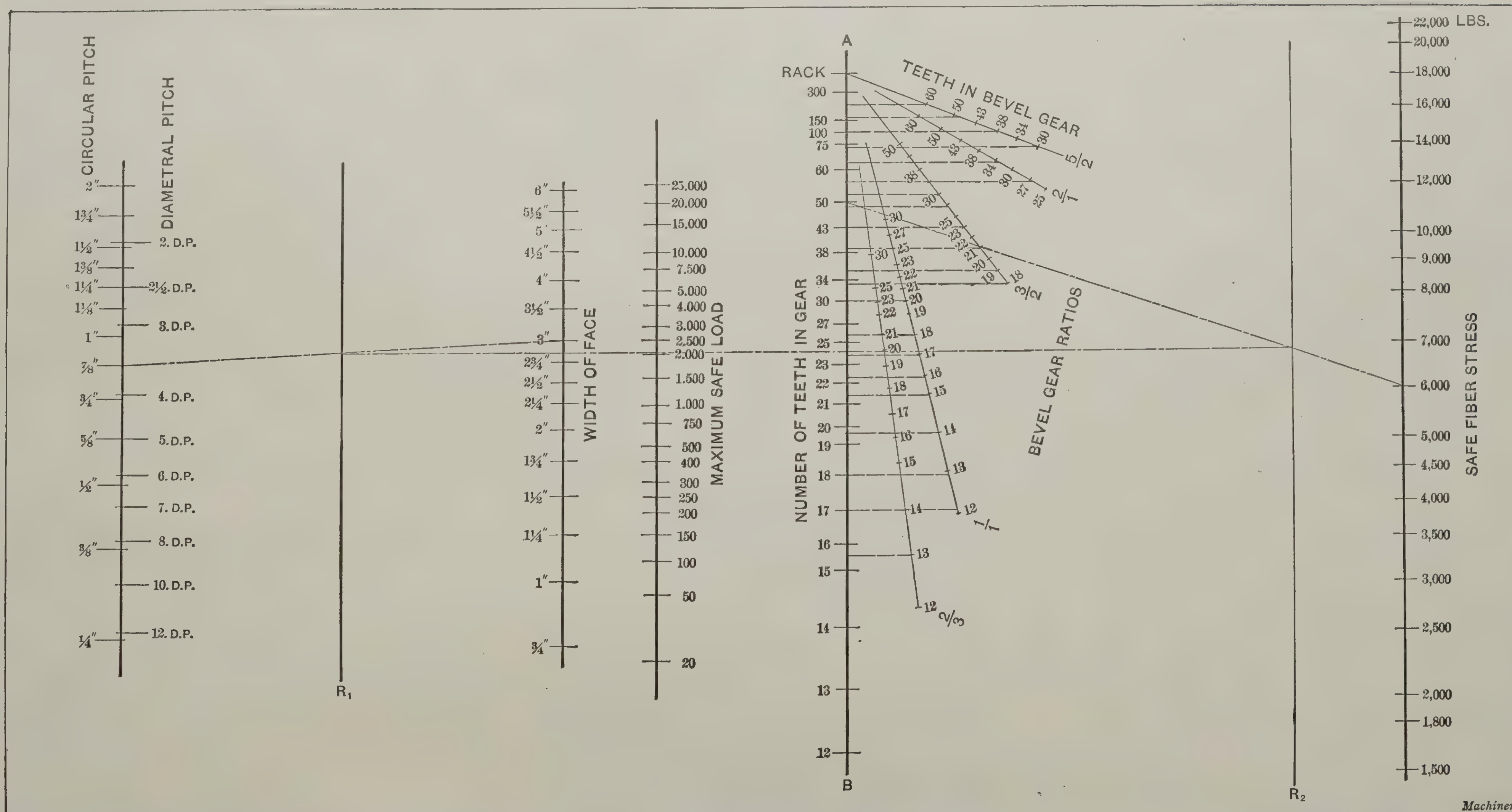
357 cubic feet of oxygen at 3 cents per cubic foot...	$10.71
143 cubic feet of acetylene at 1 cent per cubic foot..	1.43
Labor	7.40
Fuel for pre-heating and annealing..................	4.00
	$23.54

The expense of replacing the casting by a new one would have been about $600.

* * *

An investigation of the melting points of tungsten and tantalum has been carried out at the University of Wisconsin, the measurements having been taken with especial care, using the optical pyrometer and a direct vision prism transmitting monochromatic light. The melting point of tungsten was found to be 3002 degrees C. (5435 degrees F.), and of tantalum, 2798 degrees C. (4982 degrees F.). These values are somewhat different from those generally accepted.

CHART FOR FINDING THE STRENGTH OF GEAR TEETH



Conditions of Drive	Pitch Line Velocity, Feet per Minute	Approximate Safe Fiber Stress, Pounds per Square Inch					
		Spur and Bevel Gears				Helical Gears	
		Cast Iron	Steel	Phosphor-bronze	Rawhide	Cast Iron	Steel
Without shock	Any	5000–8000	18,000–20,000	14,000–16,000	2500–3500	5000–8000	18,000–20,000
With shock	200– 800	3000–6000	14,000–18,000	9000–12,000	2500–3500	5000–8000	18,000–20,000
	800–1600	2000–4500	10,000–14,000	6000–10,000	2500–3500	3000–6000	14,000–18,000
	1600–2400	1500–3000	7000–12,000	4000– 7000	2500–3500	2000–4500	10,000–16,000

HOW TO USE THE CHART

Required to find the safe load for a cast-iron gear having 50 teeth, ⅞ inch circular pitch, and 3-inch face; assume the fiber stress to be 6000 pounds per square inch. Join the graduation for ⅞ inch circular pitch with that for 3 inches width of face; also join the graduation for 50 teeth with that for 6000 pounds fiber stress. Then join the points where these two lines intersect lines R_1 and R_2, respectively. The intersection of this joining line with the maximum safe load scale gives the safe load, which for this gear is about 2050 pounds.

LOGARITHMIC CHART FOR FINDING THE STRENGTH OF GEAR TEETH*

BY H. T. MILLAR†

The accompanying illustration shows a logarithmic chart for the strength of cut gearing. The chart is based on the well-known Lewis formula. The method of using it is explained by the example shown in dash-dotted lines. Assume that it is required to find the safe load for a cast-iron gear having 50 teeth, the gear being of ⅞ inch circular pitch and having a 3-inch face. The fiber stress is assumed at 6000 pounds per square inch. To use the chart, join the graduation for ⅞ inch circular pitch with that for 3-inch width of face; also join the graduation for 50 teeth with that for 6000 pounds fiber stress. Join the points where these two lines intersect lines R_1 and R_2, respectively. The intersection of this joining line with the scale for the maximum safe load indicates that the safe load for this gear is about 2050 pounds.

The tooth form of a bevel gear is stronger than that of a spur gear of an equal number of teeth. The chart can also be used for bevel gears, as indicated. The increase in strength due to various cone angles is taken care of by the diverging lines marked with the ratio of the bevel gears. To use the diagram for bevel gears, follow the horizontal line from the actual number of teeth in the bevel gear to the scale *AB;* then use the number of teeth thus found on this scale for determining the strength, as already explained in the previous example. In using the chart for bevel gears the pitch selected must be the mean or average pitch and not the nominal pitch.

Some notes on helical gearing may be of interest, and may be found useful on account of the increased use of this class of gearing. The increased strength of helical gearing comes from two causes. The meshing action is more continuous, and, therefore, a high velocity is not so likely to induce shock. The contact between two helical teeth in mesh is very different. The line of contact is inclined across the face, beginning at the root and passing through the pitch line to the point. Considering, therefore, the tooth as a cantilever, the mean leverage of the load is less than with a straight cut tooth, where the load may have a leverage almost as great as the tooth depth. The angle of the tooth helix is usually so arranged that with a minimum width there is always contact at the pitch line of one of the teeth in mesh. In practice, it has been found that most double helical gears, especially pinions, fail through wear rather than through breakage, since in the usual case of helical gear reductions the circumferential speed of the gears is high. It is not wise to have a bearing pressure per inch of width very much higher than that given in the Lewis formula, unless the teeth are lubricated. It is also customary to select a fine pitch and a relatively wide face, say about six times the circular pitch, or 20 divided by the diametral pitch. When using the chart for helical gearing, the maximum safe load may be obtained by selecting a somewhat larger pitch than the actual one, and this pitch should be used for the graphical work.

* * *

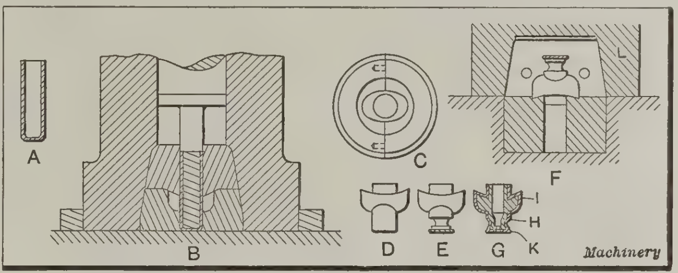
METHOD OF MAKING WATCH CASE PENDANTS

In the August, 1912, number of MACHINERY an article appeared entitled "Watch Case Manufacture," in which the making of a number of parts of watch cases is described. Little attention is given in this article, however, to the making of watch case pendants. It may, therefore, be of interest to show, in general outline, a method for making one-piece pendants as invented by Charles W. Butts of Sag Harbor, N. Y., and described in U. S. Patent No. 865,759, from which the accompanying description has been obtained. The principal object of this invention is to form a watch case pendant wholly of one piece from what is commonly known as "filled" metal or "gold-filled"; that is, gold covering a base metal, which latter must not be exposed after the pendant is formed.

The principle employed for accomplishing this result is to use dies of such a shape that when a straight tubular blank containing a core of a soft plastic metal is placed within the dies and pressure is brought to bear upon the blank and the core, the metal of the blank and core will flow into the cavities of the die and thus form a pendant of the desired shape. The pendant is then removed from the die, which is made in halves for this purpose, a central hole is drilled in it, and by means of rolls the lower part of the body of the pendant is depressed and a foot and bead are formed on it. The final over form of the foot of the pendant is obtained by placing the pendant, after the foot and bead have been formed, within a die made in halves and exerting pressure upon it. In this way it is possible to produce a pendant in one piece.

In the past, watch case pendants have generally been made in two pieces, the body and foot of the pendant having formed one piece, while the oval cap has been made in a separate part, these parts afterward being soldered together. Pendants made in this manner are not satisfactory, for the reason that, in forming the cap separate from the body of the pendant, the filling metal is necessarily exposed in some places; nor is an absolute uniformity in product possible when the pendants are made in two parts and afterward fastened together.

The accompanying illustration shows, in a general way, the methods for making the pendants in the manner described. At



A Method for Making One-piece Watch Case Pendants

A is shown the blank from which the pendant is made. This blank has a tubular section and is closed at one end. It is made of a base metal covered with a precious metal. This blank is filled with a core of base metal and then inserted in the hole in the dies at *B*, which shows a vertical section through the dies used for forming the cap. The tube with its core of soft plastic metal is shown in the center of this illustration. By filling the blank with a core of base metal, the tubular blank is caused to flow more quickly and evenly into the cavities of the die, and, at the same time, the strain on the precious metal covering is relieved while the cap on the pendant is being formed. When the plunger descends upon the blank the core of metal of the latter is upset and forced to flow outward, thus preventing the wall of the blank from collapsing inward. When the plunger has reached the limit of its downward stroke, the walls of the metal blank will have been forced tight against the walls of the cavity in the die. A plan view of the lower die is shown at *C*. The die is made in two parts in order to make possible the removal of the formed pendant after the operation is completed.

At *D* is shown the appearance of the pendant after the blanks have been operated upon by the dies shown at *B*. The core, after this operation, of course, completely fills the blank, and a hole is then drilled through it, this hole being shown in the section at *G*. The blank is then placed between rollers or other suitable tools and the cylindrical part is spun and the foot and bead formed so as to give it the shape indicated at *E*. After the foot and bead have been formed on the lower portion of the body, the blank is inverted and placed so that the oval cap will rest within the depressions of the dies shown in section at *F*. The upper die is made in halves which, when placed together, give the foot and bead their final oval shape. This is accomplished by having the two halves of the die slightly apart at the beginning of the operation, but forcing them together by the block *L* as the operation proceeds, the outside of the die and the inside of blank *L* being conical in shape as indicated. A section of the pendant after this operation is completed is shown at *G*. The part *H* is cylindrical, while the cap *I* and foot *K* are oval in shape. The hole through the pendant is made, of course, in any suitable manner to fit the winding-stem of the watch.

* See MACHINERY, January, 1908, engineering edition: "Variation of the Strength of Gear Teeth with the Velocity." See also MACHINERY's Reference Book No. 15, "Spur Gearing," Chapter VI.
† Address: 150 Waterloo Road, Manchester, England.

It will be seen that the process briefly consists in the making of a one-piece watch pendant by first upsetting a cylindrical blank to form a non-cylindrical cap and a cylindrical base, using a core of soft plastic metal within the tubular blank to accomplish this, and then drilling the hole through the soft metal core. The base is then spun to form a cylindrical foot and bead, and finally the foot and bead are compressed into a non-cylindrical shape.

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ALLOWANCES ON PARTS TO BE ASSEMBLED BY PRESSURE*

BY S. M. HOWELL†

The following article gives some data on the allowances for parts to be assembled by pressure. The subject is one of much importance in machine construction, and the data given has been secured by observation and personal experience in a large number of cases.

In making a press fit, the pressure at which the parts are assembled is estimated from the size and character of the job and the degree of tightness desired. In the case of very large work, the pressure may be limited by the capacity of the press. When the tonnage of pressure has been decided, the next step is to determine the allowance on the parts for the fit, that is, how much larger the fitted part should be than the hole into which it is forced, in order to enter at the required pressure. In plants where a special line of machinery is regularly manufactured, and the same parts are continually made, work to be assembled in this way is machined to dimensions which are known to be right from previous experience, and is usually fitted to gages; but in repair shops and other places where the work is of a more diversified character, the allowance must be determined in each individual case.

The "feel" of the calipers is, of course, a ready way of judging small variations of size, and is sufficiently reliable for many purposes, but when more definite results are desirable, a predetermined allowance, accurately measured, should be made. For this purpose an inside micrometer gage and a pair of outside calipers constitute a practical device.

In determining the allowance to be made in a given case, the governing conditions are the diameter and the length of the bearing, and to a greater or less degree also the character of the material and the smoothness of the surfaces of the fit. It is obviously impossible to accurately calculate the effect of varying degrees of hardness and other irregular conditions by means of mathematical formulas. In the majority of cases, however, the shaft or pin to be forced into place is of soft steel, and the receiving part is either of cast iron, or is a steel casting. The material is of average quality and the machined surfaces are slightly rough, the finishing cut having been taken with a moderate feed and without filing. Assuming these to be the conditions, the allowance to be made for the fit will, in a general way, depend upon the diameter and length of the bearing and the required tonnage. For finding the allowance, the following rule is applied:

Multiply the pressure in tons by 4.4, and divide the product by the product of the length and diameter in inches. The quotient is the allowance in thousandths of an inch. This rule may be given as a formula, as follows:

$$A = \frac{4.4P}{LD}$$

In this formula

A = allowance in thousandths of an inch,

D = diameter of hole in inches,

L = length of fit in inches,

P = pressure in tons.

As an example, assume that a pin is to be forced into a hole 4 inches in diameter, 6 inches long, the pressure being 40 tons. From our formula we find:

$$A = \frac{4.4 \times 40}{4 \times 6} = 7.3$$

Hence the proper allowance is 0.0073 inch.

As another example, assume that a shaft is to be forced into a hole 5 inches in diameter with a pressure of 60 tons; the length of the bearing is 8 inches. Then:

$$A = \frac{4.4 \times 60}{5 \times 8} = 6.6$$

Hence the allowance is 0.0066 inch.

The rule can be transposed so that we can find the required pressure when the allowance and the length of the bearing are known. In this case the rule will be:

Multiply the length by the diameter in inches, and multiply this product by the allowance in thousandths of an inch; divide this final product by 4.4.

The quotient will be the required pressure in tons. As a formula this rule becomes:

$$P = \frac{LDA}{4.4}$$

As an example, assume that a pin 2 inches in diameter is to be forced into a bearing 4 inches long, the allowance being 0.004 inch. What will be the required pressure in tons?

$$P = \frac{4 \times 2 \times 4}{4.4} = 7.3 \text{ tons.}$$

When forcing shafts into large rollers there is usually a short bearing at each end. In this case the shaft must be driven into both bearings at once, and the pressure required will be double that of a single bearing of the same length, or, in other words, in calculating the allowance, the length used in the formula must be equal to the sum of the length of the two bearings.

In small work where the parts are strong and it is required that they be tightly driven, an allowance of 0.002 inch per inch of diameter may be made, but care must be taken that the required pressure is not so great as to strain the material beyond its elastic limit; otherwise there is danger of damage to the work even if there is no visible distortion at the time of making the fit. In work of moderate size, an allowance of 0.001 inch per inch of diameter is usually made, but this is excessive for large diameters. In making a shrink fit, where the maximum tightness is required, a shrinkage allowance of 0.003 inch per inch of diameter may be used, provided the parts are strong enough to stand it.

A driving fit may be based upon an estimate of 10 tons pressure at the most, but the allowance should never exceed 0.001 inch per inch of diameter, and frequently must be much less. As a matter of fact, the allowance for light driving fits is often so small that it is best estimated by the "feel" of the calipers alone. If a hole is not true, but oblong, or tapers slightly, it should be calipered near the small end. In these cases, the parts will go together at a somewhat lower tonnage than if the hole were true.

The outside calipers used in this and other work requiring accuracy should have parallel chisel points about 1/16 inch wide, slightly rounded or dulled on the extreme edges. These points should be casehardened and smoothly finished. The inside pair may have one chisel point and the other point rounded or spherical. With calipers of this kind, a size may be transferred from one caliper to the other more easily and with greater certainty than if all the points were round or of an irregular shape which they might have acquired from use.

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Shrinkage and Press Fits in the Bradford Shops", August, 1911, engineering edition; "Shrinkage and Forced Fits", April and May, 1911, engineering edition; "Machine Shop Practice—Shrinkage and Forced Fits", July, 1909. See also MACHINERY'S Data Sheet Book No. 7, "Shafting, Keys and Keyways", pages 28, 29 and 31.

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One of the Middle Western railroads—the Illinois Central—has appointed an official whose duties are practically that of a "courtesy expert." The official title is: "Inspector of Passenger Train and Station Service." His duties will be to see that passengers are enabled to make use of every convenience which the system affords, to suggest improvements for the comfort of the passengers, and to travel on passenger trains so as to ascertain in person the conditions of the service as far as it pertains to the comfort and convenience of the passengers.

THE MANUFACTURE OF BLUEPRINT PAPER

CHARACTERISTICS OF PAPER, SENSITIZING AND SENSITIZING SOLUTIONS

BY F. B. HAYS*

The constantly increasing use of blueprints has caused the manufacture of blueprint paper to become an industry of considerable magnitude. The majority of people connected with engineering work have a fairly clear idea of the methods employed in making blueprints, and a few draftsmen and engineers understand the principles of coating the paper, but only a very small number have any conception of the methods and processes employed in producing large quantities of blueprint paper. The following article briefly describes the most general methods used. The machinery illustrated in the accompanying halftones is installed in the plant of the Indianapolis Blueprint and Supply Co., and is said to be the most modern and efficient type in use.

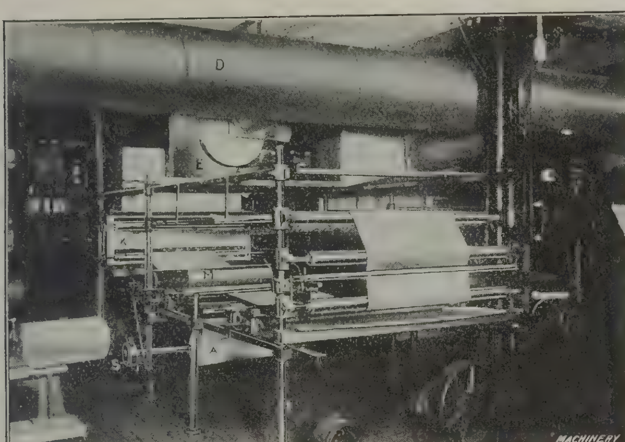

Fig. 1. Front View of Coating Machine and Dryer for Blueprint Paper

A special kind of paper is used in making blueprint paper. The principal requisites of this paper are: first, that it be free from wood pulp and the chemical impurities that are found in cheap papers such as newspaper stock, wrapping paper, etc.; second, that it be sufficiently tough to withstand frequent washing and rough handling; third, that it possess a fairly hard, and not too absorbent or coarse grained surface; and fourth, that it be properly sized on that surface which is to receive the coating. The size which gives the best results is a mixture of arrowroot flour and water. The flour is first mixed with a sufficient quantity of cold water to produce a thick paste, and then from forty to fifty parts of warm water is added.

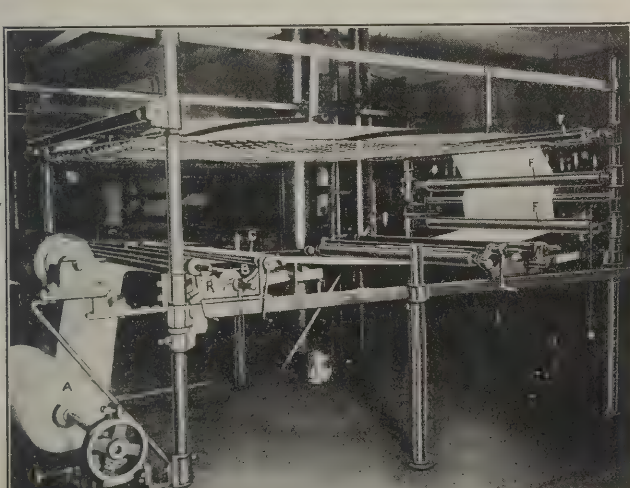

Fig. 2. Side View of Machine shown in Fig. 1

Sensitizing Solutions

The process of coating paper for blueprinting is termed "sensitizing," and it consists of coating the paper on one side with a solution that undergoes marked chemical changes when brought into contact with certain kinds of light and water. This process, although more or less complicated from a chemical standpoint, is very simple mechanically, provided only small quantities of paper are to be sensitized, but when done on a large scale special machinery and very skillful handling are required.

One of the oldest and most popular formulas for sensitizing paper that will print white lines on a blue background is: (A) Ammonia-citrate of iron, 20 parts; water, 100 parts. (B) Potassium ferricyanide, 16 parts; water, 100 parts. The sensitizing solution is made by mixing equal parts of (A) and (B) together, and filtering just before using. Another solution which gives good results, and which may be kept on hand for several months without deteriorating, is the following: (A) Ammonia-citrate of iron, 12 parts; water, 16 parts. (B) Potassium ferricyanide, 9 parts; water, 16 ounces. Mix together and filter one part each of (A) and (B), and add two parts of water just before using.

For coarse-grained, rough-surfaced papers, and silk and linen cloth, an excellent solution is obtained by the use of gum arabic. (A) Pulverized gum arabic, 1 part, dissolved in 20 parts water, and strained through muslin, combined with ammonia-citrate of iron, 5 parts. (B) Potassium ferricyanide, 4 parts, water, 20 parts. Equal parts of (A) and (B) are mixed before using. Fabrics must be washed and then sized in gelatine (hard gelatine dissolved in twenty parts water) before sensitizing.

Positive paper, or that which gives a blue line on a white background is produced in the same manner as negative paper, except that it is sensitized with different solutions. A number of mixtures may be used, but the two following are probably the most popular:

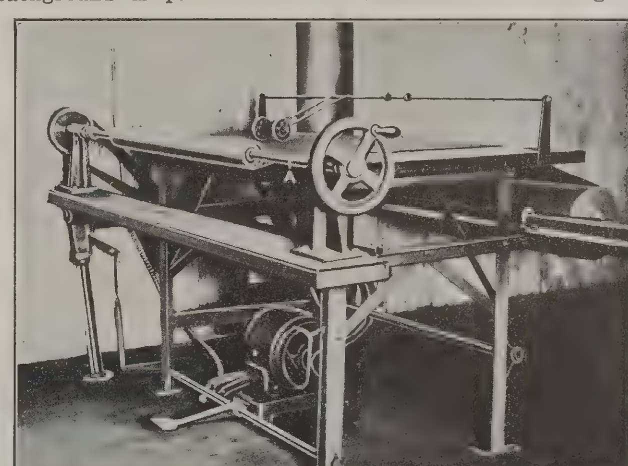

Fig. 3. Measuring Machine for Blueprint Paper

1. Oxalic acid, 1 part; iron perchloride, 2 parts; water, 20 parts.
2. (A) Powdered gum arabic, 2 parts; water, 10 parts. (B) Ammonia-citrate of iron, 2 parts; water 4 parts. (C) Chloride of iron, 1 part; water, 2 parts. First dissolve the gum and strain the solution (A) through muslin; add solution (B) to solution (A), stirring well; finally add solution (C) to the mixture of (A) and (B). This solution must be kept for twenty-four hours in the dark and must be frequently agitated before using.

Paper which produces positive black lines on a white background is sensitized and then developed. The sensitizing is a solution consisting of ferrous sulphate, 20 parts; ferric chloride, 45 parts; tartaric acid, 40 parts; water, 190 parts. The developing solution is a mixture of gallic acid, 15 parts; oxalic acid, 2 parts; water, 1700 parts. After developing, the prints are washed in running water.

In mixing any of the foregoing solutions, only distilled water should be used, and all operations should be carried out in a red or orange light.

Sensitizing the Paper

The coating of the paper with the sensitizing solutions and the subsequent drying and rolling is now done entirely by

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machinery. Fig. 1 shows a general view of a machine for this purpose. The coating machine is shown towards the front and the drier in the background. The driving mechanism is shown on the floor in front of the machine. The air for the drier is received from a purifier and forced through pipe *D* and heater *E* into the drying oven. The general operation of the machine is as follows: The sized paper starts from the roll *A*, Figs. 1 and 2, and passes between two pulling rollers and over the celluloid coating roller *B*, Fig. 2. This roller is partially submerged in the coating solution placed in tank *R*, and as it revolves it carries a small film of the solution, which is absorbed by the lower surface of the paper. A glass bar runs along the edge of the tank, and a roller *C* presses the paper against this bar so that all excess solution is wiped from its surface and returns to the tank. This latter roller also regulates the pressure between the paper and the coating roller *B*. The bearings for roller *C* are placed in a rocker arm, so that it may be raised or lowered by means of a crank, thus decreasing or increasing the tension on the paper. Another retaining tank and a similar series of rollers is shown at the other end of the machine, and serve to administer the second coat of the solution. The rollers *F* are simply guide rollers, and the tubes above the machine prevent the paper from sagging and becoming strained between the guide rollers. All of the rollers are made of brass, except the coating roller which is made of celluloid, and are mounted upon ball bearings. They are driven from the main shaft by gears proportioned to impart the same lineal speed to each roll.

At *S*, Fig. 2, is shown a band brake which regulates the tension of the paper and also prevents it from unrolling from the spools when the machine is stopped. Upon leaving the coating machine the paper immediately enters the drier, where it runs upon rollers along the upper part of the drier to the extreme end, and returns upon rollers on the lower side, leaving at *K* and being wound upon the spool *M*, Fig. 1. Both the top and bottom of the drier are covered with steam coils, and the hot air forced into it thoroughly dries the sensitized paper before it is wound upon the spool *M*. The moist air is removed from the drier by a pipe at the back, which terminates at an exhaust fan on the outside of the building.

As it is necessary to keep the colored windows of this department closed because of the injurious effects of daylight upon the finished paper and the sensitizing solutions, air is artificially supplied by blowers and exhaust fans.

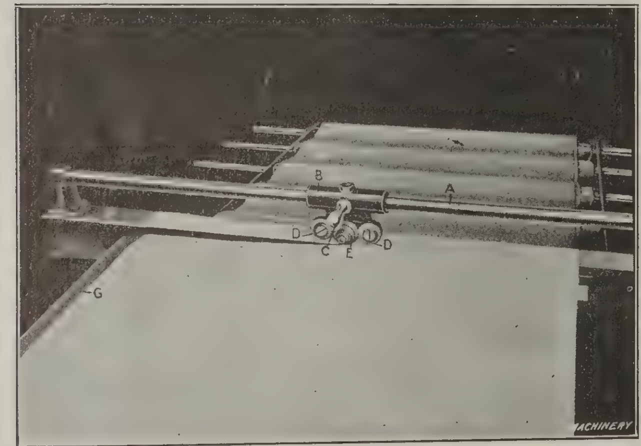


Fig. 4. A "Cutting-off" Machine

When the rolls of sensitized paper are removed from the coating and drying machines (each of which has a capacity of 1500 yards an hour), they are taken to the rerolling and measuring machine shown in Fig. 3, where they are rerolled into packages of desired length for the market. This machine consists of a "rolling" shaft *A* having a universal joint and driven through a friction clutch at the left from the motor beneath the machine; the clutch is controlled by a foot pedal. The operation of the machine is as follows: The operator places one of the large rolls of paper from the drier on the shaft at the back of the machine and starts it upon the "rolling" shaft *A* by means of the handwheel. This wheel has a jaw clutch connection with the shaft, so that it can be slipped out of connection with the shaft as soon as the paper is started, and the shaft driven by power through the clutch. As the paper passes over the table of the machine the registering device shown records the number of yards rerolled, so that the operator simply has to throw out the clutch and cut off the paper when the package has reached the proper size. The shaft *A* is then swung out on its universal joint and the roll slid off and sent to the packing department, where it is wrapped in light-proof paper and sealed up ready for the market.

Frequently orders for large quantities of short lengths of paper are received, and are handled by means of the mechanism shown in Fig. 4. This consists of four shafts, each

Fig. 5. Section of Department for Sensitizing Solutions. Note that all Solutions are kept in Light-proof Receptacles

inserted into a roll of paper, and supported by a steel plate on each end; a polished steel guide *A*; a steel I-beam support *F*, which is finished on the top and upper edges; two ball bearings *D*; a hardened tool steel cutter *E*; a handle *C*; and a body casting *B*. The paper is pulled from the rolls in four layers (one from each roll) and measured by means of a steel scale *G* on the edge of the table. The operator then pushes the cutter across the paper by means of the handle *C*, the ball bearings holding the paper rigidly in place while the cutter shears it off. The top of the beam *F* acts as a cutting table, and the finished edge serves as a sharpener for the circular cutter. Five hundred and eighty yard lengths of paper an hour are cut by this device. It is especially successful in handling tracing cloth and drawing paper.

The principles involved in the chemistry of sensitizing paper for blueprinting were first discovered about 1725, but were not practically applied until 1835 when an English scientist, Sir John Herschel, developed the ferro-prussiate process, which is still used at the present day and which serves as a basis for all other blueprinting methods. Many new branches of industry have arisen since 1835, and practically all the methods of the old industries have been greatly changed and improved, but the principal chemical processes of making blueprints are virtually the same now as they were twenty-seven years ago. Great strides have been made in the mechanical methods of making, coating, and printing blueprint paper, but no improved simple and efficient chemical process has been developed for producing sensitizing solutions, or for incorporating them with the fabrics. What we need at the present time is a cheap, reliable, quick printing paper that will require neither developing nor washing after printing, and that will withstand rough usage and not fade a short time after printing. It seems reasonable to believe that such a paper could be produced at the paper mills by incorporating the sensitizer with the primer, provided a suitable sensitizing solution were discovered. Far more wonderful developments than this have been made in the chemistry of photography, but for some reason chemists seem to have entirely overlooked its sister subject, blueprinting. Let us hope that in the near future chemists will turn their attention to this matter, and that the chemical side of blueprinting will be greatly simplified and improved.

WIRE ROPES FOR LIFTING APPLIANCES*†

AN INVESTIGATION INTO SOME OF THE MOST IMPORTANT CONDITIONS THAT AFFECT THEIR DURABILITY

The question of the durability of the parts of mechanical structures seems to be strangely neglected by all authorities. A designer has generally the choice of several formulas for calculating the mere strength of a given member, but usually he has to depend upon his own experience for the correctness of the proportions that will insure for it a reasonable length of life. The durability of wire ropes, in particular, is of great importance to all engineers, whether engaged in the design and manufacture of lifting appliances, or in their care and management.

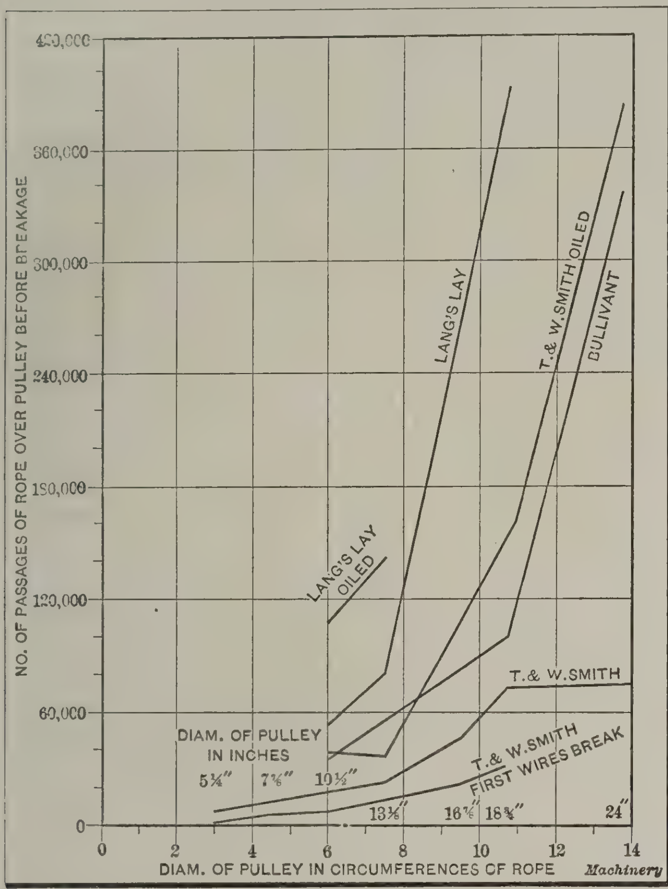


Fig. 1. Results of Experiments on the Durability of Wire Ropes

The two most important conditions appertaining to the manufacture and use of steel wire ropes that affect their durability are the quality of the material and the size of wire, and the diameter of the pulleys and arrangement of the ropes.

Quality of Material and Size of Wire

The wire used for lifting ropes is of crucible steel having a tensile strength varying from 80 to 130 tons per square inch. Although ropes made from material having a high tensile strength are of smaller diameter for a given load and a given factor of safety, this is not of great advantage to the crane designer. The stiffer character of the wire makes larger drums desirable, if the durability of the rope is to be considered, notwithstanding the fact that some rope-makers claim as an advantage for the stronger material that it does enable smaller pulleys to be used with a consequently lower cost of the working parts of the crane.

The ratio of the diameter of the individual wires to the diameter of the completed rope is an important factor. If the wires are too large, they are stressed considerably when passing over the pulleys, and accordingly the material is quickly fatigued and the wires break. Smaller wires, on the other hand, are more quickly worn through by rubbing against the pulleys and against their neighbors in the body of the rope. The stress in a wire due to bending round a pulley is directly proportional to the modulus of elasticity and to the diameter of the wire, and inversely proportional to the radius of the pulley; therefore, the radius of the pulley should be increased with an increase in the modulus of elasticity, if the same number of bends is to be endured by a stronger wire of the same diameter. Unfortunately, a theoretical calculation of the stresses induced in the wires of a rope by being bent over a pulley does not alone afford a reliable guide to the length of life to be expected from the rope, for consideration must also be given to the mutual wear that takes place among the wires.

Assuming, for the purpose of comparison, that two ropes are constructed of equal size, one from wires half the diameter of those in the other, then, for equal strength, the one rope will have four times the number of wires, and each of the wires will have one-quarter the cross-sectional area. According to the usual formula, the stress due to bending will be half as severe in the smaller as in the larger wires, when the ropes are bent over pulleys of the same diameter. If it be allowed that a reasonable figure for the estimated stress due to bending an ordinary rope over a pulley of a size usually adopted in crane design be, say, 30 tons per square inch, and that the stress due to the suspended load be 10 tons per square inch, then there will be a stress of 40 tons per square inch in the material each time the maximum load is lifted and released. The corresponding stresses in the rope of finer wires will be 15 tons per square inch due to bending, and, as before, 10 tons per square inch due to the suspended load, or a total of 25 tons per square inch.

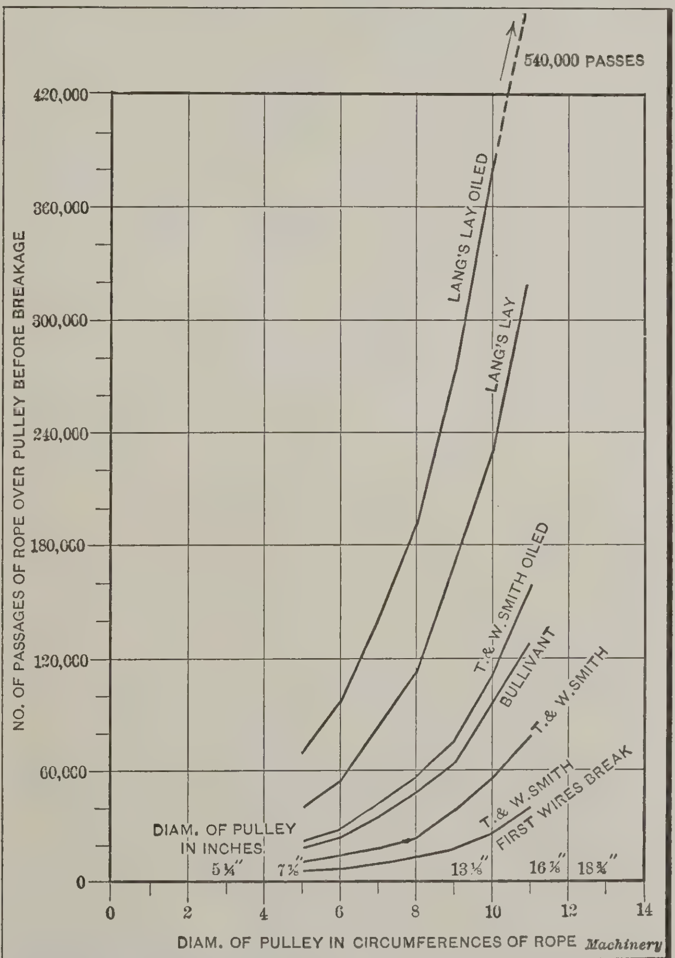


Fig. 2. Curves based on the Data in Fig. 1, covering the Conditions of General Overhead Crane Practice

There is, as yet, no agreement as to the exact effect upon endurance, of variations in the working stresses. It seems, however, to be reasonable to assume that a reduction in range of stress from 40 tons per square inch to 25 tons per square inch would increase the life of material such as ropes are

* Abstract of a paper by Mr. Daniel Adamson, read before the Belfast meeting of the Institution of Mechanical Engineers, Great Britain, July, 1912.

† See also the following articles previously published in MACHINERY: "Stresses in Wire Rope due to Bending," February, 1909, engineering edition; "Bending Stresses in Wire Rope," June, 1907, engineering edition. See also MACHINERY'S Reference Book No. 24, Chapter III, "Bending Stresses in Wire Rope."

composed of about 500 times. As no such improvement in the life of a rope has ever been experienced, or is to be reasonably expected, it must be taken for granted that abrasion is the principal factor in limiting the life of wire ropes, and, therefore, the effect of abrasion upon the suggested rope of finer wires must be considered.

When the rope of finer wires is passing over the pulley, there being four times as many wires in it, the pressure at each point of contact between the rope and the pulley and between the individual wires of the rope may be assumed to be one-quarter of what it is in the rope of larger wires. The wires being of half the diameter, the damage done to them by contact, even under this lower pressure, will be at least half that done to the coarser wires in the other rope, and this half damage done to a wire of one-quarter the sectional area will result in the cutting through of the wire in half the time, so

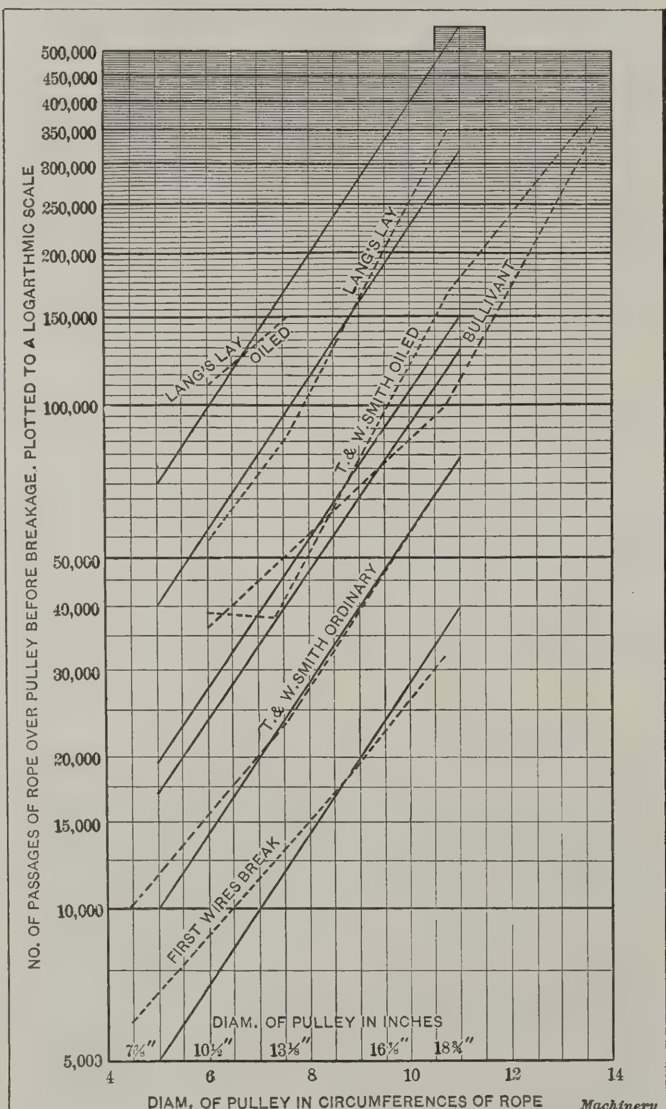


Fig. 3. Durability as affected by Diameters of Rope and Pulley

that the effect of abrasion upon the rope of finer wires will be twice as great. If a smaller pulley be used for the rope of finer wires, as suggested by some authorities, the pressure at the points of contact and the stress due to bending will be proportionately increased, so that it may reasonably be expected that with a pulley-diameter bearing in each case the same proportion to the diameter of the wires, the life of the rope with fine wires will be one-quarter of that of the rope of coarser wires working over a pulley of correspondingly increased diameter.

A German investigator (Ernst Heckel) refers to the very great surface pressures on the wires at the place of contact with the pulley (amounting in his opinion to as much as twelve tons per square inch) as a vital point in connection with the wear of wire ropes. This high pressure, accompanied as it must be by relative movement, even if quite small, readily accounts for the wear which takes place on the surface of the wires where they touch the pulleys or the other wires in the rope.

Diameter of Pulleys and Arrangement of Ropes

The lists issued by makers of wire ropes contain recommendations as to minimum sizes to be adopted, but no information is given as to the effect of using pulleys of different diameters. The author has felt for many years past the want of such information, but the experience of users afforded no reliable guidance, on account of the great difference in the conditions under which ropes work in different shops. In a paper read before the Manchester Association of Engineers by Mr. Matthews in 1902, he states that from 400 to 1700 lifts per crane per annum was the amount of duty required from certain cranes under his control, while the present author, in the discussion on Mr. Matthews' paper, mentioned from 32,400 to 43,200 lifts per crane per annum as representing his own experience in another class of work. Other important features that will affect the life of a crane rope are the average weight lifted and the average height of lift; cranes are generally occupied with loads much below their nominal capacity, but this will vary in different workshops, as will the proportion between the maximum height of lift available and the height most frequently attained by the hook.

Inquiries addressed to the users of cranes elicited varied replies; ropes working upon cranes of the same general design were found to last for periods of from two years to ten years and upwards, and one correspondent suggested that twenty years might be expected from ropes on cranes (of from five to twenty tons capacity) if damage from accidental causes could be eliminated. As might be expected, the ropes on foundry cranes have not so long a life as in erecting shops, the relative difference being perhaps as three is to five.

The most reliable and consistent information that the author has been able to discover is contained in a paper by Mr. A. S. Biggart, published in 1890 in the *Proceedings* of the Institute of Civil Engineers, Vol. CI, page 231. The experiments to which this paper refers were undertaken with the object of selecting the best form of rope to be employed in the construction of the Forth Bridge. The apparatus used by Mr. Biggart contained two pulleys, round which the rope under trial was passed, the lower pulley being weighted to give the required tension on the rope. The experiments consisted in passing the ropes, under a normal working load, to and fro over the pulleys until breakage ensued. Experiments were repeated with different diameters of pulleys and different makes of rope, and the accompanying diagram, Fig. 1, shows the life of different classes of rope as affected by the diameter of the pulleys.

The effect of oiling the ropes is shown by the diagram to be very beneficial, increasing the life of a given rope by two or three times. This is obviously due to the reduction of the cutting action of the wires upon each other. Experiments were also made to ascertain the effect on the life of a rope of running it over pulleys so arranged that the rope was subjected to reverse stresses, as shown in Fig. 4. The results obtained from this series of experiments showed that generally the life of a rope working under such conditions was only one-half that of a similar rope bent in one direction only.

Fig. 1 is based upon the actual figures tabulated in Mr. Biggart's paper, while Fig. 2 shows the present author's approximations as obtained by the simple method of drawing fair and regular curves through or near the points representing the results of Mr. Biggart's experiments over such a range of pulley diameters (measured in terms of the circumference of the ropes) as obtain in general overhead crane practice. Several interesting deductions may be drawn from a study of these figures. The time of breakage of the first wires of a rope in the lowest curve is only recorded for one make of rope, but comparing it with the second curve, which shows the time of breakage of whole ropes of the same make, it will be seen that when the first wire breaks, the rope may be assumed to have passed through one-half of its life, and as no one knowingly works a rope until it breaks entirely, the breakage of even a few wires is a sign that a rope should be carefully watched and replaced by a new one at an early opportunity.

The effect of varying the proportions of diameter of pulley to diameter of rope is one of the most important features to be

noticed. Speaking generally, Mr. Biggart's experiments show that increasing the diameter of the pulleys by an amount equal to two circumferences of the rope will double the life of the rope. This is approximately correct for all the varieties of rope and conditions experimented with, and may therefore be taken as equally correct for all the varying conditions under which cranes are worked. It is very remarkable that so simple a rule should evolve from such numerous and varied experiments, and the author hopes that its statement in this form will be of some value to designers. That it is sufficiently correct for all practical purposes may be readily seen by referring to Fig. 3 where the ratios of pulley diameters to ropes are plotted as abscissas to a linear scale, while the durability of the ropes is represented by ordinates drawn to a logarithmic scale.

These conclusions enable one to express a definite value for the effect upon the durability of ropes, of the various arrangements of pulleys that are commonly adopted in overhead cranes, some of which are illustrated in Figs. 5 to 11. Assuming that Fig. 6 (in which the ropes make three bends in working, namely, one at the upper drum and one on each side of the lower pulley, *i. e.*, at entering and leaving) is the arrangement most frequently adopted in practice, and representing the anticipated life of the rope under these conditions by 100, then the relative lives of the ropes in each of the other arrangements indicated are as shown in Table I.

TABLE I. COMPARISON OF ANTICIPATED LENGTH OF LIFE OF ROPES ARRANGED AS SHOWN IN FIGS. 5 TO 11

Fig. No.	No. of Bends	Relative Life of Rope
5	1	300
6	3	100
7	3*	75
8	7	43
9	11	27
10	7*	37½
11	11*	25

* Including one reverse bend which is twice as effective in wearing out the rope.

If it be desired to design each of the above arrangements of pulleys so that the ropes shall have equal durability, then the ratio of the drum diameters to rope circumference (if the law indicated by Figs. 2 and 3 is to be relied upon) must be increased as shown in Table II.

TABLE II. REQUIRED INCREASE IN DIAMETERS OF ROPE DRUMS (MEASURED IN TERMS OF CIRCUMFERENCE OF ROPE) REQUIRED TO GIVE EQUAL DURABILITY

Fig. No.	Increase over Diameter called for by Fig. 6
7	1 Circumference of Rope.
8	2½ Circumferences of Rope.
9	4 " "
10	3 " "
11	4 " "

It is quite usual for purchasers to specify in their inquiries that the diameters of the pulleys and drums must bear a certain relation to the diameter of the rope, but the author wishes now to emphasize the point that this stipulation is not sufficient in itself without some consideration being also given to the arrangement of the rope and pulleys.

If the generally accepted ratio of seven circumferences, or twenty-two diameters, of the rope for the diameter of the barrel be assumed as suitable for the drum and pulleys arranged as in Fig. 6, then the diameters for the other figures, to give equal durability, should be as shown in Table III.

TABLE III. RATIO OF DIAMETER OF PULLEYS AND DRUMS TO CIRCUMFERENCE OF ROPE TO GIVE EQUAL DURABILITY

Fig. No.	Ratio of Pulley and Drum Diameter to Rope Circumference
5	4 to 1
6	7 to 1
7	8 to 1
8	9.5 to 1
9	11 to 1
10	10 to 1
11	11 to 1

To make the comparisons quite fair between the different arrangements, it must now be pointed out that owing to the increased number of falls of rope adopted in Figs. 8 and 9, the size of the rope may be reduced as shown in Table IV, while retaining the same factor of safety.

TABLE IV. RELATIVE ROPE CIRCUMFERENCE ALLOWING FOR SMALLER ROPES DUE TO INCREASED NUMBER OF FALLS

Fig. No.	Number of Falls	Relative Rope Circumference
5	2	140
6	4	100
7	4	100
8	8	70
9	12	57
10	8	70
11	12	57

Combining the figures given in Tables III and IV will give drum and pulley diameters as shown in Table V.

TABLE V. DRUM AND PULLEY DIAMETERS RESULTING FROM A COMBINATION OF TABLES II AND IV, AND STILL ASSUMING THAT 100 REPRESENTS THE CONDITION IN FIG. 6

Fig. No.	Ratio of Pulley and Drum Diameter to Rope Circumference according to Table III	Relative Circumference of Rope as per Table IV	Resultant Pulley and Drum Diameter assuming Fig. 6 = 100
5	4	140	80
6	7	100	100
7	8	100	114
8	9½	70	95
9	11	57	90
10	10	70	100
11	11	57	90

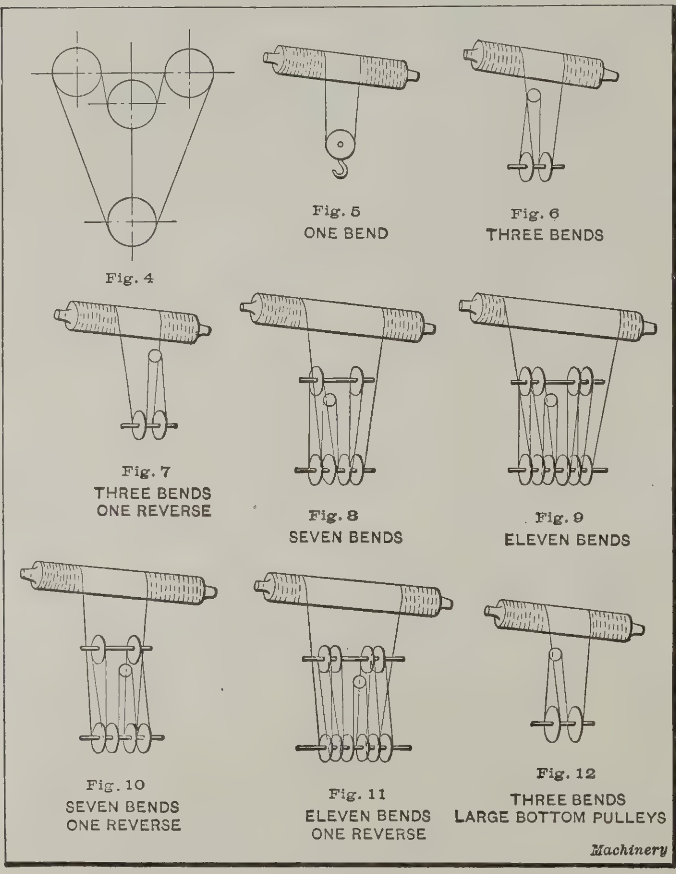
The noticeable feature in the last table is that whether two, four, or six falls are adopted, the diameter of the drum and pulleys should remain about the same, if the ropes are to have equal durability. A recent text-book upon the subject of crane design states (as an advantage of a large number of falls of rope) that the proportionately larger pulleys and barrel will insure *long* life for the ropes, but the author hopes that he has made it clear that very large proportions are necessary to insure a *reasonable* life for ropes on cranes with many falls of rope. Reference to Table V shows also the increase that should be made in the diameter of the drum and pulleys if a reverse bend occurs in the run of the rope.

Another important detail in crane design may now be referred to. In Fig. 6, as already mentioned, the ropes make two bends at the lower pulleys to one at the drum, and therefore, if the lower pulleys are made of the same diameter as the drum they will be responsible for two-thirds of the wear and tear of the rope. Now it is usually difficult to increase the diameter of the working barrel or drum of a crane, because to do so affects the ratio of the gearing and also requires a much larger framework with a corresponding increase in the cost of manufacture; but, if it is agreed, as a result of Mr. Biggart's experiments, that increasing the diameter of the pulley over which a loaded rope passes, by an amount equal to twice the circumference of the rope, reduces the evil effects of bending the rope round it to one-half, then a simple means of improving the durability of crane ropes is immediately at the disposal of the designer, namely, to increase the diameter of the pulleys in the blocks, leaving the drums of the original size, as indicated in Fig. 12. This change can usually be effected without serious alteration of the design, and may even be carried out on existing cranes. The result of increasing the diameter of the pulleys by an amount equal to two circumferences of the rope will be that the effect of the double bend round the lower pulley is halved, the resultant effect of the three bends will be equal to two only, and the relative life of the rope will be increased by 50 per cent; or the drum diameter might be reduced by an amount equal to 1.2 times the circumference of the rope with a corresponding reduction in the size of the framework of the crab or winch, while still retaining a relative life for the rope equal to that in Fig. 6. In this case the diameter of the lower pulleys would only require to be about one circumference of the rope larger than the original size of Fig. 6.

In making the foregoing comparisons of diameters of drum and pulleys with different arrangements of rope it has been assumed that the hook is raised to the full height available at each lift. This, however, is not the case in actual practice, the majority of loads not being raised one-half this height. This consideration brings to light another great advantage of the design in Fig. 12 as compared with any of the others.

Where, as is usually the case, the average height of lift in a shop does not reach half the maximum available, then that portion of the rope which passes under the lower pulley does not reach the upper drum, and accordingly is only subject to the wearing action of the two bends at the lower pulley. If, therefore, the effect of the bends at the lower pulley is reduced to one-half, by the proposed increase in diameter of the pulley, then the actual life of the rope will be doubled, instead of only being increased by 50 per cent, as was first assumed.

Where there are more than two falls of rope, as in Figs. 8 and 9, the effect of increasing the diameter of the pulleys by an amount equal to two circumferences of the rope is also very marked, reducing the effect of the seven bends in Fig. 8 to that of four and a half, with corresponding increase in the lift of the ropes. This shows up the fault of those designers



Figs. 4 to 12. Various Arrangements of Drums and Pulleys in Lifting Appliances

who adopt large drums (in order to obtain the great length of rope entailed by high lifts) and are yet content to make the pulleys of small sizes, when they could enormously increase the durability of the rope by the adoption of larger pulleys at little extra cost.

When the rope makes a reverse bend at the barrel as in Figs. 7, 10, and 11, the barrel ought to be increased in diameter to counteract the effect of the reverse bend. Thus, if in each of these cases the diameters of the drums were made larger by an amount equal to two circumferences of the rope, the durability of the rope would be equal to that in Figs. 6, 8, and 10, respectively.

Some Continental makers point out, very rightly, the desirability of making the compensating pulleys of reasonable size. The motion over such pulleys is apparently considered as negligible by some designers (judging by the forms of construction adopted), but this point of view overlooks the movement of the rope due to the swinging of the load, and the repeated bending of the rope at the same place over a small radius has an appreciable effect upon the durability of the rope.

Although the deductions laid down here appear too simple to need elaboration, a glance at the designs of many modern cranes shows that neither the designers, nor the purchasers, are aware of the importance of the principles involved; otherwise we should not see modern cranes with reverse bends in the ropes, and as many as eight plies of rope to carry the load on cranes of only 15 tons capacity.

The qualities of wire used vary considerably, and this, together with the heat-treatment in manufacture and the care taken by the makers in testing and examination, are questions that makers of ropes are in a better position to discuss than users. The "lay" of the strands and the lubrication of the rope when in use have each a considerable effect upon durability, and some guidance on these points may be obtained from Fig. 3, where "Lang's lay" is shown to have more than double the life of ropes of ordinary "lay," and ropes that are oiled last more than twice as long as when this precaution is neglected, as already mentioned. The superiority shown by "Lang's lay" naturally gives rise to the question as to why it is not exclusively used, and the answer the author has obtained from rope-makers is that such ropes must be very carefully handled to avoid "kinks," and they are also found to be more liable to "spin."

* * *

STATE TRADE SCHOOL OF BRIDGEPORT

The State of Connecticut maintains two trade schools, one of which is located in Bridgeport. The purpose of the Bridgeport school is to teach the methods of machine making, cabinet making, pattern making, drafting, machine shop practice, toolmaking, printing and plumbing.

Several plans of instruction are followed, such as day school, continuation school, and half-time school. In addition, there are vacation and evening schools. The day school course extends over two years, comprising 104 weeks of 49 hours each. The continuation school gives four hours instruction per week to apprentices employed in local factories. Each student is paid his regular wage scale by the factory while in school, and the time is employed in educational work to supplement the training he is receiving in the factory. The half-time school takes care of apprentices who alternate between the shop and the school, being employed at the factory one week and sent to the school the next. The school time is applied on their apprenticeship and the apprentice time is applied on school hours.

Each day of instruction received on the machine shop course is made up of 6½ hours shop work, one hour drafting, ¾ hour applied mathematics, ¾ hour applied science and mechanics. Shop lectures and inspection trips are given at times. In the continuation school the four hours are divided into drafting, 2½ hours, and trade mathematics, 1½ hour. In addition, the teacher occasionally visits the factories so as to keep in touch with the specific needs of each pupil. The students in the half-time school spend half of their time at their trades and the other half in school. They are rated as regular day students and receive the same instruction. Each student must finish one year of regular school training before being entered in this school. There is no charge made to students from any part of the State of Connecticut, nor are there any entrance requirements, save that the students must be fourteen years of age. The school is under the direction of Superintendent Frank L. Glynn.

* * *

HORSEPOWER AND KILOWATT

The British Association for the Advancement of Science adopted, as early as 1873, 746 watts as the equivalent of the British and American horsepower, and 736 watts as the equivalent of the metric or Continental horsepower. In a circular recently issued by the United States Bureau of Standards, it is stated that in all future publications of this bureau the former value, 746 watts, or 0.746 kilowatt, will be used as the exact equivalent of the English and American horsepower. For scientific work, it is quite important to have the horsepower thus standardized by being expressed in the so-called "absolute" system of measurement, because the common definition of 550 foot-pounds per second is scientifically correct only at a certain latitude and altitude, on account of the fact that the pound-weight, as a unit of force, varies in value as g, the acceleration of gravity, varies. The horsepower when expressed as 746 watts is equal to 550 foot-pounds per second at 50 degrees latitude and at sea level.

BALANCING AUTOMOBILE ENGINE FLYWHEELS

One of the essential points to be observed in the manufacture of a smooth-running and efficient automobile engine is to put all the moving parts in perfect balance. In the following is described the method employed by the White Co., Cleveland, Ohio, maker of high-grade automobiles and motor trucks, for balancing the flywheels used on its engines.

The first operation called the "static balance test," is carried out in the manner illustrated to the right in Fig. 2.

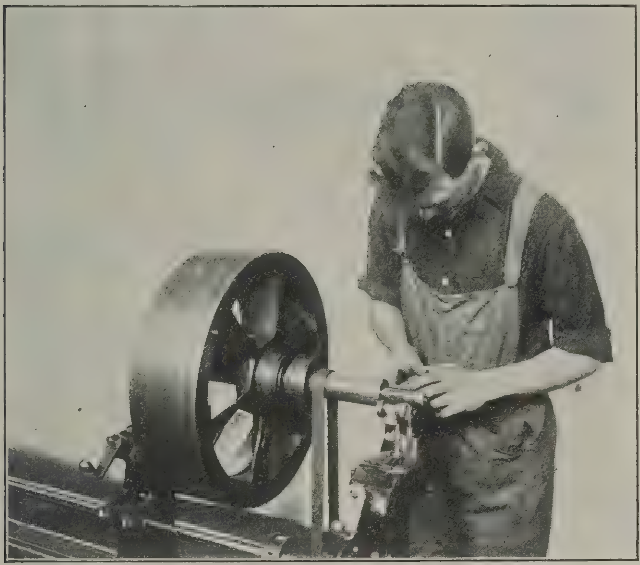


Fig. 1. The Final or Running Balance Test accomplished on a Norton Balancing Machine

Here the flywheel to be balanced is held on a hardened and ground arbor, the latter being located on knife-edges which form an integral part of the balancing stand. The stand has four legs, rigidly braced. When balancing, the operator lets the flywheel oscillate, watching it until it comes to rest. That part of the wheel which is heaviest, of course, always goes to the bottom. A piece of putty is then put on the inside of the rim opposite the heaviest side, and the flywheel is again tried and more putty added, if needed, until a close approximation to a perfect balance is obtained.

The next operation consists in removing the required amount of material from the heavy side of the rim to secure the proper balance. This operation is shown in the center of Fig. 2. The operator places the flywheel on a fixture which is tilted at an angle and is provided with a stud for holding it. The material is removed with a twist drill from that portion of the rim diametrically opposite the chunk of putty. To ascertain the amount of material to remove, the putty is placed on a scale, as shown in the foreground, and the drillings are collected and put on the other pan of the scale. A sufficient amount of material is removed to balance the putty.

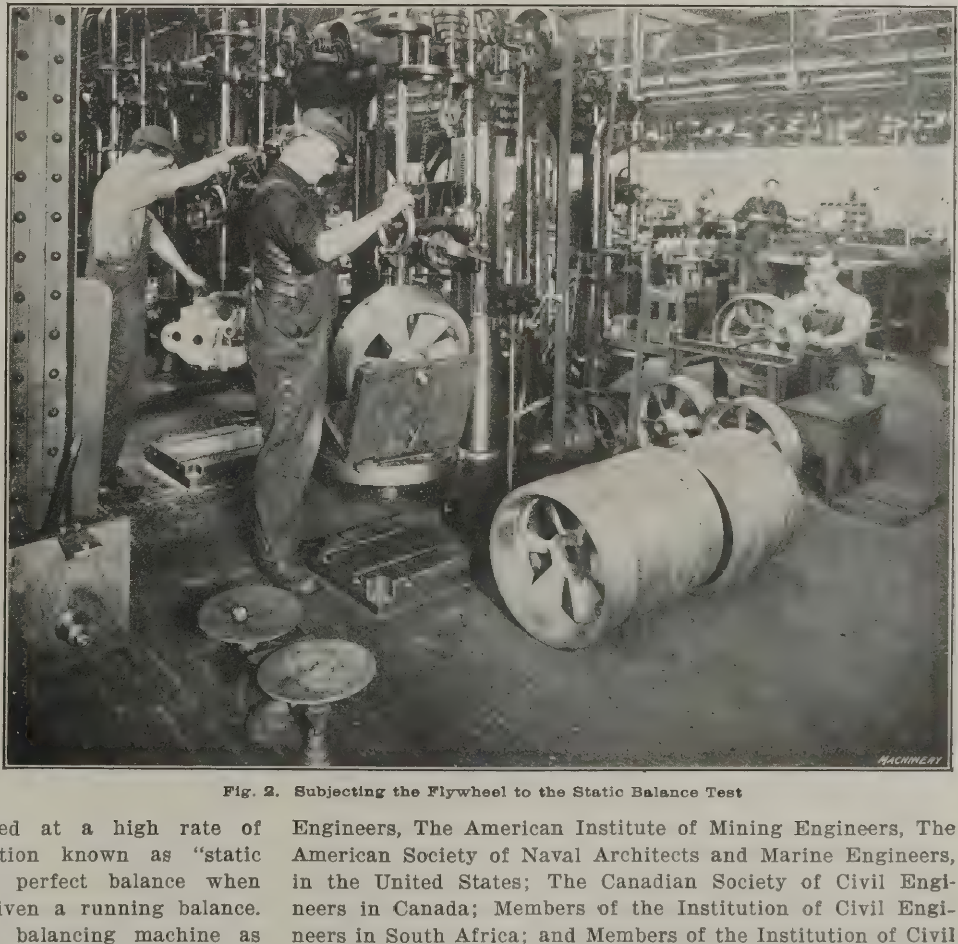


Fig. 2. Subjecting the Flywheel to the Static Balance Test

In the balance test just described, the flywheel is not rotated at a high rate of speed, but is put into the condition known as "static balance." To insure its being in perfect balance when the engine is running, it is next given a running balance. This is accomplished on a Norton balancing machine as illustrated in Fig. 1. The flywheel is again placed on an arbor, the extreme ends of which run on four pairs of rollers, and is rotated by a belt as shown in the illustration.

In order to see where the flywheel is out of balance, the small end of the arbor is coated with red lead, and as it is rotating the operator brings a copper pencil, held in a swinging member, in contact with the arbor. The points on which the pencil bears heaviest indicate the side of the rim from which it is necessary to remove material to make the flywheel balance properly when in service. From the foregoing it will be seen that by following this procedure a flywheel is obtained which aids in producing the much-desired smooth-running automobile engine. D. T. H.

* * *

LORD KELVIN MEMORIAL WINDOW SUBSCRIPTION

The engineering societies of the United States are receiving subscriptions for a memorial window to be erected in Westminster Abbey, London, to the memory of the late Lord Kelvin, the distinguished scientist and engineer. Lord Kelvin, formerly Sir William Thomson, was the inventor of the first successful receiving galvanometer for ocean cables, which is a marvel of sensitiveness. His work in the development of testing and recording apparatus for cables made submarine telegraphy a great success. The general committees formed to carry the plan into effect embrace representation from eight engineering societies in England, Ireland, Scotland, America, Canada, Victoria, South Africa and South Australia, and its chairman is William Cawthorne, Unwin, London. The societies represented are: The Institution of Civil Engineers, The Institution of Mechanical Engineers, The Institution of Electrical Engineers, The Institution of Naval Architects, The Iron and Steel Institution, The Institution of Mining and Metallurgy, The Institution of Mining Engineers, The North-east Coast Institution of Engineers and Shipbuilders, all of England; The Institution of Civil Engineers of Ireland; The Institution of Engineers and Shipbuilders in Scotland; The American Society of Civil Engineers, The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, The American Institute of Mining Engineers, The American Society of Naval Architects and Marine Engineers, in the United States; The Canadian Society of Civil Engineers in Canada; Members of the Institution of Civil Engineers in South Africa; and Members of the Institution of Civil Engineers in South Australia.

DOGS AND DRIVERS FOR LATHE WORK

A REVIEW OF THE VARIOUS DESIGNS OF DRIVERS FOR WORK HELD BETWEEN CENTERS

BY H. E. WOOD*

The lathe dog constitutes such an important part of the equipment of a machine shop, and there are so many different types of these devices in use, that it may be of interest to mechanics to follow the writer in a brief review of the most commonly used designs. Many of the lathe dogs shown in the following have been made for special purposes. It may appear that they are not of great utility, but in emergency cases, under special requirements, they have been found useful. A brief reference will be made to each of the lathe dogs shown. The illustrations show clearly the construction, and there is little need for a detailed description.

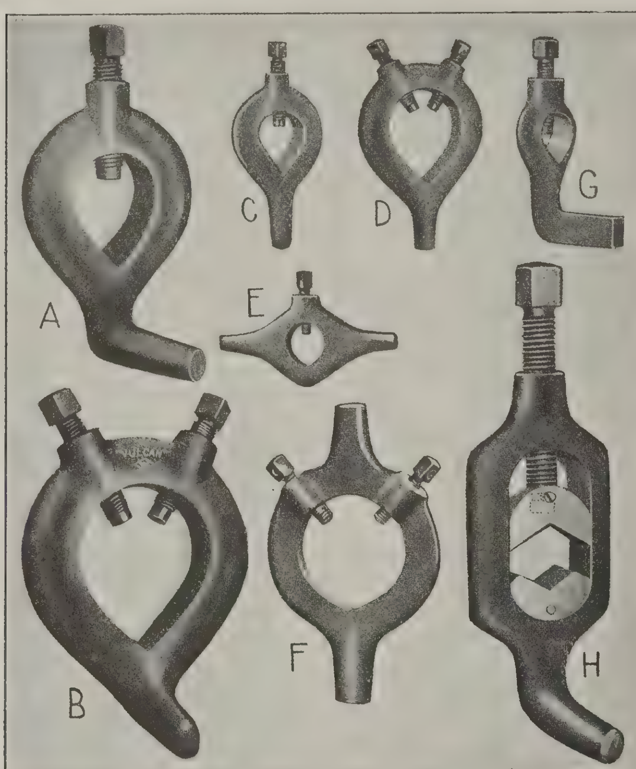


Fig. 1. Miscellaneous Examples of Lathe Dogs

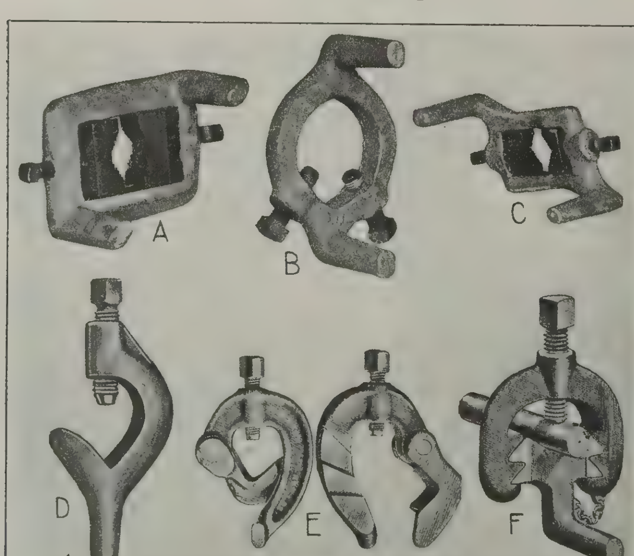


Fig. 2. Lathe Dogs of Special Construction

At *A* in Fig. 1 is shown one of the most commonly used lathe dogs—that with a bent tail and a single screw. At *B* is shown the same type of dog, but having two screws. At *C* is shown what is called a straight-tail dog with one screw, and at *D* the same dog with two screws. When these latter dogs are used, a stud driver, of course, is employed to drive against the tail. At *E* and *F* are shown double-tail dogs with one and two screws, respectively. At *G* is shown a dog which, although similar to that shown at *A*, has a flat tail with parallel sides.

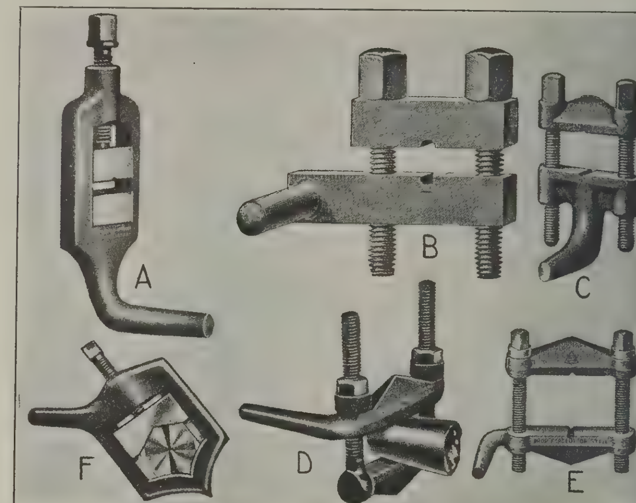


Fig. 3. Die Dog, Clamp Dogs, etc.

This type of dog is used in the milling machine rather than in the lathe, the flat tail making it convenient to secure it with a set-screw when used in the milling machine.

A dog somewhat different from those previously shown is illustrated at *A* in Fig. 3. This is called a die-dog because of its similarity to a thread-cutting die. At *H* in Fig. 1 is shown the so-called "O. K." design of dog. The design of these two dogs is intended to prevent the binding screws from marking the work. At *A*, *B* and *C*, Fig. 2, are shown three double-tailed dogs designed by the Fitchburg Machine Works, which are especially adapted to the Lo-swing lathe made by that company. The prime object of double-tailed dogs is to equalize the pulling strain on the dog on both sides of the center. This relieves the work of undue side strain. At *D* in the same illustration is shown a type of dog called an open-side dog because of the opening at one side which permits of the dog being put onto the work after it is placed on the centers. At *E* is shown the Brinton patented dog which can be slipped on and off the work while it is on its centers, and at *F* is shown a type of dog made in two parts. This dog is adjustable for size, as indicated, there being three possible positions of the lower part within the upper. It is patented by Mr. Richmond Parsons. At *B* in Fig. 3 is shown a very common type of clamp dog, and at *C* the same type of dog with bent tail. At *D* is shown another dog of similar type, but in this design the lower jaw can swivel so as to accommodate tapered work. At *E* is shown still another type of the clamp dog class. At *F* in Fig. 3 is shown a type of patented dog made by the Western Tool & Mfg. Co. Fig. 4 shows what is called a reduction dog.

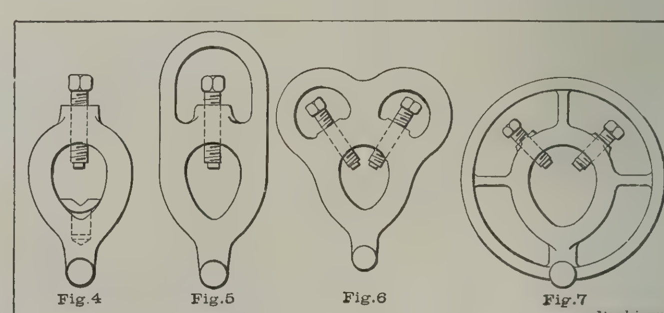


Fig. 4. Adjustable Dog. Figs. 5 to 7. Safety Dogs

Figs. 5, 6, and 7 show three types of dogs with protected screws. It is rather difficult to guard the set-screw on the lathe dog properly so that it cannot cause injury to the operator, but these illustrations indicate what can be done. Fig. 8 shows a somewhat unusual type of double-tail dog provided

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with inserted shoes to assist in the holding of the work. This dog is patented by Mr. William L. Reid. Fig. 9 shows an elaborate type of what is usually termed a hold-back dog. Its object and the manner in which it is used is clearly shown in the engraving, it being used on work where one end runs in a

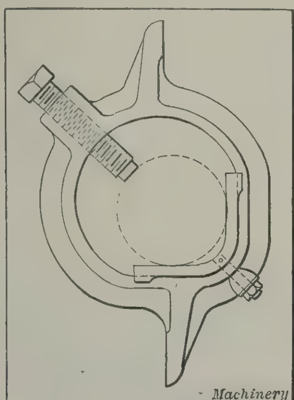
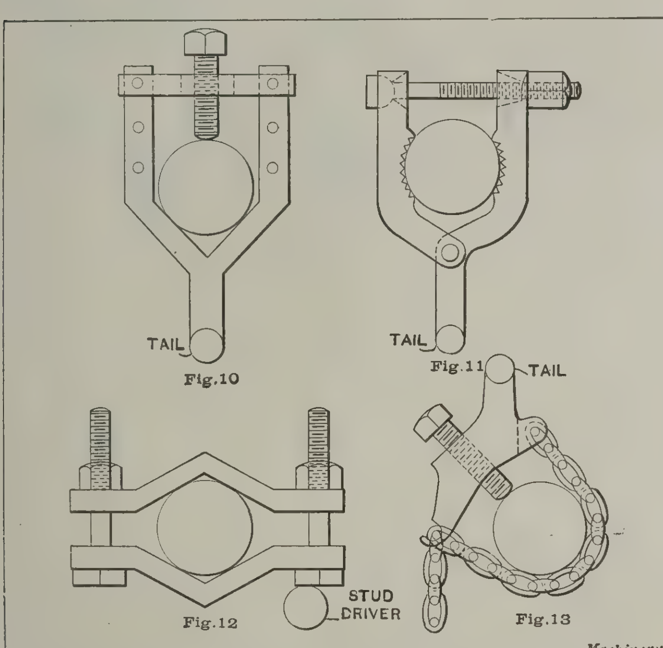


Fig. 8. The Reid Lathe Dog

steadyrest, to hold the work against the lathe center. The springs back of the faceplate give the required elasticity to the entire tool. This device eliminates the use of the belt-lace or lashing process which is more or less unhandy. This lathe dog was patented by Mr. Milton B. Hill. In Fig. 10 is



Figs. 10 to 13. Miscellaneous Dogs of Special Construction

shown a "homemade" type of dog. The cross-bar is forked where it fits over the side bars. Fig. 11 shows a dog with corrugated jaws, jointed as indicated. This dog is very convenient for certain purposes. Fig. 12 shows a popular type of driving dog. Dogs of this kind are usually made to suit im-

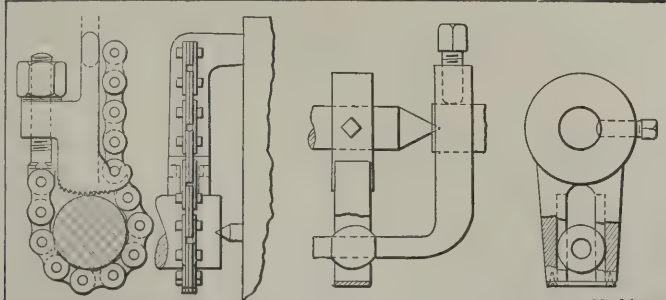


Fig. 14. The Clark Chain Lathe Dog

Fig. 15. The Hill Improved Type of Dog

mediate requirements. Fig. 13 shows a peculiar form of adjustable chain dog. This dog has a capacity for a wide variety of sizes according to the length of the chain. Fig. 14 shows a similar kind of dog patented by Mr. Hugh Elmer Clark, the claim for this dog being that it is easily attached to and detached from the work without removing the latter from the centers.

In Fig. 15 is shown a dog which is more especially adapted for the milling machine, and which is intended for taper work

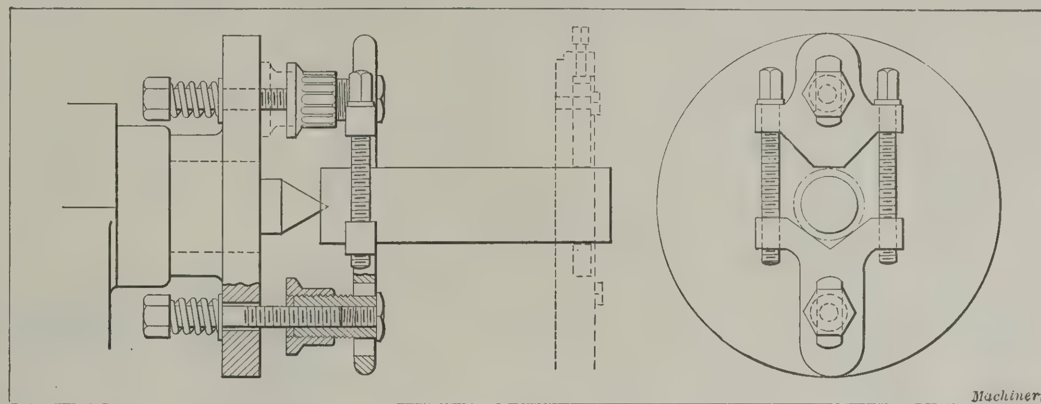


Fig. 9. The Hill Hold-back Dog

when it is necessary to have a radial and transverse movement and at the same time have no backlash in the rotating direction. This dog is patented by Mr. Milton B. Hill.

Fig. 16 shows a dog specially designed for use when producing a large number of pieces of the same size. This dog is termed a faceplate dog, principally because it is secured to the faceplate of the lathe. It is patented by Mr. Adam Tindel. Fig. 17 shows a dog which operates without screws. It is quick-acting, but can drive in one direction only. This design is patented by Mr. Thomas C. Thompson. Fig. 18 shows a dog especially devised for driving work which has irregular surfaces of any sort. It is patented by Mr. Louis Goddun. Fig. 19 shows a lathe dog which can be tightened without a wrench. It is patented by Mr. Frank L. Osgood. It can be attached to and detached from the work without removing the latter from the lathe. Fig. 20 shows a very simple but strong and efficient dog which can also be attached to and removed from the work

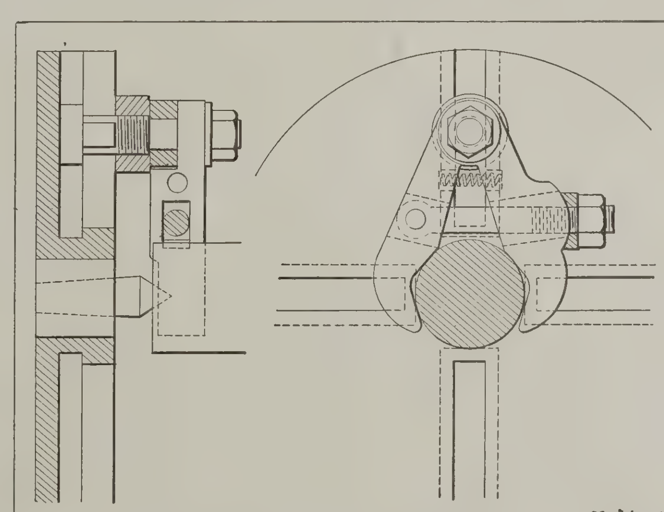


Fig. 16. The Tindel Lathe Dog

while the latter is held between centers. Fig. 21 shows a number of types of clamp dogs. The one at *A* has brass-faced clips to protect finished work from being marred. The dogs shown at *E* and *F* are also provided with soft jaws for protecting the work. Those shown at *D*, *E* and *F* are intended to be self-balancing dogs for grinding machines.

In addition to the devices illustrated, there are shown in the following some devices which can hardly be classed as dogs, but which are merely makeshifts used in place of dogs. Fig. 22 shows a very common method of driving a piece of lathe work, the device consisting of two V-blocks clamped onto the work with an ordinary C-clamp. In Fig. 23 the clamp is used with its screw directly on the piece being turned. It will be noticed that the center line of the screw is a trifle in front of the center line of the work and that there is a block behind the work. This arrangement has been adopted in order to insure

that the screw will not work off the shaft. The use of a stud driver in the faceplate of the lathe is, of course, necessary when these methods are employed. Fig. 24 shows another commonly used method where either a wooden or iron parallel clamp is screwed onto the shaft or work.

Fig. 25 shows a cheap makeshift which is often resorted to. This dog consists simply of a piece of scrap iron with a hole

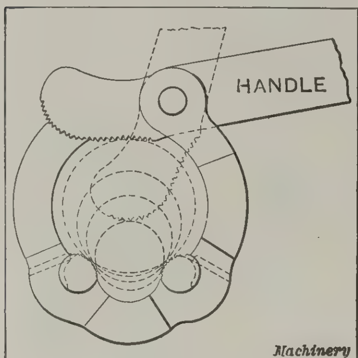


Fig. 17. The Thompson Lathe Dog, which operates without Screws

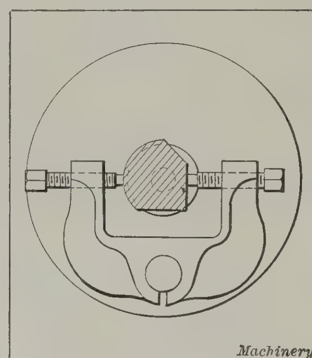


Fig. 18. Lathe Dog for Irregularly Shaped Work

through it, large enough to take the work for which it is wanted. Fig. 26 shows another makeshift consisting of a common collar with an extra set-screw in it and a hole drilled for a piece of round iron driven into the collar and used as a tail. Fig. 27 shows a threaded lathe dog with a split hub and binding screw. When work is threaded on the end, the diam-

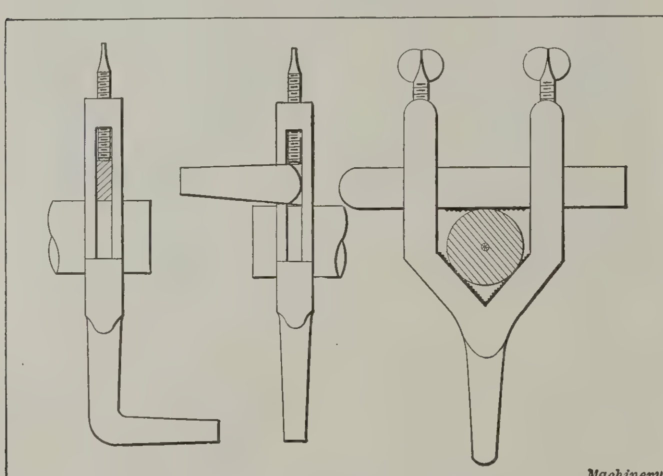


Fig. 19. The Osgood Lathe Dog

eter of the thread being the same as that in the dog, the latter can be screwed onto the work and clamped by the binding screw so as to drive the work without injuring the thread. Fig. 28 shows another type of dog with a threaded hole in it. This dog is intended to be placed on the ends of studs or pieces made in the screw machine, or on any piece not having

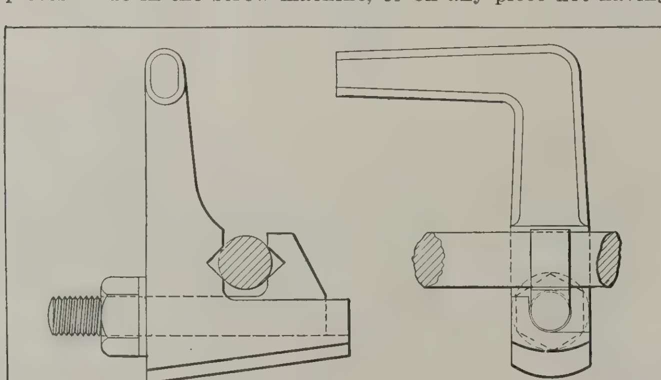


Fig. 20. Type of Open Dog

a center. Fig. 29 shows another cheap, "homemade," open-side, adjustable dog. This type is made from a round piece of cold-rolled steel, bent as shown. Three pin-holes are drilled through it so as to receive the pin which holds the head, which is adjustable from one position to another. Fig. 30 shows a simple method of driving a piece of work, the dog consisting merely of a piece of flat iron bent over to suit the work, with a bolt for binding as shown. Fig. 31 is another type consisting merely of a piece of flat iron, bent as required and drilled and tapped for a set-screw. Fig. 32 is especially intended for use on finished work, when one wishes to avoid any marks which might be made by the lathe dog.

There are, of course, innumerable devices that have been made for special purposes, but those shown are typical and indicate what may be done. In addition there are, also, of course, a number of drivers used on faceplates for driving chucked work not held between the centers. These, however, are not strictly lathe dogs, and as they are often made to suit special requirements and have hardly any common characteristics, they are not dealt with in this connection.

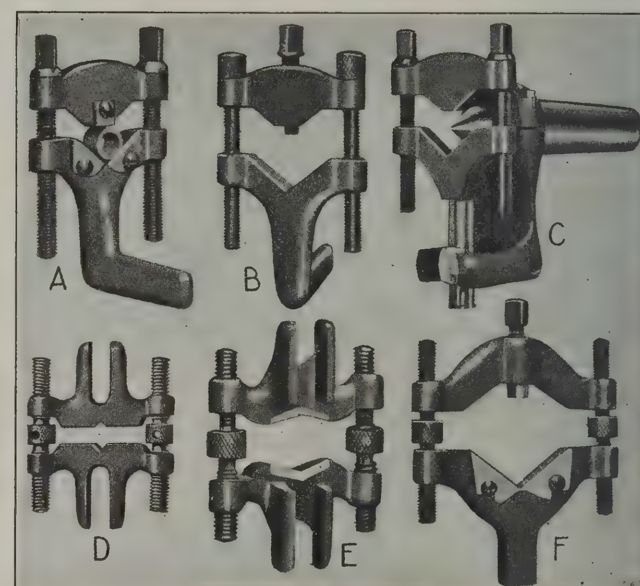
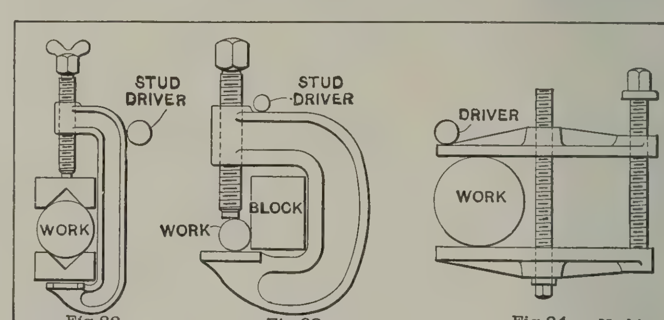


Fig. 21. Hill Clamp Dogs

In Fig. 33 is shown a safety lathe dog which has been brought out by Elmer J. Michaud of South Windham, Conn. Every machinist who has operated a lathe realizes the danger incident to the use of the ordinary lathe dog with its unguarded set-screw, which tends to catch in the clothing, especially when filing. This lathe dog is so shaped that it



Figs. 22 to 24. Makeshift Dogs

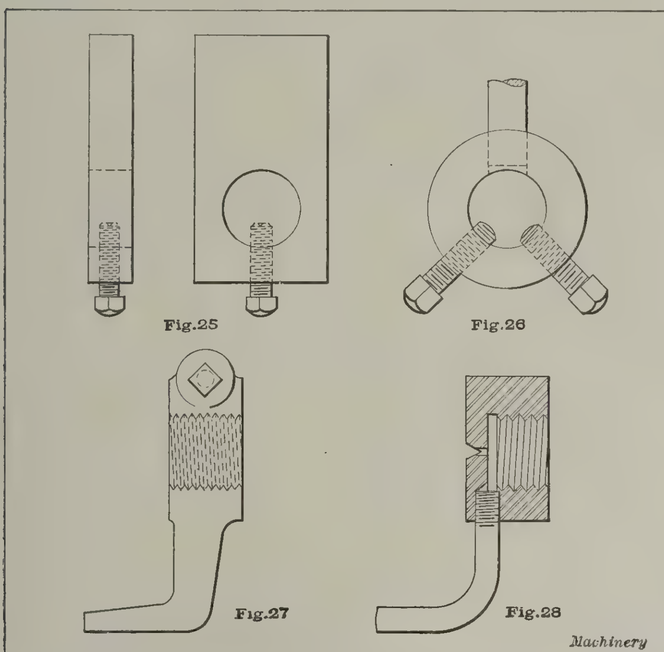
provides a guard, the tail of the dog being curved around in front of the set-screw on the leading side, thus affording protection. It can be clearly seen that this feature does not interfere with loosening or tightening the set-screw.

* * *

A method of accurately shaping very small dies, punches and other tools to an irregular form, developed by the watchmakers of Switzerland, employs a projectoscope or magic lantern as a magnifier. The shape required is drawn carefully to a scale of, say, fifty times actual size. The tools are made to size and shape as nearly as possible by common methods and are finished by stoning off the high parts which extend beyond the limits of the drawing when projected on it by the lantern. The inaccuracies are thus multiplied fifty times and the spots that do not coincide with the drawing are stoned off by a specially devised grinding rig that is controlled by the toolmaker, the tool being worked down without removing it from the lantern.

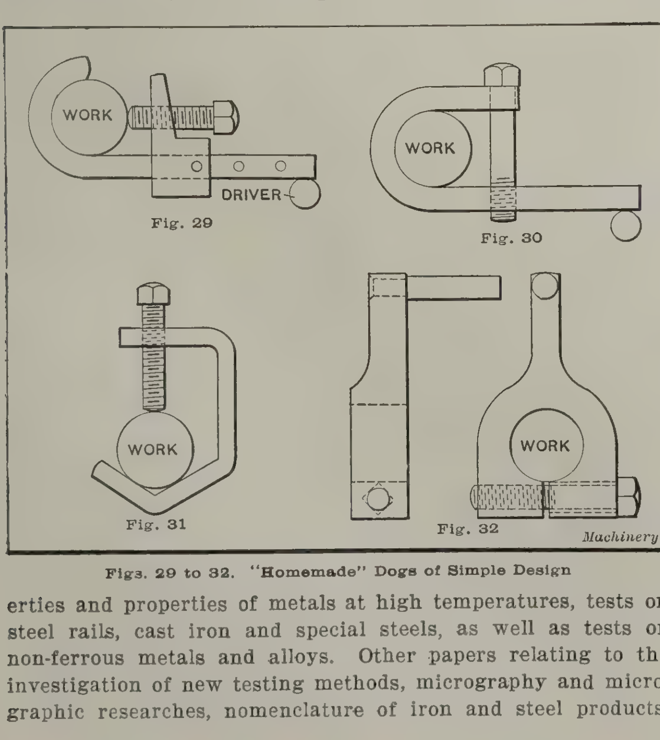
CONGRESS OF INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

The sixth congress of the International Association for Testing Materials was held in the Engineering Societies Building, New York City, September 2 to 7. Twenty-four nations were represented in the congress, the various foreign governments, as well as engineering societies here and abroad, having sent delegates. The object of the society is to further the progress of engineering by augmenting the knowledge relating to materials, by devising proper means and methods for the testing of materials, by drawing up specifications for materials for various purposes, and, in general, by providing standardized and uniform methods of engineering practice, in as far as the properties of materials of construction are concerned.



Figs. 25 to 28. Other Examples of Makeshift and Special Dogs

The congress was divided into three sections: one on metals, with a sub-section on cast iron and special steels; one on cement and stone; and one on miscellaneous materials. One hundred and fifty-three papers formed the program for the sixth congress. These papers related to hardness testing, to wear tests of steels, impact tests, corrosion tests for pipes, endurance tests, tests relating to magnetic and electric properties and properties of metals at high temperatures, tests on steel rails, cast iron and special steels, as well as tests on non-ferrous metals and alloys. Other papers relating to the investigation of new testing methods, micrography and micrographic researches, nomenclature of iron and steel products, as well as a considerable number of papers relating to cement, stone, paints, timbers, oils, road materials and rubber, were also presented.



Figs. 29 to 32. "Homemade" Dogs of Simple Design

The International Association for Testing Materials meets every three years in a congress devoted to the presentation and discussion of technical papers along the lines outlined. The last congress was held at Copenhagen, Denmark, in 1909. The preparations for the sixth congress have been in the hands of the American Society for Testing Materials, which is affiliated with the International Association. The social features included an informal reception under the auspices of the American Society for Testing Materials, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the American Institute of Mining Engineers, on Monday, September 2, and an excursion on the Hudson River to the military academy at West Point on September 4. On September 5 there was a reception tendered to the foreign members by the American Society of Civil Engineers. For those of the foreign members who desired to see something of America and its industrial development, a special excursion hotel train was arranged after the adjournment of the convention, making a week's tour, visiting Washington, Pittsburg, Buffalo and Niagara Falls.

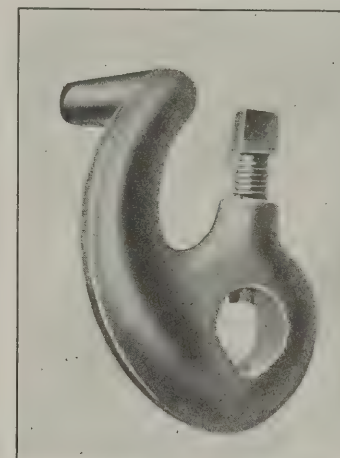


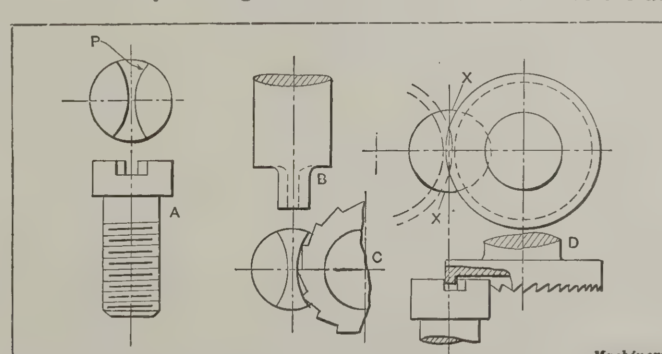
Fig. 33. Michaud Safety Dog

Before adjourning the congress elected as the new president of the International Association, Prof. N. Belelubsky of St. Petersburg, Russia, professor emeritus of the Institute of Engineers of Ways of Communication. The next international congress of the association will be held in 1915 in St. Petersburg.

* * *

UNUSUAL FORM OF SLOT IN FILLISTER-HEAD SCREW

An unusual form of slot in fillister-head screws is illustrated in a recent issue of the *Mechanical World*. This form of slot is used by an English firm and is claimed to have the advantage of providing a screw slot that is not likely to be injured; it also provides for a strong form of screw-driver. In the illustration *A* shows the screw, *B* the screw-driver, *C* the cutter used for milling the screw-driver, and *D* the annular cutter employed for milling the slot in the screw head. It is evident that two milling operations with this cutter are required for each slot. In addition, an ordinary plain cutter must be run through in order to remove the piece *X*, which otherwise would remain at the ends of the slot. The screw head is strengthened in this way, it is claimed, because the pressure of the screw-driver is received in the direction of the arrow *P*, in which there is a better backing of metal to withstand the pressure. The slot is, in fact, of the same shape that an ordinary plain slot tends to assume after it has been used for some time.



Form of Screw-driver, and Screw-head Slot and Method of Producing it

CHARACTERISTICS OF WROUGHT-IRON

A REVIEW OF KINDS, USES, PECULIARITIES, AND METHODS OF TESTING

BY A. L. HAAS*

Wrought-iron has, to a very large extent, been superseded by mild steel. Nevertheless, a large field remains where its resistance to fatigue and the ease with which it can be welded renders it valuable. Where reliability is of prime importance, no other material is superior to it.

Yorkshire iron of the best quality is still made in large quantities. There is no finer commercial grade of iron to be obtained anywhere than the iron known as Lowmoor or Farnley. The iron made in Staffordshire is of a lower grade, and it is this quality of iron that is threatened with extinction by mild steel. The cost varies, of course, with the quality, the best Yorkshire iron demanding twice the price of low-grade Staffordshire iron.

There are some articles for which wrought-iron is always used, for example, crane chains, lifting hooks, locomotive draw gears, etc. Years ago marine engine shafting was invariably made from wrought-iron. The firm of Blair, of Stockton on Lees, one of the earliest makers of marine engines and one of the most conservative firms at the present time, still makes (or, at least, until very recently did make) its shafting from this material. It is a well-known saying on the Northeast coast that no ship with Blair engines has ever been known to break down at sea from a fractured shaft. Two leading makers of steam fire engines still use Lowmoor plate for their boilers. These boilers are subjected to a heavy duty in spite of their small size. In locomotive practice Lowmoor iron rivets are still used for the boilers.


Pieces of Wrought-iron having been subjected to the "Rams Horn" Test

Corrosion of Wrought-iron

The resistance of wrought-iron to corrosion is remarkable, in spite of any statements to the contrary based on short periods of comparative tests. At Delhi, in India, there is a monumental column of this material which is over one thousand years old. The writer is informed on good authority that in various humid parts of India native-made iron, whose origin is too far back to be definitely known, is still seen fully exposed to weather conditions. At the Epping church, near London, there are some exposed iron hand-rails, one hundred and fifty years old, the section of which has not been diminished below the margin of safety during this period. This iron was probably smelted and puddled in small quantities, using charcoal for fuel, from particularly high-grade and easily reduced ore.

Corrosion in iron takes place in layers on account of its fibrous structure. The make-up of an iron bar can be compared with that of a wire rope, the spaces between the wires being filled with a silicious matter, which latter is naturally more or less weather- or corrosion-proof. In the instance of the hand-rails at the Epping church, the structure is plainly apparent, as corrosion has left the rails knotted like the trunk of an old tree. The pitting characteristic of steel is absent in this ancient iron.

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It is a fact admitting of no controversy that the use of mild steel for ship plates has reduced the life of the hulls by one-half, and a similar reduction in life has accompanied the adoption of mild steel for boilers. The writer has personally observed steel deck plates around hatches which were originally ⅜ inch thick, that in a fourteen-year old steamer had been reduced to a thickness of 1/16 inch over a considerable area. The same vessel had to have the entire engine and boiler room tank (top, floors and intercostals) renewed after the same period. The original 7/16-inch plate could in a great many places be perforated with a good blow from a sharp scaling hammer.

On the other hand, an old steamer called the *Dodo*, which used to ply regularly between Cardiff and Spain, and which was provided with one of the earliest iron hulls ever built, was 65 years old in 1900. It is still running, and, hence, is now 77 years old. A fireman who sailed in her, and subsequently with the writer, said that he was afraid to break coal in her lower bunker or to scrape up dust with his shovel, using undue violence, for fear he would break through the bottom. A similar steel hull would have been in the ship breaker's hands in half that length of time. In fact, wooden hulls last longer than these do. A collier trading between Newcastle and London was sold for a coal store hulk at the youthful age of 150 years. In many ports scattered throughout the world old British wooden ships converted into stationary hulks can frequently be seen.

Present-day Tendency to Reduce First Cost and Increase Cost of Upkeep

It seems to the writer that the present-day tendency is to reduce the first cost, increase the cost of upkeep, and decrease the length of service without corresponding advantages, by the use of newer materials. Of course, circumstances alter cases, and there are instances where economy is of no account. There is a works in the Birmingham district in England which was recently taken over by an up-to-date concern. In these works there was a beam engine built by Bolton & Watt, which must have been about eighty-five years old. It was found advantageous to run this antique engine as the sole means of power. The engine cost nothing and the new concern built its furnaces with boilers mounted over them, and hence obtained, as one might say, for nothing, easily twice the amount of steam that could be used. The economy of modern engines, or of producer gas, is of no interest to this firm. The fuel has to be burned anyway, and the waste of steam is of no moment.

One of the largest users—as distinguished from producers—of wrought-iron, who employs this material exclusively in the articles of his manufacture, has a strong belief that there will come a revival in its use; yet this man does not belong to the old school, but is a live, prosperous man under fifty. Could some newer process of puddling be devised to produce larger quantities at a single operation, the use of wrought-iron would certainly be extended and its price reduced.

Peculiarities of Wrought-iron

In testing wrought-iron some peculiarities have come to the writer's notice. Best Yorkshire (Lowmoor and Farnley) if nicked ⅛ inch deep around, say, a 1-inch bar, with a sharp set, and broken short over the anvil with a single blow, shows a curious fracture. The bar breaks dead short and square. The fracture is coarsely granular, resembling badly burned steel, only the granular structure is coarser. The bar nicked on one side only, and carefully bent with the nick a couple of inches from the edge of the vise or anvil, shows a beautiful gray, silky, fibrous structure, free from crystals and perfect in every way. Only the best Yorkshire iron shows this peculiarity, which to the writer's knowledge has never been satisfactorily explained.

Some peculiarities have been noted in connection with the welding of wrought-iron. The lower grades make an ap-

parent weld at almost a melting temperature, as well as at low heat. With the better grades of iron, however, this cannot be done, and a heat between closer limits of temperature is necessary. Hence, this kind of iron needs a careful and competent blacksmith, and he must give closer attention to his work than with the cheaper grades. A burned weld and a partial shut cannot pass even a cursory glance, as would similar welds in common grades of iron. Another point with regard to welding is that the less the iron is worked at the weld, the better the job. The writer has seen welds that have been reduced several tons in tensile strength by a smith unversed in this part of the art, unnecessarily working the weld at a comparatively low heat to make a good looking job.

Testing Wrought-iron

When mild steel is tested the strength "with" and "across" the direction of rolling is nearly equal, and for ordinary purposes of design can be so assumed. With wrought-iron, however, this is not the case. In bending tests, also, the angle

TABLE I. TENSILE STRENGTH AND ELONGATION OF WROUGHT-IRON BARS

Sectional Area	Yorkshire Iron		B B Staffordshire		B B B Staffordshire		Staffordshire	
	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent
1 square inch and under.	23	26	24	20–23*	23	23–25*	24	23
Above 1 square inch, under 4 square inches....	22	24	23	22	23	24	24	22
Above 4 sq. inches, under 8 square inches...	22	22	22	20	22	23	22	20
Above 8 square inches..	21	21	21	20	21	20	21	20
Channels, Angles, Tees.	22	21	22	15	23	15	22	15
Rivets..................	23	26	23	24	23	25	23	24

* Lower elongation: Rounds and squares 9/16-inch and under; flats 7/16-inch in thickness and under. Higher Elongation: Rounds and squares 5/8-inch and over; flat 1/2-inch in thickness and over, up to 1 square inch in area.

through which the iron can be bent with safety varies considerably, according to whether the bending is "with" or "across" the grain. The accompanying tables give a summary of the characteristics of wrought-iron, these tables being the results of long experience with this kind of material.

A number of wrought-iron pieces which have been tested in the manner that was commonly used years ago, and which still survives in some quarters, are shown in the accompanying halftone. Tests of this kind are known as "rams horn" tests, and are intended to indicate both the forging qualities of the iron and the closeness of the piling. A hole, 1¼ times the size of the bar or the thickness of the plate, is drifted hot from the solid, leaving the same distance clear from the end

TABLE II. TENSILE STRENGTH AND ELONGATION OF WROUGHT-IRON PLATE

Grade of Iron	Tensile Strength	Elongation in 8 Inches, Per Cent
Yorkshire.........	With grain, 21 tons Across grain, 19 tons	With grain, 20 Across grain, 12
Staffordshire BB ..	With grain, 21 tons Across grain, 18 tons	With grain, 10 Across grain, 5
Staffordshire BBB.	With grain, 22 tons Across grain, 18 tons	With grain, 12 Across grain, 7

or the side. The metal between the hole and the end of the bar is split with a sharp set from both sides and turned over as indicated in the engraving, the name of the test being derived from the appearance of the pieces after the bending is completed. When flat plates are tested, one horn is turned sideways and the other forward. Sizes up to two square inches in sectional area can be tested in one heat, but usually two heats are required. A second hole of the same size is drifted lower down the bar at right angles to the first. The test specimen, when cold, should show no defects, the piling should not split, and the surface of the "rams horns" should be free from red-short cracks. A clean fire, an experienced blacksmith, and considerable speed are required in order to make a satisfactory test, especially in the common grades of iron.

The only physical test bearing a direct relation to the prices and quality of iron is the reduction of area at the point of

TABLE III. COLD BENDING TESTS OF PLATE, ALL QUALITIES

Thickness of Plate, Inches	With the Grain, through Angle (in Degrees)	Across the Grain, through Angle (in Degrees)	Thickness of Plate, Inches	With the Grain, through Angle (in Degrees)	Across the Grain, through Angle (in Degrees)
1 and 15/16	20	7½	½	42½	17½
7/8 and 13/16	22½	10	7/16	50	20
¾	25	10	3/8	60	25
11/16	27½	12½	5/16	70	30
5/8	30	12½	¼	90	40
9/16	35	15	3/16	100	60

The inner radius of the curve at the bend not to exceed 1½ times the thickness of the plate.

fracture, when broken in a tensile strength test. In good iron this reduction of area should be 40 per cent. Two pieces of iron, one of which is twice as expensive as the other, will often have the same tensile strength and elongation, but the reduction of area will indicate which is the better iron. The best Yorkshire bar iron has been known to have over 60 per cent reduction of area, and usually it exceeds 50 per cent, but a cheap grade of bar iron rarely reaches 30 per cent. Good Staffordshire iron should have approximately 40 per cent reduction of area.

Chain made from Wrought-iron

As welded chain is one of the principal uses for which wrought-iron is still exclusively employed, a few remarks re-

TABLE IV. SPECIFICATIONS OF DRIFTING TESTS

Description of Iron	B B Staffordshire	B B B Staffordshire
Rounds up to 3 inches in diameter	Drift with grain to 1¼ times diameter, and across grain equal to diameter	Drift with grain to 1½ times diameter and across to 1¼ times diameter
Squares up to 3 inches side	Drift with grain equal to side of square, and across equal to ¾ times side	Drift with grain to 1¼ times side, and across equal to side
Rounds and squares over 3 inches diameter of side	Drift to ⅛ diameter or side	Drift to 1¼ times diameter or side
Flats up to 6 inches wide and under 1 inch thick	Drift to 2½ times thickness at a distance from edge equal to thickness	Drift to 2¾ times thickness at a distance from edge equal to thickness
Flats up to any width over 1 inch thick	Drift to 2 times thickness at a distance from edge equal to thickness	Drift to 2½ times thickness at a distance from edge equal to thickness

lating to the welding of chain of this kind may be of interest. In the making of high-grade crane chain, the value of the reduction of area cited above is clearly shown in the tests of the finished chain. The elongation of a good sample under tensile test bears a direct relation to the reduction of area obtained from the bar iron from which it is made. The greater the reduction of area in the bar, the greater the percentage of elongation in the finished chain.

A well made chain under tensile test never breaks in the weld, but always at the end of the link which is not welded, or at the side. A break at the weld proves poor workmanship, no matter what iron is used. If the chain is of the best quality of iron, and the workmanship is first-class, the chain should stiffen under the breaking stress so that it becomes solid like a piece of bar iron. This stiffening under a breaking load is a certain indication of quality. Chains made from

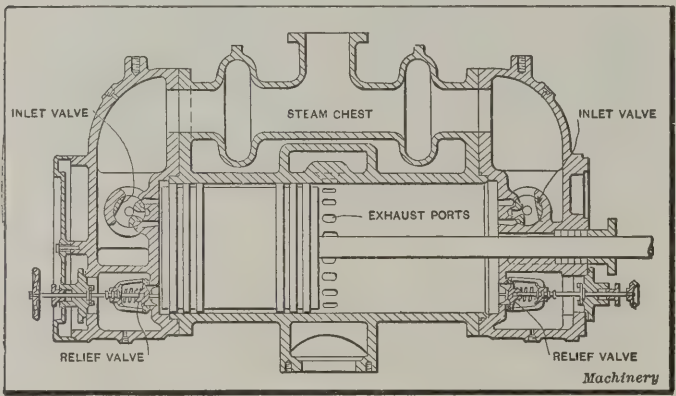
a common grade of iron do not stiffen. The stiffness is such that in good chain the end of the test piece can be held in the hand, and the test piece holds its own weight without movement or bending. If, when in use, a chain sling is found to lack freedom of movement, even to a slight degree, it should be discarded instantly because of the danger attached, as the chain must have been at some time overstressed.

A practical example of the value of annealing can be obtained from a wrought-iron chain by anyone. A link of such a chain of a good class of iron, say a sling chain, known to be in need of annealing, can easily be broken by a single blow of the hammer, with the link held vertically on the anvil. The fracture is coarsely crystalline and the break is sharp and nearly square. After proper heat-treatment the next link can be flattened or maltreated in almost any manner short of actually cutting it, but it will not break.

* * *

THE UNIFLOW STEAM ENGINE

The difference between the temperature of the live steam admitted to an engine cylinder and that of the exhaust leaving it makes the cylinder walls, cylinder head and piston act as reservoirs of heat which alternately fill and discharge at every stroke. The greater the ratio of expansion, the greater the difference in temperatures at the beginning and end of the stroke, and hence the greater the heat loss. This heat loss is commonly attributed to "initial condensation," but this phenomenon is simply the evidence of heat being imparted to the cylinder to raise it to the temperature of the incoming live steam. The abstraction of heat from saturated steam immediately causes condensation, which is followed by evaporation and cooling as the pressure falls.



Longitudinal Section of Uniflow Steam Engine Cylinder

The superior economy of the multiple-cylinder engine is due to the fact that the range of expansion is divided between two or more cylinders and the temperature difference in each cylinder is not so great as in a simple engine working to the same number of expansions. In other words the high pressure cylinder is hotter than the intermediate, and the intermediate is hotter than the low-pressure. If the whole range of expansion was effected in one cylinder its temperature would be an average between that of the live and exhaust steam.

In theory, the greater the number of cylinders, the higher the efficiency, but mechanical losses set a practical limit to the number of cylinders, four being as many as it is profitable to use. It is in this respect that the turbine is at a great advantage over the reciprocating engine. The zones of temperature can be graded by very small differences, thus reducing losses from heat interchange to a minimum. The Parsons turbine is really an expansion nozzle, hot at one end and relatively cold at the other.

Much ingenuity has been expended on steam engine design to reduce the heat losses in simple engines and make their performance approach more nearly in economy that of multiple-cylinder engines. One of the simplest and most effective cylinders is that of the so-called "uniflow" engine, patented in 1886 in Great Britain by Mr. L. J. Todd, and developed by Prof. Stumpf of Charlottenburg, Germany. This type of simple engine has recently been taken up by an American engine builder who claims that he can develop a horsepower on 24½ pounds steam non-condensing, and on 13¼ pounds condensing at 100 per cent load. At 100 per cent overload the consumption rises to 30 pounds and 14½ pounds, respectively.

The principle of the uniflow type of steam engine is that of admitting the steam at the ends of the cylinders as in all Corliss engines and exhausting at the center, thus causing no reversal of steam flow in the cylinder. The cylinder barrel is slightly more than two times the length of the stroke, the excess being in the width of the central exhaust port or ports and the clearances between the piston and cylinder heads. The increased efficiency is due partly to non-reversal of flow, the admission ends thus remaining hotter, but chiefly to reduced time of exhaust. In the common type of engine the cylinder walls are exposed to the exhaust temperature for about ninety per cent of the time required for the return stroke, whereas in the uniflow engine the exhaust period is much less.

On the return or exhaust stroke the steam remaining in the cylinder after the outer edges of the ports are passed by the piston is trapped and compressed in the clearance space to live steam pressure. This feature of the cycle, while apparently economical, is not so, thermodynamically, for the reason that the power required to compress has been generated in a comparatively low efficiency cycle and the resulting available energy in the compressed steam is far below that required for its conversion. But mechanically this feature is unavoidable for two reasons, the first being the very structure of the uniflow type, and second the need of cushioning effect in the cylinder to check the reciprocating parts and prevent shock and noise, a common requirement, of course, of all reciprocating piston engines.

* * *

RATHENAU GOLD MEDAL

The Allgemeine Elektricitäts Gesellschaft (A.E.G.) of Berlin has notified President Arthur Williams of the American Museum of Safety, New York, that the Rathenau gold medal has been placed at the disposal of the museum for award annually for the best device or process for safeguarding life and limb or promoting health in the electrical industry. The competition is open to every country in the world, the only condition being that the device or process must be exhibited at the American Museum of Safety in New York City. This is the first time that a high European honor has been given to an American institution and indicates the standing of the American Safety Museum among European scientists.

The Rathenau medal is well known in the European scientific world. It was presented to Dr. Emil Rathenau, president and founder of the Allgemeine Elektricitäts Gesellschaft, the greatest European electric company, on the occasion of his seventieth birthday, with the felicitations of the Kaiser for his services in the field of electro-technics. (He was the man who introduced incandescent lighting into Germany). One medal will now be cast each year from the original die for the American Museum of Safety to award.

* * *

THE USE OF WASTE STEAM

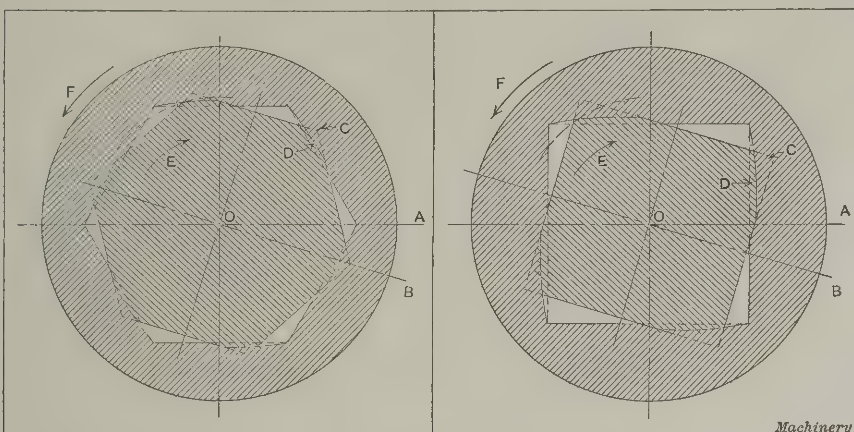
The use to which steam which formerly went to waste has been put at the Indiana Steel & Wire Co., Muncie, Ind., indicates what could be done to increase the efficiency of the steam plant in many industrial plants. In the power plant of this company two 22 by 42 inch Corliss non-condensing engines operate a series of wire-drawing benches. Each engine carries a load averaging from 370 to 400 H. P., and operates continually with the exception of Sundays and holidays. Up to two years ago electric power was purchased from an outside source to drive the machines for making wire fencing, wire nails, etc., but at that time it was decided to utilize the exhaust steam from the Corliss engines to generate this electric power. A 600 K. W. mixed-pressure Curtis turbine was installed and the exhaust steam from the two Corliss engines used to drive this turbine, which, in turn, exhausts into a condenser maintaining a vacuum of 28 inches. In case the engines are shut down, the mixed-pressure turbine automatically cuts in sufficiently high pressure steam to continue to run. The turbine now carries the entire motor load of 600 H. P., using steam that was formerly allowed to go to waste.

SQUARE VS. HEXAGON HOLLOW SET-SCREWS

ANALYSIS OF STRESSES, AND COMPARISON FOR WEAR AND STRENGTH

BY JOHN S. MYERS*

Since hollow set-screws have come into vogue, supplying a long-felt need of the manufacturer with humanitarian instincts, a controversy has arisen as to the respective merits of the square and the hexagonal form of hole, which presents an interesting problem. It is the object of this article to investigate analytically the relative claims to superiority of the two forms.



Figs. 1 and 2. Illustrations showing the Effect of Wear in the Case of a Hexagonal and a Square Wrench and Socket

Any mechanic knows that the corners of an ordinary hexagonal nut are more easily bruised and rounded off than the corners of a square nut, when using an open-ended or monkey wrench. Especially is this the case when, under dire stress of circumstances, one is compelled to use a wrench which does not fit properly, or a monkey wrench with a weak back. Nevertheless, hexagonal nuts have almost entirely superseded square ones in machine construction, for, as it seems, good and sufficient reasons. However, when we consider the case of a socket wrench, the answer to the question as to which form of nut would burr up easiest is not so apparent, for with the hexagonal nut we have six obtuse corners in action, against four square corners on the square nut; whereas, with the open-ended wrench, there are but two corners under pressure in either form. The case of the square versus the hexagonal nut, even with a socket wrench, is, however, considerably different from the case of the hollow set-screw; for, with the same size of bolt the distance across the flats of the square nut is equal to that of the hexagonal one, whereas, with the hollow set-screw, the distance across the corners is the limiting feature.

Comparison for Wear

In Fig. 1 we have a hexagonal inner member driving in the direction of arrow E against a resistance of the outer member in the direction of arrow F. It is assumed that the corners of the inner member have been worn as at C, and the faces of the outer member as at D, permitting a relative angular rotation AOB. Fig. 2 represents a square inner member with an assumed wear sufficient to permit of an angular displacement AOB, equal to the similar angle in Fig. 1. Comparing the two, it is seen that the square form would have to be worn much more than the hexagonal to permit of equal angular looseness, so that, unless the pressure on the corners of the square is sufficiently higher than that on the corners of the hexagon to offset this advantage, we would expect the square form to wear longer than the hexagonal.

Arbitrarily assuming the distance across the corners for the two forms to be equal, the depth of the two inner members to be equal, the torsional moments delivered equal, and the driving forces to be concentrated upon the extreme corners, as represented in Figs. 3 and 4, we may proceed as follows:

For the square form (Fig. 3) F acts at a lever arm $l = \dfrac{C}{2\sqrt{2}}$ (1)

The turning moment of the four forces is

$$T = 4Fl = 4F\frac{C}{2\sqrt{2}}$$

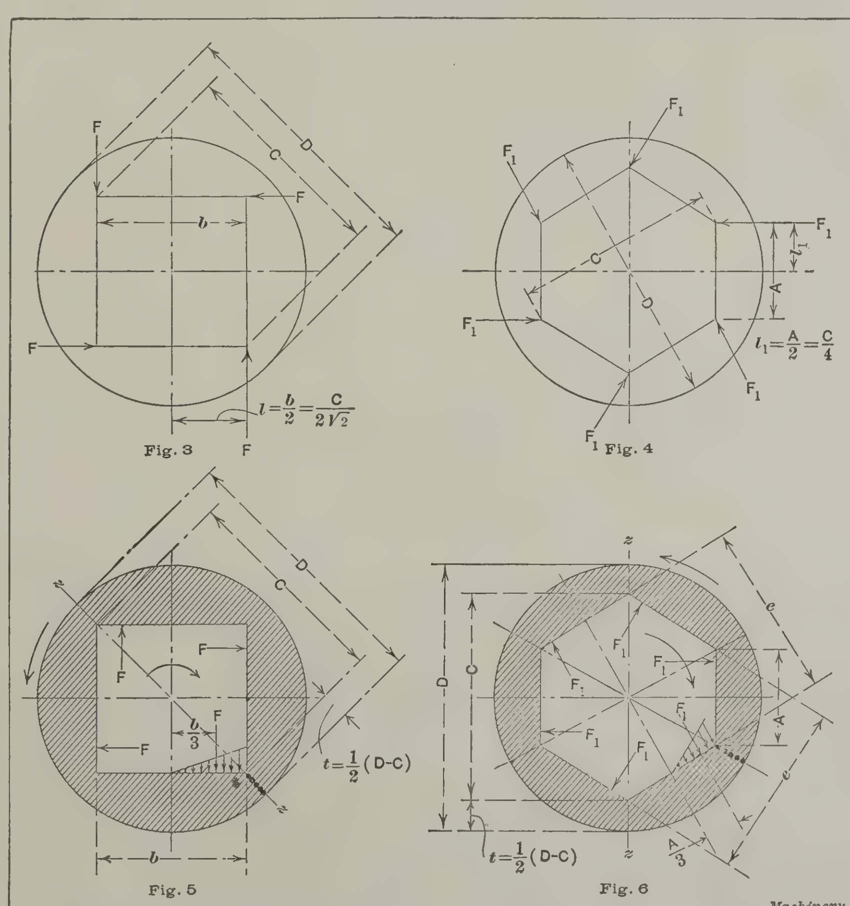
$= FC\sqrt{2}$, from which

$$F = \frac{T}{C\sqrt{2}} = 0.707\frac{T}{C} \qquad (2)$$

For the hexagon (Fig. 4), $l_1 = \dfrac{C}{4}$ (3)

The torsional moment is $T = 6F_1l_1 = 6F_1\dfrac{C}{4}$, or

$$F_1 = \frac{2T}{3C} = 0.667\frac{T}{C} \qquad (4)$$



Figs. 3 to 6. Diagram for Analyzing Relative Strength and Wearing Qualities of Square and Hexagon Hollow Set-screws

From (2) and (4), $\dfrac{F}{F_1} = \dfrac{0.707}{0.667} = 1.06.$ (5)

This indicates that, under the assumed conditions, the total pressure (not the unit pressure) on the corners of the square

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is 6 per cent higher than that on the corners of the hexagon.

Comparison for Strength

Comparing the square and hexagon for torsional strength, we have the torsional section modulus of the square as:

$$Z_{ps} = \frac{C^3_s}{12} \tag{6}$$

and for the hexagon:

$$Z_{ph} = 0.1353\ C^3_h. \quad \text{(See table.)} \tag{7}$$

When $C_s = C_h$, the ratio of relative strengths is:

$$\frac{Z_{ph}}{Z_{ps}} = 0.1353\ C^3_h \times \frac{12}{C^3_s} = 1.62 \tag{8}$$

or, when of equal distances across the corners the hexagon is torsionally 62 per cent stronger than the square.

If we equate $Z_{ps} = Z_{ph}$ and solve, we have:

$$C_s = 1.175\ C_h \quad (9) \qquad \text{or, } C_h = 0.851\ C_s \quad (9a)$$

which indicates that, for equal torsional strength the distance across the corner of the square form should be 1.175 times the same dimension for the hexagon, or, viewed the other way, the distance across the corners of the hexagon need only be 0.851 times the same dimension of the square.

Now, for $C_s = C_h$ we have, from (5), the total pressure on the corners of the square 1.06 times that on the hexagon, while in (8) the hexagon is shown to be torsionally 1.62 times stronger than the square; hence, if both are stressed to their full strength, the pressure on the corners of the hexagon is $\frac{1.62}{1.06} = 1.53$ times the similar pressure on the square (10).

In the case of the hollow set-screw, however, the outer member is of equal (if not of greater) importance than the inner member. The ideal condition would be to have both members of equal strength. Investigating in this direction, we have for the torsional section modulus of a circular section with a square hole (Case V in table):

$$Z_p = \frac{\pi D^3}{16} - \frac{b^4}{3D}. \tag{11}$$

For the square inner member (Case II in table):

$$Z_p = \frac{b^3}{3\sqrt{2}}. \tag{12}$$

Equating these, we have:

$$\frac{b^3}{3\sqrt{2}} = \frac{\pi D^3}{16} - \frac{b^4}{3D}. \tag{13}$$

Now let $b = xD$; then:

$$\frac{x^3 D^3}{3\sqrt{2}} = \frac{\pi D^3}{16} - \frac{x^4 D^4}{3D}, \text{ or } \frac{x^3}{\sqrt{2}} + x^4 = \frac{3}{16}\pi \tag{14}$$

From (14) we have $x = 0.74$, or $b = 0.74D$. (15)

But $b = \frac{C}{\sqrt{2}}$, hence:

$$\frac{C}{\sqrt{2}} = 0.74D \text{ or } C = 1.046D. \tag{16}$$

The significance of Equation (16) is that it is impossible to make a square inner member of torsional strength equal to the round outer member, because the distance across the corners of the square becomes greater than the diameter of the outer member thus splitting it up into four separate sections.

Treating the hexagonal form in a similar manner it is found that, for the inner and outer members to be of equal strength, we would have:

$$C = 0.912D \tag{17}$$

Just how thin the metal over the corners might be made without destroying the continuity of the section, and thus entirely upsetting the conditions upon which the theory of torsion is based, is problematic. It would, however, seem impracticable to give C as large a value as indicated by (17).

Proportion of the Inner to the Outer Member and their Relative Strengths—The Square Form

The problem now resolves itself into one of how large the inner member may be made without danger of rupture in the outer member at the corners. Referring to Fig. 5, the pressure against the sides of the square is maximum at the advancing corner and may be assumed to diminish uniformly to zero at the center of the side. The center of pressure on each face is then at F, at a distance of 1/3 b from the center, and the torsional moment of the four forces is:

$$T = \frac{4Fb}{3}. \tag{18}$$

Taking the depth of the square hole as equal to b, the area of material resisting rupture at the corner, as at z, is:

$$a = tb = \frac{D - C}{2}b, \text{ and, since } C = b\sqrt{2},\ a = \frac{D - b\sqrt{2}}{2}b \tag{19}$$

With a unit stress of S this area is capable of resisting a force of:

$$F_s = aS = \frac{D - b\sqrt{2}}{2}bS \tag{20}$$

Now, for simplicity of treatment as well as safety, we will consider the entire force F in Fig. 5 as concentrated upon this area a. We then have $F = F_s$, and, by substituting the value of F_s as given by (20) for F in (18) we have:

$$T = \frac{4b}{3}\left(\frac{D - b\sqrt{2}}{2}\right)bS = \frac{2}{3}b^2 S(D - b\sqrt{2}) \tag{21}$$

This equation represents the extreme torque of the outer member without causing rupture at the corners.

The torsional strength of the inner member is:

$$T = Z_p S = \frac{Sb^3}{3\sqrt{2}} \tag{22}$$

Equating (21) and (22) we have:

$$\frac{2}{3}b^2 S(D - b\sqrt{2}) = \frac{Sb^3}{3\sqrt{2}}$$

from which

$$b = \frac{2\sqrt{2}}{5}D = 0.566\ D \tag{23}$$

$$\text{or } C = 0.800\ D \tag{23a}$$

Equations (23) and (23a) represent the largest size of square inner member that can be used without danger of rupture of the outer member at the corners.

Substituting the value of b as given by (23) in (12) we have:

$$Z_p = \left(\frac{2\sqrt{2}}{5}D\right)^3 \div 3\sqrt{2} = \frac{16}{375}D^3 = 0.0427\ D^3 \tag{24}$$

which is a measure of the torsional strength of the square form of the inner member.

If we divide the result of Equation (24) by the torsional section modulus of a solid circular section (Case I in table) we have:

$$\frac{16D^3}{375} \times \frac{16}{\pi D^3} = 0.2173. \tag{25}$$

This indicates that a square inner member may approximate 22 per cent of the torsional strength of a solid circular section of a diameter equal to that of the outer member.

Proportion of the Inner to the Outer Member and their Relative Strengths—The Hexagonal Form

Investigating the case of the hexagonal form of inner member in a similar manner (see Fig. 6), we have first that the torsional moment of the six forces F_1 is:

$$T = 6F_1\frac{A}{3} = 2F_1A. \tag{26}$$

Assuming the depth of hole to equal e, the area resisting F_1 is $a = e\frac{D - C}{2}$, and since $e = A\sqrt{3}$,

$$a = A\sqrt{3}\frac{D - C}{2} \tag{27}$$

The force that this area is able to resist is:

$$F_1 = aS = \frac{\sqrt{3}}{2}AS(D - C), \text{ or, since } C = 2A$$

$$F_1 = \frac{\sqrt{3}}{2} A S (D - 2A) \qquad (28)$$

Substituting this value of F_1 in (26) we have:

$$T = \sqrt{3} A^2 S (D - 2A) \qquad (29)$$

The torsional strength of a hexagon (see Case III in table) is:

$$T = Z_p S = \tfrac{5}{8} \sqrt{3} A^3 S \qquad (30)$$

Equating (29) and (30), and reducing gives us:

$$A = \tfrac{8}{21} D = 0.381 D \qquad (31)$$

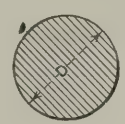
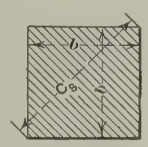
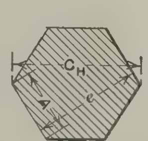
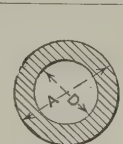
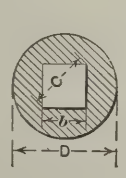
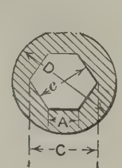
From (31) we have $C = 0.762 D$ (31a); or $e = 0.66 D$ (31b).

the torsional section modulus of a solid circular section, as given in Case I of the table, we have:

$$0.0598 D^3 \times \frac{16}{\pi D^3} = 0.3048 \qquad (34)$$

which indicates that the hexagonal inner member may develop approximately 30 per cent of the strength of a solid circular section of a diameter equal to the outer member, as against 22 per cent for the square form of inner member. Stated in another way, the hexagonal form is $0.3048 \div 0.2173 = 1.4$, or 40 per cent stronger than the square form for equal sizes of the outer member.

PROPERTIES OF SECTIONS

Case	Section	Polar Moment of Inertia I_p	Polar Section Modulus Z_p	Remarks
I		$I_p = \frac{\pi D^4}{32} = 0.098 D^4$	$Z_p = \frac{\pi D^3}{16} = 0.196 D^3$	
II		$I_p = \frac{b^4}{6} = 0.1667 b^4$	$Z_p = \frac{b^3}{3\sqrt{2}} = 0.236 b^3 = \frac{C^3_s}{12}$	Taking Case II as an inner member for Case V and making $b = 0.566 D$, the inner member would be the weakest and the section modulus for II is $Z_p = 0.043 D^3$
III		$I_p = \frac{5\sqrt{3}}{8} A^4 = 1.0825 A^4$	$Z_p = \frac{5}{8}\sqrt{3} A^3 = 1.0825 A^3$ $= \frac{5\sqrt{3}}{64} C^3_h = 0.1353 C^3_h$ $= \frac{5}{24} e^3 = 0.2083 e^3$	Taking Case III as an inner member for Case VI and making $e = 0.66 D$, the section modulus for III is $Z_p = 0.06 D^3$
IV		$I_p = \frac{\pi}{32}(A^4 - D^4)$ $= 0.098 (A^4 - D^4)$	$Z_p = \frac{\pi}{16}\left(\frac{A^4 - D^4}{A}\right)$ $= 0.196 \left(\frac{A^4 - D^4}{A}\right)$	If the inner section of diameter D is to be of torsional strength equal to the outer hollow member, make $D = 0.82 A$ or $A = 1.22 D$
V		$I_p = \frac{\pi D^4}{32} - \frac{b^4}{6}$ $= 0.098 D^4 - 0.167 b^4$	$Z_p = \frac{\pi D^3}{16} - \frac{b^4}{3D}$ $= 0.196 D^3 - 0.333 \frac{b^4}{D}$ With an inner member the largest probable safe value of b is $b = 0.566 D$, from which $C = 0.8 D$	If the inner section were to be of strength equal to the outer section it would be necessary to make $b = 0.74 D$ or $C = 1.046 D$, which is impossible, since C would be greater than D
VI		$I_p = \frac{\pi D^4}{32} - \frac{5\sqrt{3}}{8} A^4$ $= 0.098 D^4 - 1.0825 A^4$	$Z_p = \frac{\pi D^3}{16} - \frac{5\sqrt{3} A^4}{4D}$ $= 0.196 D^3 - 2.165 \frac{A^4}{D}$ With an inner member the largest probable safe value of e is $e = 0.66 D$, from which $C = 0.762 D$	If the inner section were to be of strength equal to the outer section, make $A = 0.456 D$ or $C = 0.912 D$. This leaves the material very thin at the corners.

Equations (31), (31a) and (31b) represent the various dimensions of the largest size of hexagon that can be used without danger of rupture of the outer member at the corners.

The torsional section modulus of a hexagon (Case III in table) is:

$$Z_p = \tfrac{5}{8} \sqrt{3} A^3 \qquad (32)$$

Substituting the value of A from (31) in (32) gives:

$$Z_p = \tfrac{5}{8} \sqrt{3} \left(\tfrac{8}{21} D\right)^3 = 0.0598 D^3 \qquad (33)$$

Equation (33) is the measure of the torsional strength of the hexagonal form of inner member. If we divide this by

Unit Pressure on Driving Faces—The Square Form

Considering the pressure to be distributed as indicated in Fig. 5, with the depth of the inner member equal to b, we have the unit bearing pressure on the driving faces at the corners of the square as

$$P_s = \frac{F}{b \times \frac{1}{2} b} \times 2 = \frac{4F}{b^2} \qquad (35)$$

From (18) we have $F = \frac{3T}{4b}$. (18a)

Substituting this value of F in (35) gives us:

$$P_s = \frac{4}{b^2} \times \frac{3\,T}{4\,b} = \frac{3\,T}{b^3} \qquad (36)$$

Now substituting in (36) the value of b as given by (23) we have:

$$P_s = 3\,T\left(\frac{5}{2\sqrt{2}\,D}\right)^3 = 16.573\,\frac{T}{D^3} \qquad (37)$$

In (24) we have the section modulus of the square member, which, multiplied by the stress S, gives:

$$T = 0.0427\,D^3 S \qquad (38)$$

Substituting this value of T in (37) we have:

$$P_s = \frac{16.573}{D^3} \times 0.0427\,D^3 S = 0.708\,S \qquad (39)$$

Equation (39) gives the unit bearing pressure on the corners as about 71 per cent of the torsional stress in the inner member, which is a very safe bearing value, and indicates that the inner member would fail by twisting rather than by crushing at the corners.

Unit Pressure on Driving Faces—The Hexagonal Form

Treating the hexagonal form of Fig. 6 in a similar manner, with depth of inner member equal to e, we have for the unit bearing pressure at the corners:

$$P_h = \frac{F_1}{e \times \frac{1}{2} A} \times 2 = \frac{4\,F_1}{e\,A} \qquad (40)$$

Now $e = A\sqrt{3}$, and, from (26), $F_1 = \dfrac{T}{2A}$; then:

$$P_h = \frac{4\,T}{2\,A \times A\sqrt{3}\,A} = \frac{2\sqrt{3}}{3}\,\frac{T}{A^3} \qquad (41)$$

From (31), $A = \dfrac{8}{21}D$, then:

$$P_h = T\,\frac{2\sqrt{3}}{3} \times \left(\frac{21}{8\,D}\right)^3 = 20.886\,\frac{T}{D^3} \qquad (42)$$

From Equation (33) we have, for the strength of the hexagon:

$$T = 0.0598 D^3 S \qquad (43)$$

Substituting this in (42) gives us:

$$P_h = \frac{20.886}{D^3} \times 0.0598\,D^3 S = 1.249\,S \qquad (44)$$

Equation (44) gives the unit bearing pressure at the corners as about 25 per cent higher than the torsional stress in the inner member, which is about in the same relation as the ultimate tensile and shearing strength, so that this bearing pressure is not too high.

When both forms are developing their full respective strengths we have, from (44) and (39), the ratio

$$\frac{P_h}{P_s} = \frac{1.249}{0.708} = 1.76 \qquad (45)$$

or, under this condition, the unit pressure on the corners of the hexagon is about 76 per cent higher than on the corners of the square; so that, if tested to destruction, we would expect the corners of the inner member and the internal faces of the outer member to be much more distorted in the case of the hexagon than in the case of the square.

When both outer members are of equal size and transmit equal torques, we have from (42) and (37) the ratio

$$\frac{P_h}{P_s} = \frac{20.886\,T}{D^3} \times \frac{D^3}{16.573\,T} = 1.26 \qquad (46)$$

or, under this condition, the unit pressure on the corners of the hexagon is about 26 per cent greater than that on the corners of the square.

Conclusions—Comparison of the Two Forms of Set-screws

1.—With the distance across corners equal and the depth of inner members equal for the two forms:

a.—The hexagonal form is torsionally 62 per cent stronger than the square. See Equation (8).

b.—Under the same conditions, and considering the total driving forces as concentrated at the extreme corners,* this force is 6 per cent higher for the square than for the hexagon, if delivering equal torques. See Equation (5).

2.—For equal torsional strength the distance across the corners of the square should be 1.175 times the similar dimension for the hexagon. See Equations (9) and (9a).

3.—It is impossible to have the inner member of torsional strength equal to the outer member, because the outer member would rupture at the corners. This impossible but desirable condition is more nearly attained with the hexagon than with the square. See Equations (16) and (17).

4.—With the depth of hole equal to the distance across the flats of the inner member:

a.—We may, for the square form, make $b = 0.566D$, or $C = 0.8D$. See Equations (23) and (23a).

b.—For the hexagonal forms we may make $e = 0.66D$ or $C = 0.762D$. See Equations (31a) and (31b).

c.—These proportions will prevent rupture at the corners when the full torsional strength is developed.

d.—When so proportioned the square member develops 22 per cent and the hexagonal member 30 per cent of the strength of a solid circular member of diameter D. See Equations (25) and (34).

e.—The hexagonal form is thus 40 per cent stronger than the square form for equal sizes of the outer member.

f.—The unit bearing pressure on the driving faces is 71 per cent of the unit torsional stress for the square, and 125 per cent of the unit torsional stress for the hexagon. See Equations (39) and (44).

g.—When subjected to equal torques, with equal sizes of outer member, the unit bearing pressure on the driving faces is 26 per cent higher for the hexagonal than for the square form. See Equation (46).

5.—The hexagonal form is thus shown to be superior for strength, or for equal strength to be smaller, hence more compact.

6.—The square form is superior in wearing qualities because of less unit bearing pressure on the driving faces.

7.—Hence, the proper field for the hexagonal form is for parts not requiring much adjustment, such as set-screws in collars, wheel-hubs, etc., while the field for the square form is in parts requiring frequent adjustment, such as the screws in lathe and drill chucks. Use the hexagonal form for compactness and strength; the square form for wearing qualities.

* This is an arbitrary assumption. The writer believes the distribution of forces to be more nearly as shown in Figs. 5 and 6.

* * *

TESTING STEEL FOR AUTOMOBILE PARTS

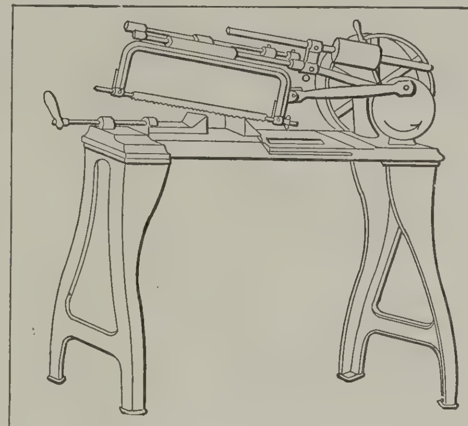
The careful tests to which the products of the G. Derihon Co. of Liege, Belgium, are put, explain the high standard which this firm has reached in the manufacture of automobile parts subjected to high stresses and shock. Since 1904 this firm has employed the Fremont drop test, and the results obtained have been very satisfactory. At the Derihon shops a test piece is taken from every piece out of which an automobile part is forged, and this test piece is forwarded to the customer together with the part ordered and a record of the results of the test. Thus, when sending out an order of twenty-eight steering levers, the company accompanies it with a list of twenty-eight tests. This increases the cost per lever by approximately five cents, but it gives an absolute certainty that the piece will stand as much as it is expected to. This policy makes it necessary for the firm to test from ten thousand to twelve thousand pieces per month, and on account of the experience thus obtained, it is interesting to note some of the conclusions arrived at by this firm with relation to the method of making these tests. For the drop test the firm uses test specimens 10 by 8 millimeters (25/64 by 5/16 inch, approximately) with a one-millimeter nick (3/64 inch approximately). If test pieces of larger dimensions are used, they are not likely to reveal minor defects. While brittleness in steel is often a local condition, it would be none the less objectionable and dangerous in the completed machine detail. As an indication of what can be accomplished by a commercial shop testing department and by taking advantage of the knowledge obtained from the tests made, it may be mentioned that at the outset the Derihon firm had to reject, for brittleness, from 20 to 40 per cent of the pieces tested, whereas during 1911 the total number of rejected parts averaged 0.3 per cent. This result has been obtained entirely from the fact that the testing of the steel has enabled the firm to apply proper heat-treatment to its steel products. In the opinion of M. Derihon it is possible to make all steels of good quality non-brittle. The whole question is simply one of heat-treatment, different steels, of course, requiring entirely different treatment in order that satisfactory results may be obtained.

RECIPROCATING STRAIGHT-BLADE SAWING MACHINES*

DEVELOPMENT OF HACKSAW MACHINES, WITH SPECIAL REFERENCE TO BRITISH PRACTICE

The material presented in the following has been gathered with the idea of setting forth the merits of the straight-blade reciprocating saw for metal work, as compared with those of the band saw and the circular saw. The latter types have been developed to approximately the same degree of efficiency which has been attained in other types of machine tools, while many reciprocating saws remain in essentially the condition in which they were first placed upon the market. The author believes that the Millers Falls Co. placed the first hacksawing machine upon the market. This machine is shown in Fig. 1, from which it will appear that its design is of a character hardly suitable to modern shop conditions. Fig. 2 shows the next hacksaw machine that was introduced. This is a more elaborate and heavier type than the preceding, and the old hacksaw frame has given way to a stronger design.

Another very early pattern of hacksaw was the Eureka, shown in Fig. 3. This machine was made by G. Thompson, Son & Co. It is designed along far better lines than the preceding types, having a solid base and provision for guiding the saws. The thrust is in a direct line, and the upper guide is made to extend in such a way that it admits of a large variation in the length of blade used. The long blade, similar to a band saw, is coiled up and brought out for use as the working part becomes worn. This coil contains about twenty-five feet.



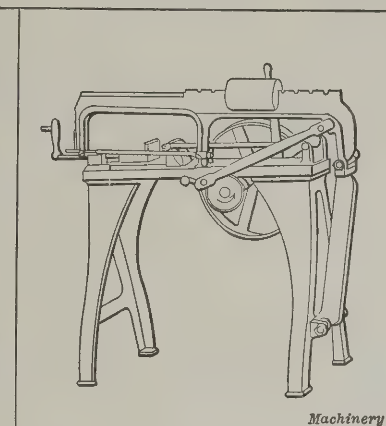
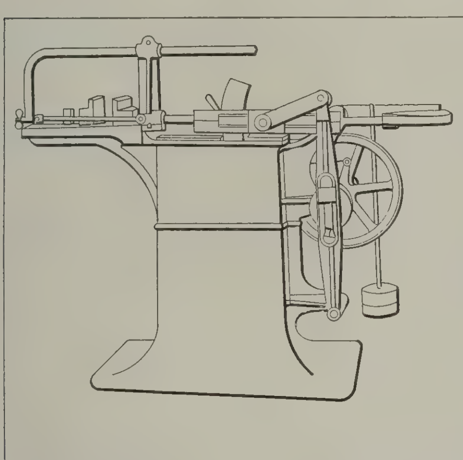


Fig. 1. The Star, the First Type of Hacksaw Machine. Fig. 2. The Simplex, another Early Type



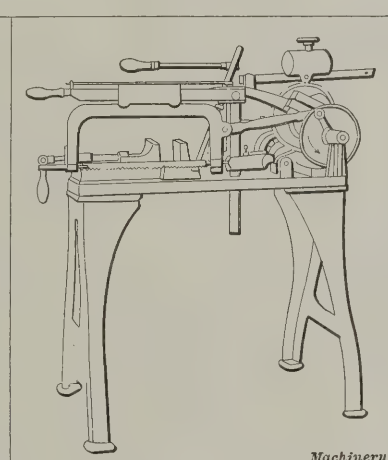


Fig. 3. The Eureka Hacksaw Machine. Fig. 4. The Milford Machine, an Improved Type

The Milford saw, shown in Fig. 4, is a still more carefully designed tool. It is fitted with a quick return and a clutch device for lifting the blade free of the work on the idle or return stroke. It has a gear drive of 4 to 1 and an automatic stop. In the author's opinion, these four designs are a fair illustration of the progress of the original type of hacksawing machine up to a recent date.

Messrs. Herberts of Manchester, England, were the first firm who seriously took up the matter of improving the design of hacksaw machines. The object was to make a stronger machine which would be capable of working more rapidly and of taking larger sections. They have made saws of a capacity hitherto commercially unknown, the largest being capable of taking 18 by 30 inches. Among other improvements they introduced an automatic feed for the work, and an eccentric motion was given to the fulcrum of the saw frame, as shown in Fig. 5. This made it possible for the fulcrum of the saw frame to be moved around slightly at intervals of 20 strokes, thus putting the saw at a different angle to the work. In this way it was working on a comparatively small surface at all times and was thus capable of handling larger sections. Such saws were capable of cutting a 4-inch bar in twenty minutes, as compared with an hour taken by the earlier types of machines. The only disadvantage of this method lay in the strain placed upon the saw blade after each move of the eccentric. The author believes that his firm was the first to use a stronger and better blade, and they were aided in this by the Sterling Co., who used tungsten steel.

Messrs. Holroyd & Co., of Milnrow, England, also introduced an excellent machine for rapid work with the same object in view that Messrs. Herberts had. In the Holroyd machine the bar was slightly turned around at intervals of several strokes instead of altering the angle of the saw. The advantage of this system lay in the fact that as the bar was continually turning around, it was difficult for the saw to run out, and the work would be approximately as true as that produced in a cutting-off lathe.

Advantages of Hacksaw Machines

The advantages of hacksaw machines as compared with other types are briefly as follows: First, the cost of the machine and blades, is comparatively low and the blades can be brought to any temper to suit the work. Second, a hacksaw will cut to any depth that the frame which holds it will permit; extra depth does not necessitate extra cost of blades as in the case of the circular saw, where the bosses limit the depth of cut to approximately 1/3 the diameter of the saw. It may also be mentioned in this connection that a circular saw is necessarily fairly thick and exceedingly difficult to get quite hard. Circular saws are also liable to break if hardened beyond certain limits. Third, in the case of band saws it is frequently necessary to cut the blade in order to thread it through the work, and, like the circular saws, it is almost impossible to get them quite hard. Fourth, another advantage of the straight blade over the circular saw or lathe cutting-off machine lies in the narrowness of the cut, say 1/16 inch instead of ¼ inch.

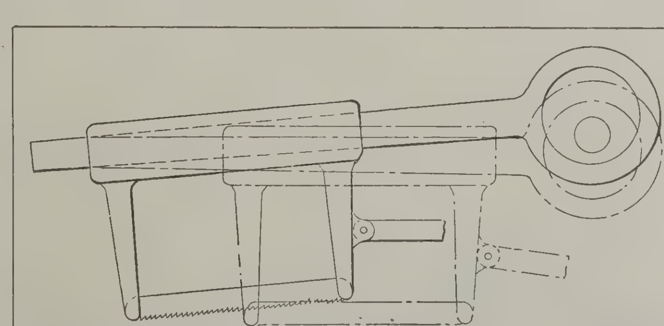


Fig. 5. Eccentric for tilting the Saw

* Abstract of a paper by Mr. Charles Wicksteed read before the Belfast meeting of the Institution of Mechanical Engineers, July, 1912.

This difference in the width of cut makes a great saving possible when working on such expensive materials as high-speed steel. Fifth, the power taken by a hacksaw is about one-fourth of that taken by a circular saw.

When once convinced that the straight-blade sawing machines had as great advantages as their competitors, it did not take long to discover the principles on which the blades must be made and operated. These may be briefly outlined as follows:

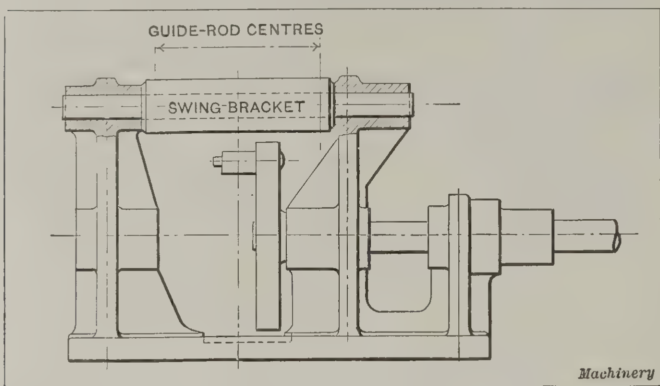


Fig. 6. Arrangement of Bearings for Guide Frame, viewed from the Back

First, the blade must be kept absolutely firm and perfectly square with the work. Second, it must be strong enough to stand all the weight that the teeth will take without breaking. Third, the blade must be made of the highest possible quality of steel with the best cutting edge that is practicable. Fourth, the machine must be well designed and work without

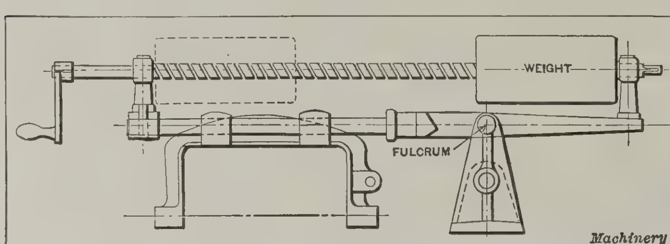


Fig. 7. Method of adjusting Position of Weight

spring or vibration. Fifth, since the pressure on the blade must be considerable, a reliable release on the return stroke must be provided. However, the results of experiments by the author have shown that unless the weight was heavy it made little difference whether the blade was released on the return stroke or not, but where a heavy weight is used, the blade will be quickly destroyed unless this precaution is observed.

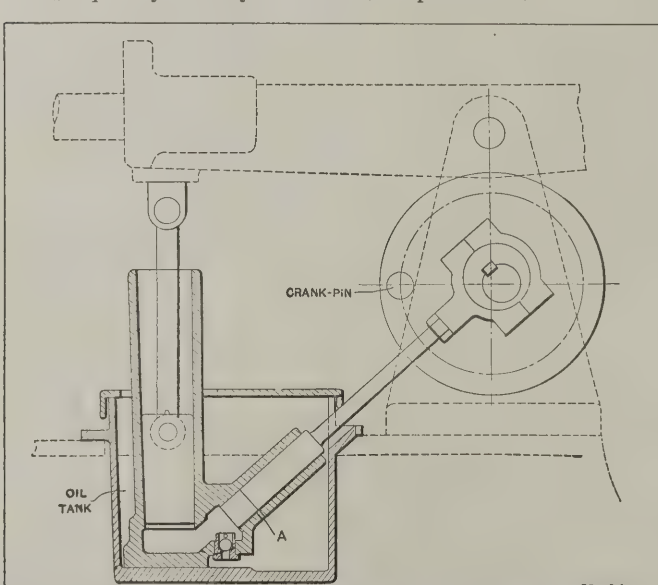


Fig. 8. Pump and Ram used to lift and lower the Saw at End of Stroke

Taking the points just mentioned into consideration, it will be evident that the blades have not been developed to this high standard without the expenditure of a great deal of effort on the part of the manufacturers. These improvements may be briefly outlined as follows: First, for ordinary work, a coarse pitch tooth, not less than 10 to the inch, has been found most suitable. Such teeth cut better, clear themselves better, and give a better opportunity for side clearance which is especially necessary in the deep blades used on heavy machines. Second, to make the teeth strong enough to take all the weight that they will stand, it is not necessary to do any special tempering. If the teeth are properly hardened, the back of the blades will also be of the proper hardness. Third, additional strength must be obtained by increasing the depth and not the thickness of the blade. An increase in thickness means a corresponding increase in the amount of power required to drive the machine. Theoretically, the thinner the blade can be made the better. This is limited, however, by difficulty experienced in hardening deep thin blades in such a way that they are absolutely straight. Deep blades are also more difficult to work and still keep the

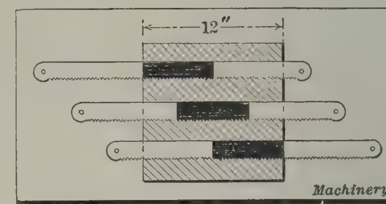


Fig. 9. Diagram showing how Saw is freed of Swarth

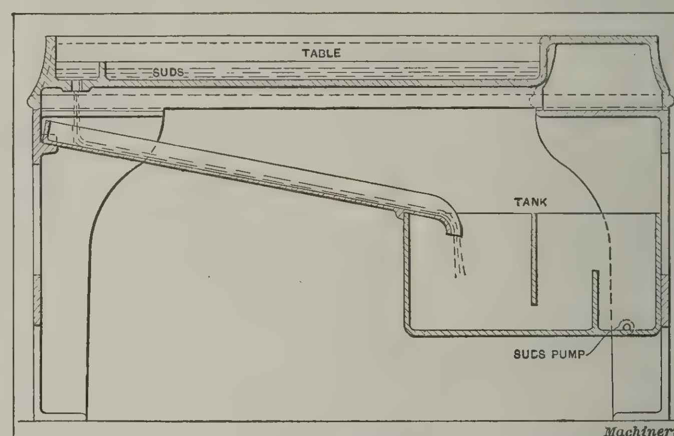


Fig. 10. Arrangement of Tank and Pump Connections

proper clearance. The blades used by the author vary from ¾ inch to 2 inches in depth and from No. 19 to No. 16 wire-gage in thickness. Fourth, the greatest weight that a tooth will take without injury must be ascertained and the blades then made strong enough to carry it. A weight of 210 pounds is about

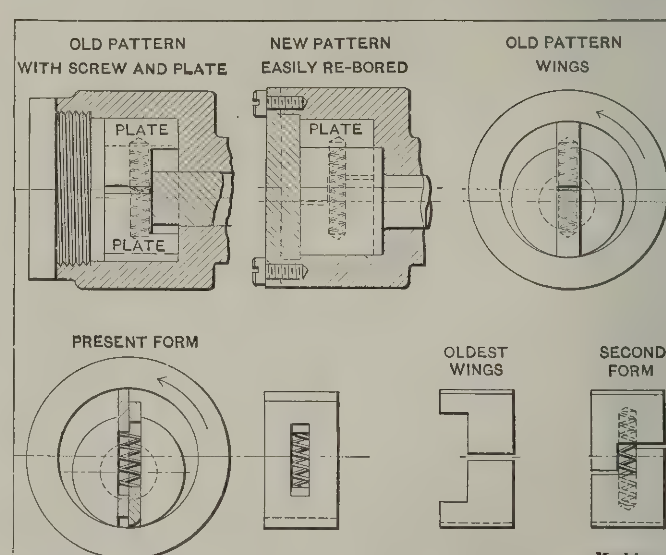


Fig. 11. The Type of Lubrication Pump used

right for a 6-inch machine, and enables the machine to use practically the full capacity of the blade up to a 4-inch round bar. As the machines become larger, the proportion of weight is increased. Thus a 15-inch machine requires 700 pounds on the saw to get the full capacity of the blade when working on a 10-inch surface.

Design of Machines

After having said this much about blades, it is hardly necessary to point out that corresponding improvements were required in the machines that drive them.

One of the greatest faults in early types of hacksaws is found

in the fact that the guide frame was almost universally pivoted on the crankshaft. Narrow bearings were usually employed, thus giving some play to begin with, which was constantly increased by wear. Hence the design lacked the first essential of a good machine. The loose guide allowed the saw to run out, to produce bad work, and to break the blades. To avoid these fundamental defects, the author applied a guide frame which is pivoted on independent bearings of the type shown in Fig. 6. These bearings have no other work to do than to guide the frame, and there is practically no wear. The machine is of rigid construction and the bed is of sufficient width to provide a bearing for the bar on both sides of the saw. The guide bars are placed far apart and all bearings are of ample proportions and bronze-bushed. The weights have been correspondingly increased so that a 6-inch machine weighs 550 pounds and a 15-inch machine 2500 pounds. Such weights are necessary to make the machine perfectly firm and free from vibration.

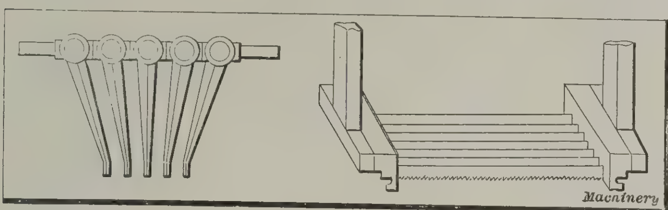


Fig. 12. Two Styles of Saw Racks used on Multiple Machines

The additional weight used on the blade made it necessary to adopt a convenient method of varying it according to the requirements of the work. This is done by means of a sliding weight on a bar which runs from the extreme end of the frame to a point well behind the fulcrum of the spring bracket. In the heavy machines this weight is adjusted by a quick pitch screw, the arrangement being shown in Fig. 7. Having such a heavy weight to deal with, it was next necessary to provide means to protect the machine from breakage in case the blade should break. A reliable release was also required on the return stroke of the blade. The latter is a difficult thing to provide for by purely mechanical means, as the plane of the saw varies at every stroke; but experiments have shown that it is essential for the saw to be lifted off the work at the end of the cutting stroke and put down again accurately at the end of the return stroke. If this is not done the output will either be seriously interfered with or the blade will be injured.

Fig. 8 shows the device by which the release of the saw is obtained. It will be seen that an eccentric set in time with the crank-pin on the crankshaft works a plunger in connection with the dash-pot. This plunger comes down and closes the port *A* at exactly the end of the stroke, thus gently lifting the frame sufficiently off the work during the return stroke and letting it down again as soon as the working stroke begins. There are no complications and no wear in this device, as both pistons are simply made a good fit and worked in oil. A foot-valve is provided to let the oil in when the frame is lifted by hand.

Later modifications of this device have been made to make it useful for other purposes. The port is made small enough to convert the larger cylinder into a dash-pot, thus making it impossible for the frame to fall, as it can only be lowered as fast as the oil is pressed through the small port *A*. This port is about 1/32 inch in diameter in the case of the small machines.

The stroke of the author's machine is from 5 to 8 inches. The longer stroke adopted in the larger machines was not found necessary to get rid of the swarth, but simply because it was found advisable to reduce the strokes as the length of the frames was increased. The question of the relative length of the blade to the stroke and the diameter of the bar is interesting. A long stroke should be avoided, as it entails a correspondingly long blade as well as a more cumbersome machine. If there is no lift on the return stroke, the stroke must be made as long as the section being cut, to get rid of the swarth.

Fig. 9 shows a 12-inch section being cut with a machine operating on a 6-inch stroke. In this diagram the middle part of the blade is shown black. This section has no opportunity of getting rid of its swarth, and will therefore, if not lifted, take the greatest part of it backward and forward. With sufficient lift on the return stroke, however, the swarth is dropped and raked 6 inches forward on the cutting stroke. Consequently it is only necessary to make the teeth deep and large enough to hold the swarth gathered during two strokes.

The lubricant used for saw blades is soap-suds, and great attention has been paid to the pump and tank used for lubricating purposes. The fact that the swarth made by the saws is exceedingly fine, and that it is much more difficult to operate a pump properly with suds than with oil, necessitated a careful provision to keep the swarth away from the pump. Fig. 10 shows the arrangement of the tank and connection, where it will be seen that the suds are first collected by a recess in the bed and then drained at the front end, which is farthest away from the point where the swarth is dropped. The suds then run through a trough to a tank at the back end of the machine. This tank is divided by two weirs, the lubricant going under the first weir and over the second. In this way any light swarth floating on the surface of the fluid is stopped.

Type of Pump Used

Wing pumps were decided upon as most satisfactory for this service, but the best type available was of such construction that it would not wear well. The simple type of pump shown in Fig. 11 was finally adopted. In this type a by-pass is provided, not with a separate valve, but simply by making the wings of the pump taper against the pressure, so that when a full discharge is not required the increased pressure of the suds presses the wings inward. The cover is fastened by screws instead of being secured by a thread in the end of the cylinder, this design making it easy to rebore when necessary. The wings are provided with two small slots of such a length that one spring put in the middle will press up the wings on each side. This is an improvement over the old method where the wings met in the middle, thus leaving very little bearing surface. The gradual wearing of this bearing caused friction which led to the destruction of the pump.

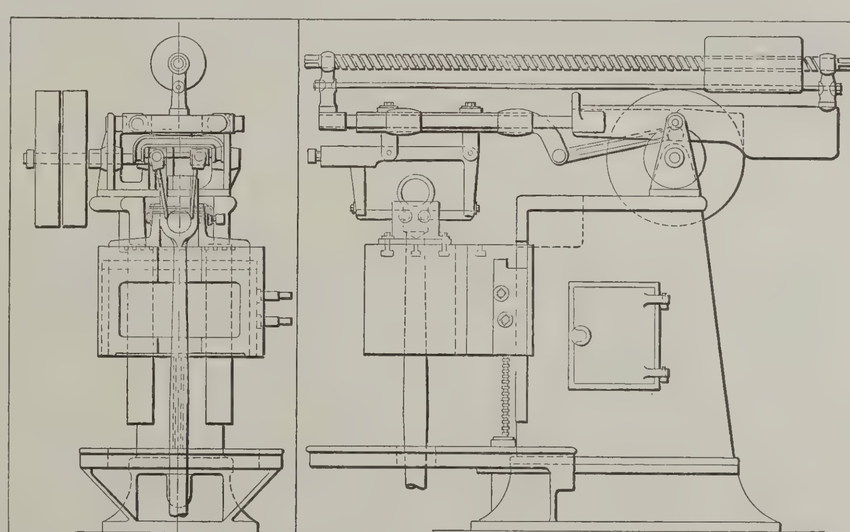


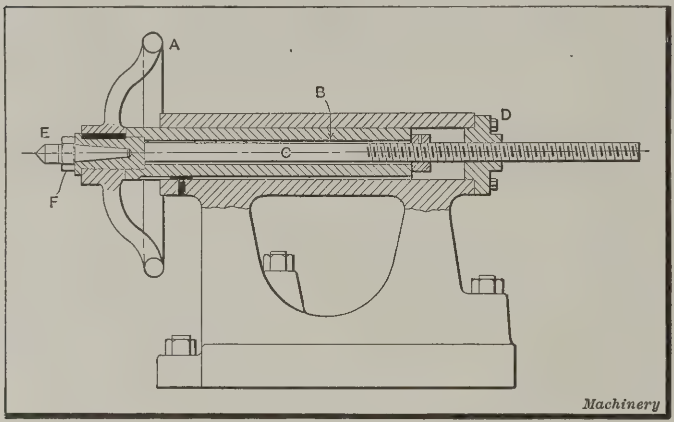
Fig. 13. The Shaping Machine Saw

The result of these improvements is that sawing can be done practically true, say to 0.010 inch in cutting a 6-inch bar, and mild steel can be cut at a speed of approximately 1 to 2 inches per minute. The breakage of the blades is also rare. In conclusion, the author states that his purpose in presenting this review is merely to trace the development of a most useful tool, so far as it has gone. He is of the opinion that nothing like perfection has yet been approached, and believes that in rapidity of work, endurance of blades, and in the size of machines, the reciprocating straight-blade sawing machine has many advantages sufficient to warrant making its improvement a matter of careful study.

IMPROVED LARGE LATHE TAILSTOCK

A new form of tailstock for large lathes designed to facilitate adjustment when centering heavy and awkward parts, was recently illustrated in the *Practical Engineer.* The common position of the handwheel on the outer end of the tail spindle is so far from the center point on large lathes that the machinist can reach it with difficulty when watching the center enter the work. On very large forge lathes the adjusting handwheel is sometimes placed on the side of the tailstock, near the inner end of the spindle and is connected to the screw by a shaft and bevel and spur gears to overcome the difficulty. This construction is objectionable, of course, for medium size lathes on the score of cost.

In the new design the handwheel *A* is placed on the inner end of the tailstock where it is mounted on the screw *C*. The center *E* is set in the end of the screw, the screw being made with an enlarged end for the socket. The screw is supported by the quill *B* and is threaded in the nut *D*. A nut *F* is provided on the center for ejecting it as the construction does not permit the self-discharging principle of the common form of tailstock to be used.



Tailstock for Heavy Lathes having Handwheel on Inner End

The contributor of the design points out that it is not well adapted to small lathes because of the interference of the handwheel with the compound rest. By giving the handwheel considerable dish, however, and overhanging the nose of the tailstock this defect might be overcome. The projection of the screw is another objectionable feature which might be avoided by slightly changing the design so that the parts would telescope, the nut being made in the form of a tube with the thread at the end. This construction would necessarily make the quill somewhat larger relatively than shown in the illustration, but would materially reduce the overall length and improve the appearance.

An objection to the design not mentioned by the contributor, of little importance, perhaps on heavy lathes, but of some weight in the design of small lathes, and especially toolroom lathes, is that the tail center is mounted in a revolving part and cannot, therefore, be considered a dead center. Eccentricity of the center point would cause trouble by throwing the centers out of line.

* * *

FATIGUE STRESSES IN MACHINE STEEL

In a paper on "Endurance Tests of Machine Steel," presented before the International Association for Testing Materials, New York, September, 1912, Mr. J. O. Roos of Hjelmsäter calls attention to the so-called "fatigue ruptures" which occur in parts which are subjected to continually repeated shocks or stresses of small magnitude. Machine parts which are subjected to continual stresses in varying directions, or to repeated shocks even though of comparatively small magnitude, can hardly be satisfactorily designed (nor can the material be chosen) from a mere knowledge of the behavior of the material under a steady stress, such as imposed upon it by ordinary tensile stress testing machines. From the numerous cases of machine parts broken under actual working conditions, and which Mr. Roos had had occasion to examine in the course of his work, the most tangible and positive result obtained was that at least 80 per cent of these ruptures had been caused by fatigue stresses, the surface of the fracture showing the characteristic crack for this kind of a break. Among the pieces of this kind examined were railway car axles, parts of steam engines, and parts from motor cars and trucks. Most fatigue ruptures in practice are caused by bending stresses, and very frequently by a revolving bending stress. Hence, to test materials for this class of stress, the tests should be made to stress the material in a manner similar to that in which it will be stressed while under actual working conditions. This can be accomplished by subjecting a projecting test piece held at one end to a load at the other end, and revolving the test piece while subjected to the load. A machine for carrying out tests of this kind has been developed in the United States by Mr. Henry Souther of Hartford, Conn.

* * *

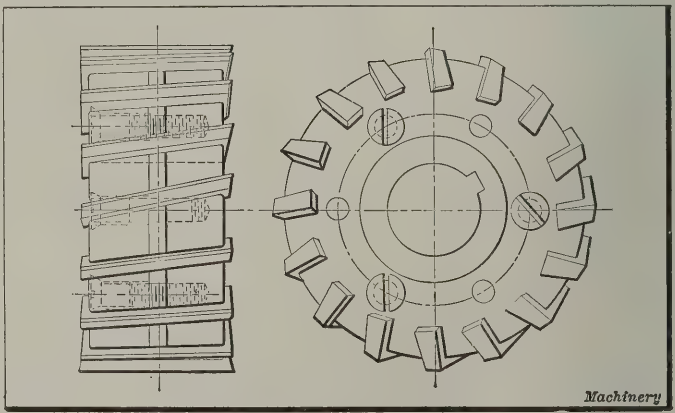
THE NITROGEN INDUSTRY IN NORWAY

One of the interesting features of the eighth international congress of applied chemistry, held in New York during the early part of September, was a lecture delivered by Dr. Samuel Eyde of Christiania, Norway, in which he described the development of the nitrogen plants that have recently been built in Norway, and in the development of which he has played a leading part. Lantern slides were shown of four great nitrogen plants under Dr. Eyde's control, having a total capacity of 200,000 horsepower and producing yearly 80,000 tons of nitrate of lime for fertilizing purposes, 10,000 tons of nitrate of ammonia for use in explosives, and 10,000 tons of nitrate of soda for use in coloring industries. It is very interesting to note how a country so poor in regard to natural resources as is Norway, except for the enormous power represented by the water falls, has in this way been able to develop an industry requiring practically no other raw materials than air and water. It has been predicted that chemical industries in which electricity plays an important part will, in the future, be largely concentrated in the Scandinavian countries because of their available water power, and hence their cheap supply of electric energy. As Norway, especially, is a country which is not suited for agriculture, the development of these industries is a highly important factor in its prosperity.

* * *

NEW TYPE OF INSERTED-BLADE MILLING CUTTER

The accompanying illustration shows a new development in inserted-blade milling cutters, patented by the Sächsischen Maschinenfabrik in Chemnitz, Germany. The body of this inserted-blade cutter consists of two disk-shaped parts, held together by screws and dowel pins, as indicated in the accompanying illustration. The slots are milled in the two parts at the same time, the disks being held a suitable distance apart. The blades are then inserted and the two parts clamped together by the screws shown. This clamping, of course, binds or wedges the blades firmly in place, as the two disks are brought up against each other. The dowel pins prevent the body parts from rotating with relation to each other.



New Type of Inserted-blade Milling Cutter, of German Design

SCIENTIFICALLY MANAGED PRESS WORK

WORCESTER PRESSED STEEL CO.'S METHOD OF ROUTING MULTIPLE-OPERATION JOBS

BY CHESTER L. LUCAS*

To start sheets of heavy steel at a blanking and drawing press at one end of a row of presses and keep the semi-completed shells moving down the entire line of drawing presses, passing the work from operator to operator, until it emerges after the thirteenth operation a completed steel bowl, is a feat of modern press work of which the Worcester Pressed Steel Co., Worcester, Mass., may well be proud. Fig. 1 shows the line of presses used on this work, and Fig. 2 represents a section of the connected presses, showing how the work is passed from press to press.

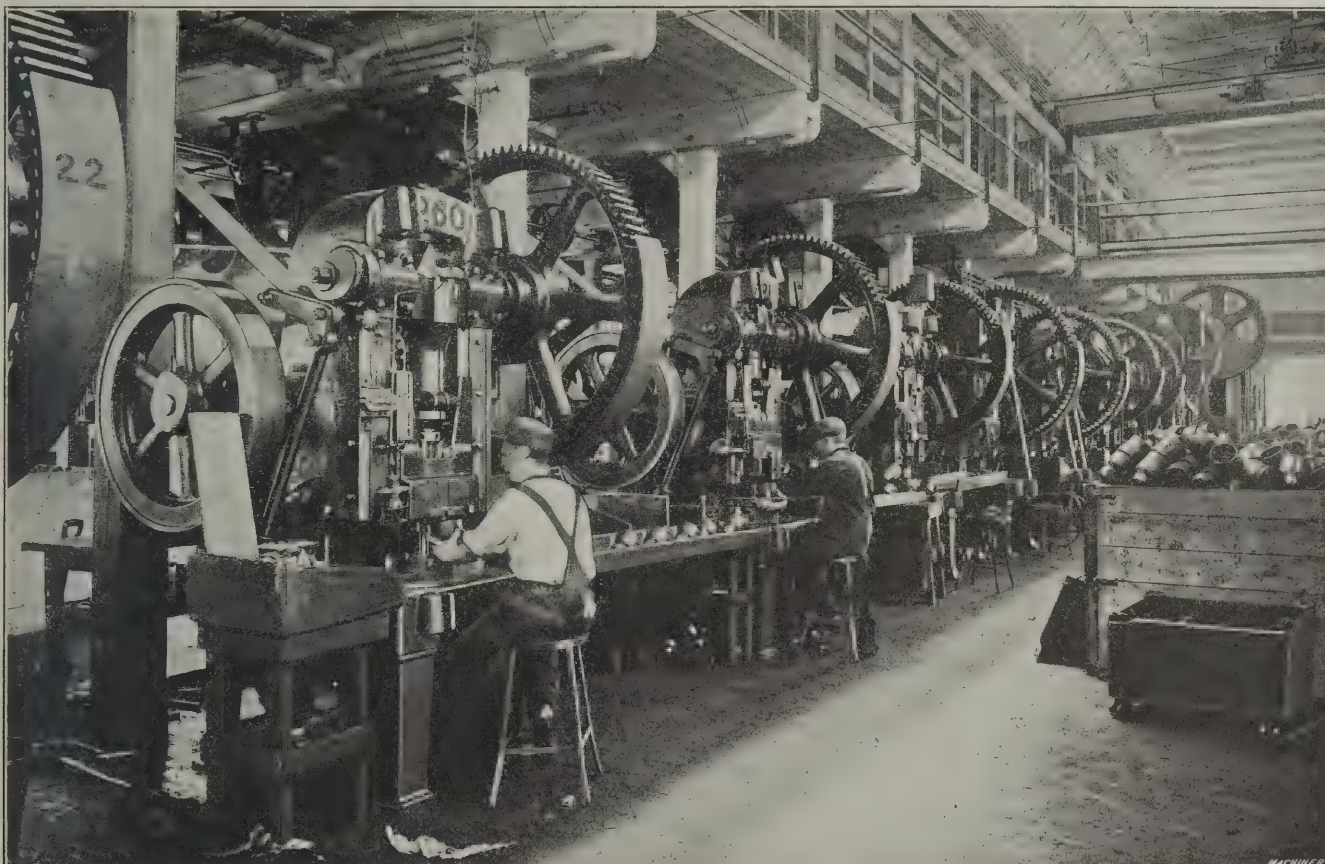


Fig. 1. The Presses used in Producing the Steel Bowls

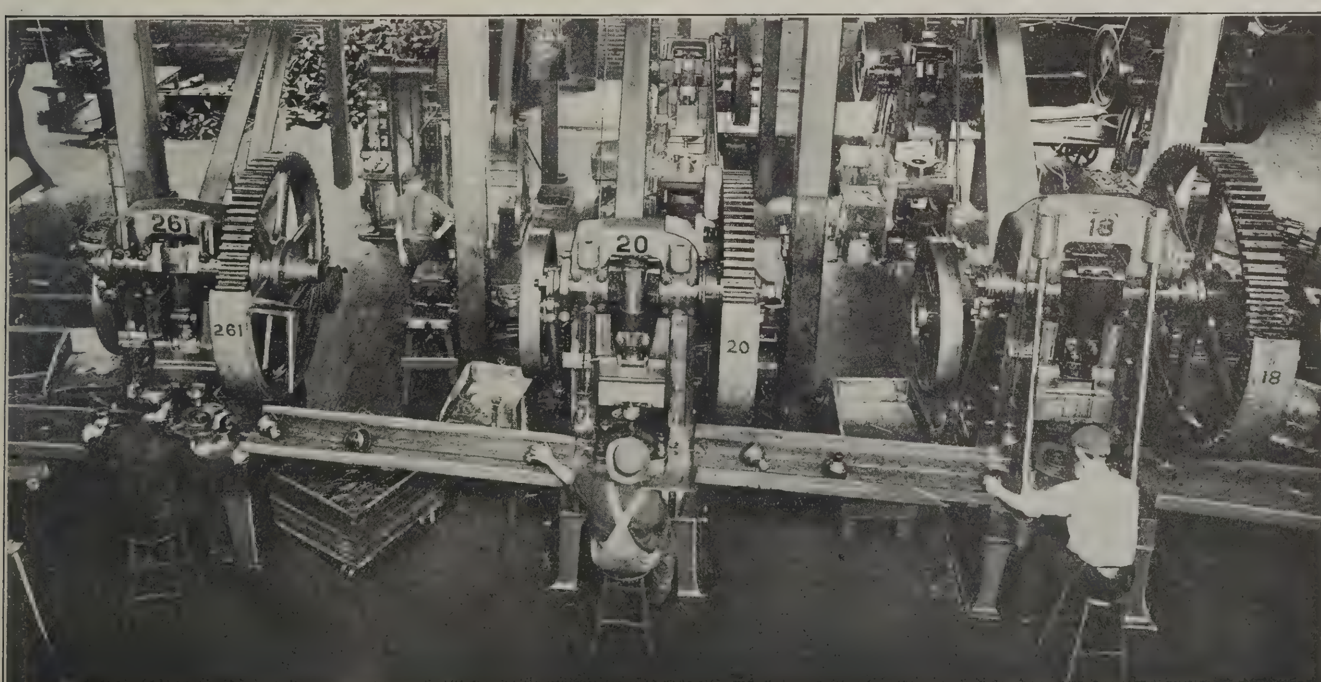


Fig. 2. A Section of the Row, showing Method of Handling the Work

The pressed steel bowl referred to is one which is used in large quantities on a special class of machinery. The completed bowl is approximately as shown in the line engraving, Fig. 3, being five inches in diameter. The fact that the stamping is made from heavy sheet steel, 0.150 inch thick, is the point which makes the production of this piece the more remarkable. The successive steps in drawing the shell

* Associate Editor of MACHINERY.

are clearly indicated in the group illustration, Fig. 4, which shows the results of the work performed in each of the thirteen operations. By comparing the work with the two-foot rule shown in the foreground, a good idea of the dimensions of the pieces can be obtained.

The first operation, namely, that of cutting and drawing the blank, is performed on a large double-action power press, and after leaving this press the shells go to a large single-action press. Another reduction follows which leaves the blank deeper, but smaller in diameter. After this stage the shells are annealed and taken to the first press in the foreground of the illustration Fig. 1. From this point the shells continue down the line of presses, being passed from operator to operator by means of chutes along which the work is thrown. The method of routing the work is more clearly illustrated in Fig. 2. Before the shells are completed another annealing operation becomes necessary, because the final op-

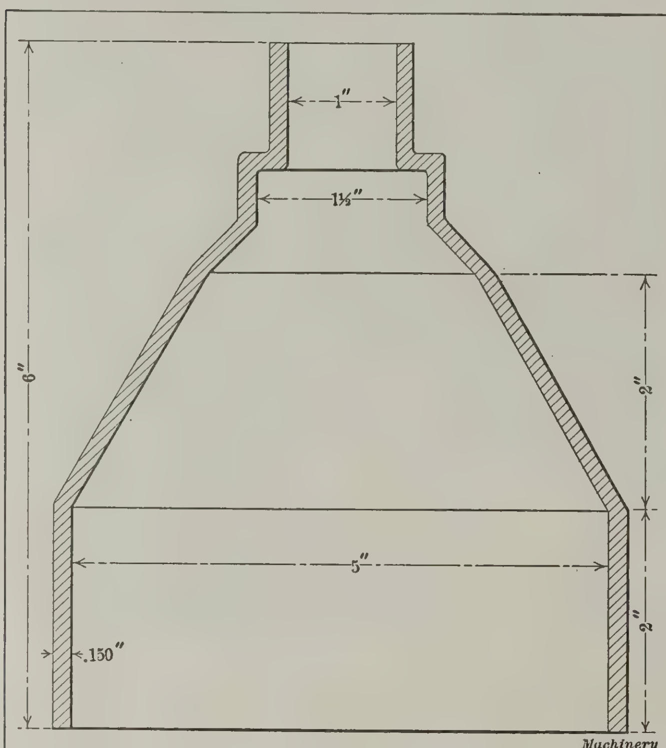


Fig. 3. Details of Steel Bowl

erations, which are for the purpose of setting the metal at the tip end of the shell, require that the stock be as soft as possible. Owing to their location it was impossible to clearly show two of the presses used for final punching and setting operations, but Figs. 1 and 2 adequately illustrate the principle of handling this job.

These shells are made in lots of from 5000 to 10,000, and after the presses are set up and the blanks started, the completed shells are turned out at the rate of 400 per hour. It is obvious that this method of handling press-work pushes the work off the floor and out of the way quickly. Piles

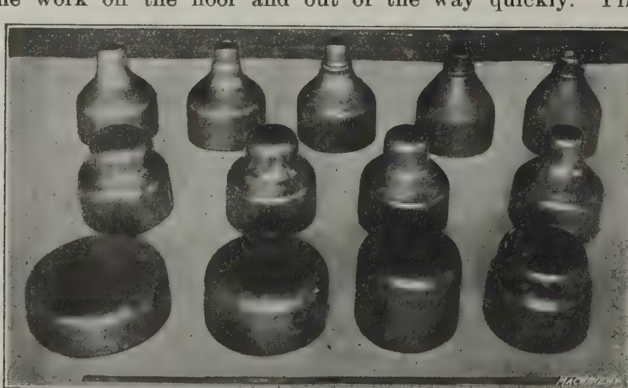


Fig. 4. Successive Steps in the Press-work

of half completed work do not accumulate, and once started, there is a steady stream of completed shells traveling to the shipping room until the last shell has gone "down the line."

In Fig. 5 may be seen a large Toledo double-action drawing press, a machine which handles drawing and forming operations on large work like brake drums, axle housings, cases, shells, etc. This press is one of the largest of its type ever built in this country and has a capacity for exerting a 1000-

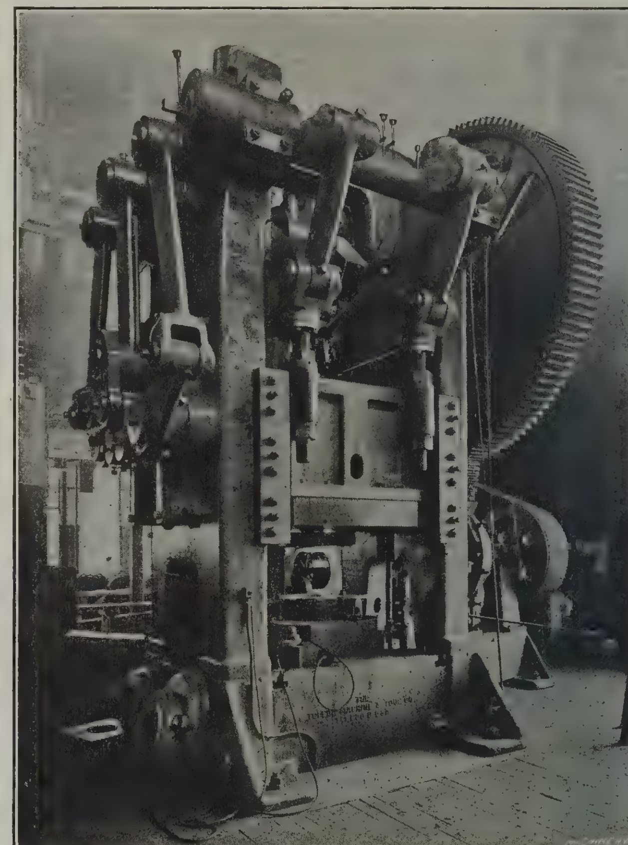


Fig. 5. The Large Toggle Drawing Press

ton pressure. The area of the bed is 60 inches square; the stroke of the plunger is 26 inches; stroke of the blank-holder is 18 inches. The crankshaft of this press is 12 inches in diameter, and the construction of the toggle mechanism is such that a long dwell under heavy pressure is given to the blank-holder. The advantage of this feature is that it provides means for drawing sheet metals with a minimum of trouble from wrinkling. The press frame is of the built-up type, rigidly bound together with forged steel tie-rods 6-inch diameter which have been shrunk into place. The power for operating is furnished by a 75-horsepower motor.

The premium system of piece work is employed on all

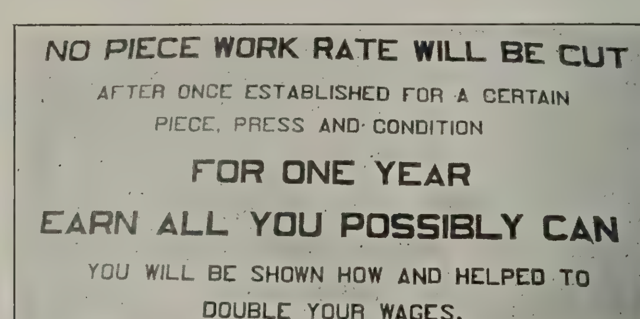


Fig. 6. A Factor in the Success of the Premium System

operations in the factory, and it works out with great success. One of the chief reasons for its success, and one which other factories will do well to note is manifested in the presence of large signs on the bulletin-boards, a facsimile of which is shown in Fig. 6, which assures the men that piecework prices once established will not be reduced for at least a year's time.

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INDEX TO MACHINERY

The eighteenth volume of MACHINERY was completed with the August number, and the general index covering the engineering, shop and railway editions is ready for distribution. Copies will be sent to any address on request.

PREVENTION OF ELECTRICAL ACCIDENTS IN MACHINE SHOPS

In an article in the *Engineering Magazine*, Mr. Emmett Campbell Hall deals with the question of electrical accidents and mentions some of the precautions that ought to be taken in order to avoid them.

Considering the extensive use made of electricity both for lighting and power in almost all modern industrial establishments, the general lack of knowledge concerning its dangers, and the not infrequent helplessness and panic which is manifested when someone receives an accidental shock, is somewhat surprising. Most electrical accidents are due to ignorance or carelessness, and not infrequently an ill-advised attempt at rescue results in a second accident. Scarcely less important than a knowledge of how to avoid a shock, is information as to what should be done if such accidents do occur, as they sometimes will through unavoidable causes, even when the greatest care is exercised.

The human body is an electric conductor, although not so good a one as a wire or a metal rail, and current will flow through the body when it is made part of a circuit. The amount of current which will flow through the body depends upon the voltage or pressure of the current, and upon the completeness of the contact between the body and the circuit. A single-cell battery, giving one to two volts, can cause a current to flow through the body, but the current is too small to be felt. A shock, though not a violent one, will be received from a 110-volt circuit; currents of greater strength must be carefully guarded against.

If a perfect insulator could be found, a man might stand upon it and place his hand upon a trolley wire through which a 500-volt current was passing, and receive no shock, because the circuit through the body would not be complete, and no current could flow. If a man should stand on damp earth and handle a charged wire with gloves slightly damp from sweat, he would probably receive a severe shock; if he wore no gloves, the shock would knock him down, and possibly kill him. There is no such thing as a perfect insulator, though for practical purposes a number of things may be so considered. The most that can be done is to insulate the body to such a degree that the current which passes through it will be so small that no shock will be felt. In other words, a small percentage of the total force of the current is almost sure to pass through the body, no matter what form of body insulation is used. It is therefore obvious that the amount of current which will get through the insulation increases as the voltage that is handled increases. It is not difficult to guard against shock from a 110-volt current, comparatively little insulation being effective. It is much more difficult to protect the body from 250 volts, and circuits of 500 volts or more should be carefully approached, no matter what form of insulation is used.

Next to contact with live wires, the most likely cause of shock is contact with parts of machines or equipment that are not supposed or intended to carry current, but which are accidentally charged with electricity. This charging is caused by the failure of insulation, or by a live wire coming in contact with the equipment. The frame of a motor or cutting machine, or the iron casing of an enclosed switch, may become alive and will be as dangerous as a trolley wire.

The frame of an electric locomotive is usually so completely in contact with the track rail that a man cannot get a shock even by standing on the rail and touching the locomotive; but this, under one peculiar condition, may not be true. If the rails have been heavily sanded, the locomotive may be almost completely insulated from them, and in that case a shock may be received from the locomotive frame or from the draw-bars of the cars coupled to the locomotive.

It is impossible to tell whether conditions are safe unless the man concerned has made them so himself—no one can tell by looking at a motor, for instance, whether or not the parts that carry current have come in contact with the frame of the machine. Whenever possible, common sense should dictate that the current be cut off before anything is touched that *might possibly* be charged. If it is impossible to cut off the current, or if repairs must be made to live apparatus, the only way to be safe is to provide something suitable to stand on while doing the work. *Dryness* is the most desirable quality in such an article. Perfectly dry boards, free from nails, are good.

Rubber gloves, or leather gloves in good condition and without metallic fastenings, will protect the body from shock. If the rubber covering of gloves is worn thin, the gloves give almost no protection, and the same is true of leather gloves which from any cause are damp. Rubber boots without nails in the soles or heels are good protection when new, but if the soles are worn or cracked their value is doubtful. Rubber tape on the handles of pliers and other tools cannot be depended on unless the tape has been freshly and carefully applied. If a man has to make some adjustment, he should use but one hand, if possible, and he should also try to place his body in such an attitude that the involuntary recoil from a possible shock will remove his hands from the apparatus instead of causing him to grasp it.

When a man has received a shock which renders him senseless, two things should be done as soon as possible; remove the victim from contact with the electric wire, and revive him by getting him to breathe. Great care should be exercised by the rescuer not to get a shock himself. If a switch is at hand, the current should, of course, be cut off, but if there will be any delay in cutting off the current, remove the body from the circuit by means of a piece of dry wood, using it to push the body aside or to lift from the body whatever is carrying current to it. Tools with *dry* wooden handles, such as picks or shovels, may be used for this purpose. The body can be safely grasped with the hands, if the hands are protected with several thicknesses of *dry* cloth, or if the rescuer stands upon a piece of *dry* wood. Take hold by the victim's clothing only, if practicable, not of the body where bare. If nothing else can be done, it may be possible to short-circuit the current, and thus blow the circuit breakers or fuses. A short circuit may be made by placing a piece of pipe or other metal article so that it will connect the two sides of the circuit. For instance, if the victim is in contact with a trolley wire, the wire, chain, or what not, should be thrown across the trolley wire and the track rail, so as to be in contact with both. In doing this, one must, of course, be sure that the pipe or chain leaves his own hand before it touches the current-carrying part of the circuit.

* * *

WAGES IN VARIOUS COUNTRIES

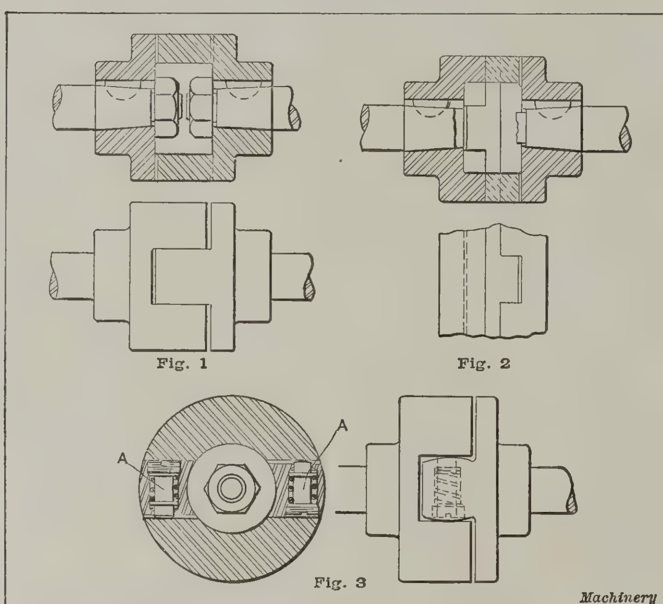
From the results of thorough investigations undertaken by the Board of Trade, England, relating to the wages paid to workmen in England, Germany, France, Belgium and the United States, some interesting data on the comparative wages in these countries may be obtained. These data present a fair average, as not less than ninety-four industrial centers in Great Britain, thirty-three in Germany, thirty in France, fifteen in Belgium and twenty-eight in the United States furnish the basis for the comparison. As a general average it may be stated that the wages of American workmen are 50 per cent higher than those of English workmen. In the European countries wages are highest in England and lowest in Belgium. English workmen are, in general, paid 25 per cent more than German workmen, and 36 per cent more than workmen in France. Relating to wages in the metal industries, the following figures will be of interest: Lathe hands are paid in London $9.50 per week of fifty-four hours; in Berlin, from $9.10 to $9.45 per week of from fifty-seven to sixty hours; in Sheffield, $9.25; in Düsseldorf, from $8.00 to $8.75; and in Antwerp, $5.85, for sixty hours a week. Of European countries, England shows not only the highest wages paid but also the shortest working hours. Belgium with the lowest wages has also the longest working hours. The investigation also covers the cost of living in the different countries. Thus, for example, rents for similar accommodations are nearly twice as high in England as in Belgium, and about twice as high in the United States as in England. The average prices of food products as compared with the English prices are 17 per cent higher in Germany; 18 per cent higher in France; 1 per cent lower in Belgium; and 28 per cent higher in the United States.

AUTOMOBILE MAGNETO COUPLINGS

BY GEORGE E. POPE*

Recently a magneto coupling was to be designed which was to combine simplicity with full freedom of universal-joint action. Several designs were tried, the results obtained being recorded in the following.

The first coupling designed was made as shown in Fig. 1, with the exception that the tongue was made about 0.010 inch smaller than the slot. This design, of course, had a universal-joint action, but the noise was very objectionable. This noise was partly due to the great difference in power transmitted while the armature of the magneto traveled by a gap as compared with that transmitted when it passed a pole. The objectionable noise was eliminated by making the tongue a sliding fit in the groove, as shown in Fig. 1, but this construction necessitated an accurate alignment of the magneto shaft with the driving shaft, and defeated the object of a universal-joint action. Another design, as shown in Fig. 2, was then tried. This is simply an adaptation of what is commonly known as "Oldham's" coupling. This worked very satisfactorily and the only objection was that there was considerable milling work to be done on the intermediate piece.



Figs. 1 to 3. Different Types of Couplings Designed

The next step in the development was to make the tongue of the coupling shown in Fig. 1 with rounded sides, as indicated in Fig. 3. This arrangement gave a satisfactory universal-joint action, especially when the tongue was made 0.010 inch smaller than the groove and the spring pins *A* were added to keep the driving surfaces in contact. In this coupling, however, it is necessary that the tongues be milled properly; and the first operation in doing this work consists of merely milling a slot through the end as if the grooved part of the coupling was about to be made. The permissible maximum width of this groove or slot is readily determined, as indicated in Fig. 5. This slot serves a double purpose; *i. e.*, it relieves the form cutter of most of the work, and it provides a means for preventing the work from turning when milling the upper side of the rounded portion of the tongue, as shown in Fig. 6, where the cylindrical piece *B* enters into the groove milled while one side of the tongue is formed.

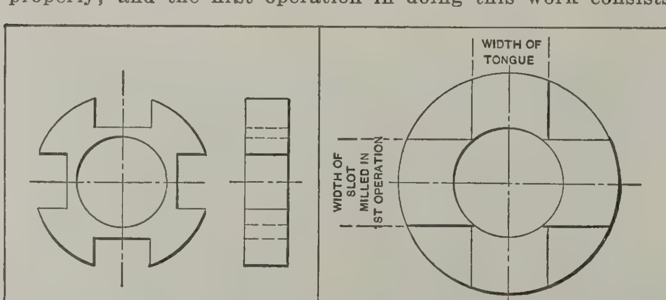


Fig. 4. Alternative Design of Connecting Part in Fig. 2 Fig. 5. Illustration of Method of finding Width of Tongue in Fig. 3

* Address: 586 Warren St., Bridgeport, Conn.

The fixture shown in Fig. 6 is, perhaps, of special interest, on account of its quick action in bringing the set-screws *C* into position. The piece carrying the set-screws is a section of cold-rolled steel placed between the uprights *A*, which take the backward thrust of the screws. These pieces are hinged freely at both ends on pins, the ends of which are milled off, as shown. These ends are in contact with flat springs which hold the parts *D* in an upright position with the screws vertical while the work (of which there can be six or ten pieces in the same fixture) is being removed or inserted.

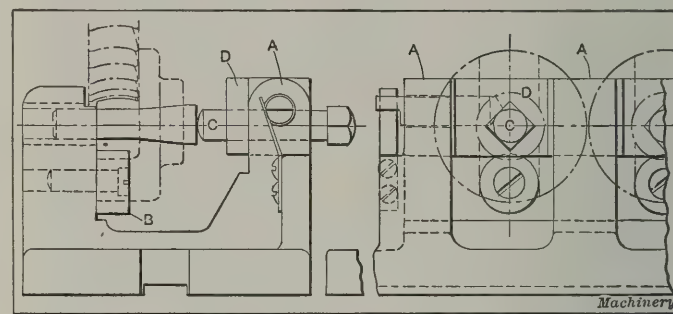


Fig. 6. Milling Fixture used for Milling Tongue in Coupling in Fig. 3

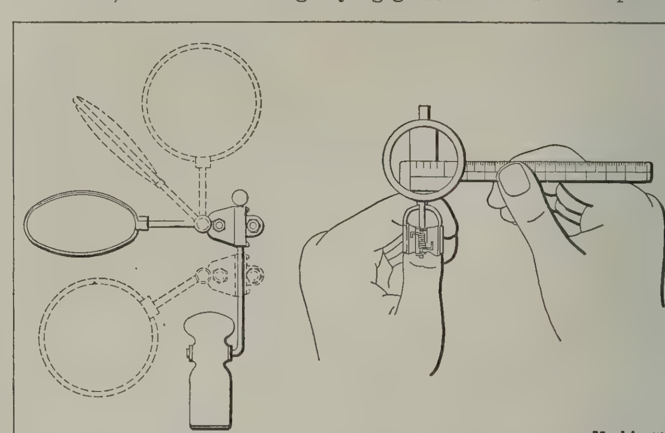
A slightly different design for a coupling of the type shown in Fig. 2 is to have the intermediate piece contain the slots, instead of the tongues. The intermediate piece will then look as indicated in Fig. 4. These pieces can then be milled in gangs on an arbor, but the other parts of the coupling become more difficult to mill, as both of them now have tongues, and it is doubtful if anything is saved by this design.

It may be remarked that although these different designs of couplings were made primarily for automobile magnetos, they probably can be applied to other kinds of work where it is inadvisable or impracticable to accurately align the connecting shafts.

* * *

HANDY MAGNIFYING GLASS FOR SHOP USE

The accompanying illustration shows a useful device recently placed on the market by Messrs. Pfeil & Co., Clerkenwell, London, E. C. This device, as illustrated in the *Mechanical World*, consists of a magnifying glass mounted on a special clip which can be clasped onto the left-hand thumb, and is known as the "third hand." The object of the device is to enable an article to be held, examined and turned under the lens, and yet leave the other hand free for holding the measuring instrument. The clip can be clasped on any finger so that small articles can be examined on the palm of one hand and moved and turned around by the other. The illustration to the right suggests one of the uses of the device. As shown by the dotted lines in the illustration to the left, the magnifying glass is universally jointed to the holder so that it can be set in almost any position.



Handy Magnifying Glass that can be attached to the Thumb, leaving Both Hands Free to handle Work and Measuring Instrument

COMMERCIAL GRINDING*

A FEW PRACTICAL EXAMPLES FROM ACTUAL WORK

BY F. B. JACOBS†

Where is the machinist of twenty or more years' experience who cannot recall the time when small and medium-sized shafts, spindles, etc., were always carefully turned from Bessemer steel and finished by filing? In those days, the few grinding machines that existed were generally of the universal type, and were confined to the tool-room, being used only on work that had to be corrected after hardening. While it can not be denied that the shop practice of the "good old days" resulted in excellent mechanics, it is also quite evident that the concern that still employs the old methods finds itself seriously handicapped in meeting prices set by modern practice. In the finishing of accurate machine parts, the grinding machine has replaced the lathe, and the grinding wheel has taken the place of father's file.

The present-day grinding machine owes the greater part of its success to the modern grinding wheel; for no matter how carefully the machine is designed and constructed, its output is always seriously handicapped if wheels of the wrong materials, grits, grades and bonds are used. The following illustrations and descriptions are not intended to show what could be done under ideal conditions; on the other hand they are taken from actual work as the writer found it in various shops under everyday working conditions.

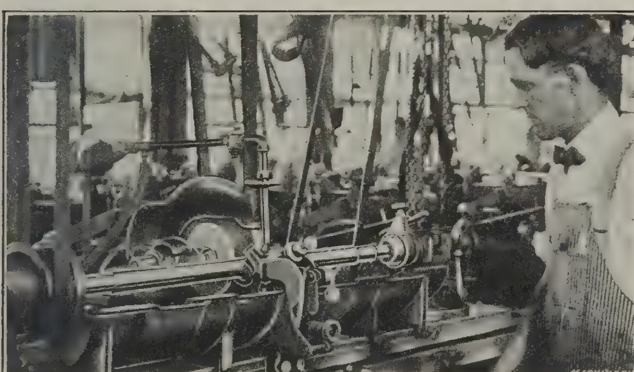


Fig. 1. Finishing Steel Shafts in a Brown & Sharpe Universal Grinder

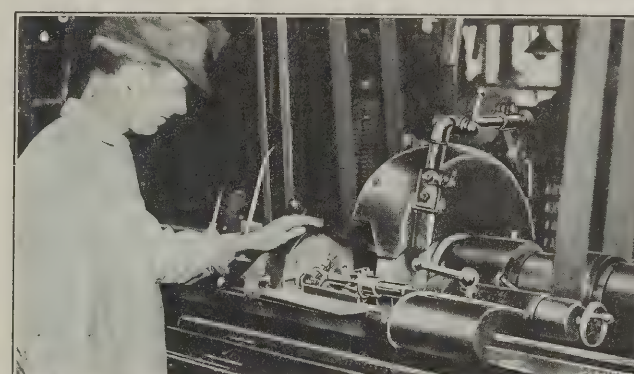


Fig. 2. Grinding Bevel Gear Hub with a Wide-faced Wheel

Fig. 3. Group of Bevel Gears being ground in Fig. 2

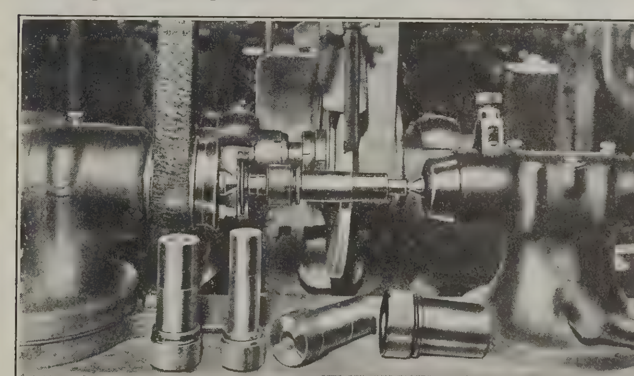


Fig. 4. Grinding Jig Bushings

In Fig. 1 is shown the operation of finishing a 40-point carbon steel shaft in a Brown & Sharpe No. 3 universal grinder, equipped with a carborundum wheel 365 grit, L grade, B3 plus bond. This piece is 2 feet 10½ inches long, and 1⅝ inch in diameter. It is first rough-turned, leaving 0.015 inch for grinding. As the illustration shows, the work is supported by a compound back-rest, this being necessary to overcome chattering under heavy cuts. While removing the greater amount of the stock the back-rest jaws are used "solid," bearing in a groove ground for this purpose. While taking the last few cuts the jaws are held against the work by the springs with which the rest is provided, care being taken to see that the jaws do not bear hard enough on the piece to throw it out of alignment. The time consumed in grinding this piece is twenty minutes, and the finish left is excellent.

*See also "Efficiency in Cylindrical Grinding," MACHINERY, March, 1912, and the articles there referred to.

† Address: Care of Carborundum Co., 826 Arch St., Philadelphia, Pa.

The grinding operation shown in Fig. 2 is a radical departure from ordinary grinding practice, as the traverse feed is discarded except as a means of locating the work in its relative position with the wheel. The work consists of grinding bevel gear pinions used in the differential gear of automobiles, several of which are shown in Fig. 3. These are made of machine steel, pack-hardened. The surface to be ground is 1 7/16 inch long, and 1¾ inch in diameter. The grinding is done on a Norton plain grinder, equipped with an "Aloxite" wheel, made specially for this class of grinding. This wheel is 18 inches in diameter, 2-inch face, 5-inch hole, 246 grit, N grade, D-497 bond, and is run at a speed of 1400 R. P. M. Experience has shown that a saving of as high as fifty per cent of the grinding time is possible in grinding hardened steel pieces of comparatively short lengths by the method described.

As shown in Fig. 2, the work is held between the centers of the grinding machine on an ordinary mandrel or arbor, and is "dogged" in the regular way. The work speed is 140 R. P. M., and for removing 0.020 inch, the grinding time is 1¾ minute per piece. After locating the work between the centers, the operator brings the shoulder of the pinion to bear slightly on the wheel, and then, by means of the cross-feed screw, the wheel is fed directly to the work until the proper diameter is reached. This is shown by the graduations on the cross-feed. Before grinding, the wheel is carefully trued, and owing to its rapid cutting and accurate sizing qualities, many dozen pieces can be accurately finished without altering the adjustment of the cross-feed stop or re-truing the wheel. It may be added that grinding under these conditions is only in its infancy, and it can be safely stated that before many years have passed it will be common practice to use wheels as wide as six or eight inches for finishing work by the method described.

The grinding of jig bushings is an operation that calls for extreme care, otherwise the value of accurate spacing of the holes in the jig is lost. It is not intended, however, to convey the idea that the tool-maker should consume unnecessary time by carefully feeling his way along, because the tool grinding department can be made as efficient as any other, by the use of the proper wheels and methods. The bushings shown

in Fig. 4 average one inch in diameter and are two inches long. They are made of tool steel, hardened, and drawn very slightly. The grinding is done on a Brown & Sharpe No. 2 universal grinder equipped with an "Aloxite" wheel 12 inches in diameter, ½-inch face, 5-inch hole, 405 grit, N grade, D-497 bond. This wheel is run at a speed of 1800 R. P. M. The bushings are held on special arbors as illustrated in Fig. 5. These arbors are straight and a wringing fit in the bushing for the greater part of their length. A slight taper at the end serves to hold the bushing from turning. The illustration shows this taper somewhat exaggerated, to illustrate the principle.

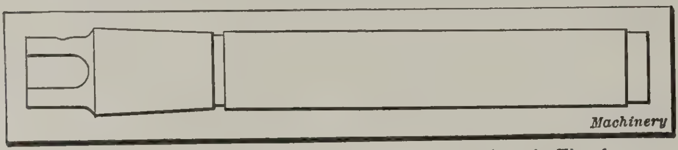


Fig. 5. Arbor used when Grinding the Jig Bushings in Fig. 4

In grinding these bushings, a work speed of seventy-five feet per minute was used, while the traverse feed was the fastest that this machine was capable of giving in connection with this work speed, or one-quarter of the width of the wheel for each revolution of the work. Under these conditions the bushings were ground in five minutes each, which is very rapid when it is considered that the limit of accuracy is approximately 0.0003 inch. The bushings were afterwards finished by lapping to fit the lining bushings.

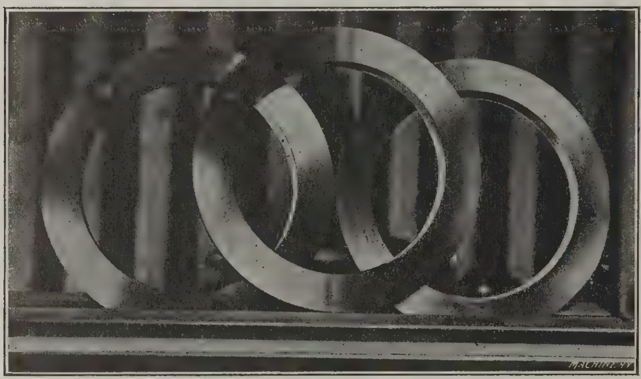


Fig. 6. Thrust-bearing Rings, 8 inches in Diameter, shown being ground in Fig. 7

The process of face grinding, or the finishing of the sides of pieces by holding them in a chuck on the universal grinding machine, and feeding them past the periphery of the grinding wheel, is by no means of recent origin, this method having been employed for many years in finishing tool work, such as the sides of milling cutters and other tools of like nature. In the last few years, however, owing to the rapid cutting qualities of the modern grinding wheel, face grinding has become a regular commercial process. In Fig. 6 are shown several thrust bearing rings, eight inches in diameter, with a six-inch hole. These rings are made of machine steel, and, after being pack-hardened, are rapidly and economically ground on a No. 2 Bath universal grinder as shown in Fig. 7. The grinding wheel used is "Aloxite," 8 inches in diameter, ¾-inch face, 1⅜-inch hole, 365 grit, O grade, D-496 bond, and is run at a speed of 2300 R. P. M.

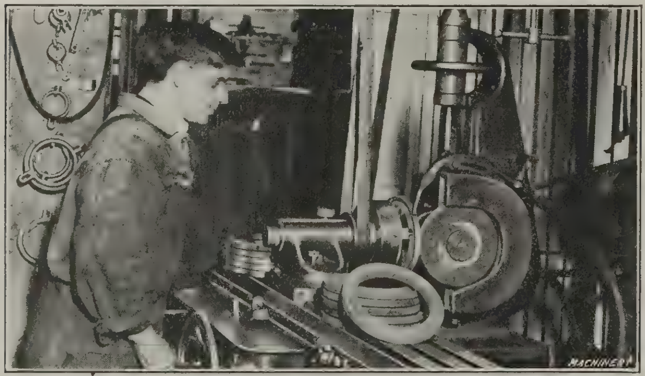


Fig. 7. Grinding Thrust Bearing Rings on a Bath Grinder

The work is held in a three-jaw chuck which is screwed firmly to the headstock spindle and set at an angle of 90 degrees with the wheel spindle. In locating the work in the chuck, the operator exercises care so as not to clamp the jaws too tightly; otherwise the pieces will spring out of shape. The work speed is 140 R. P. M. for both the roughing and finishing operations. In roughing, the operator feeds the wheel directly into the work until the sparks show heavy; then, by means of the traverse feed, the work is automatically carried back and forth past the wheel, the operator feeding the wheel into the work about 0.001 inch at each reversal of the platen. When the piece has been ground nearly to thickness the cross-feed is thrown out, the work still feeding past the wheel. This process, generally called "grinding out," gives an excellent finish even when a comparatively coarse wheel is used. Owing to the rapid cutting qualities of the modern grinding wheel, this is accomplished in five or six strokes. The grinding time for these pieces, including chucking, when removing approximately 0.010 inch, is five minutes, and the finish left is excellent.

* * *

STRENGTH TESTING OF STEELS

In a paper on "Research of the Hardness of Steel," read by Capt. C. Grard before the congress of the International Association for Testing Materials held in New York City, September, 1912, an investigation into the accuracy possible with the Brinell hardness testing method was recorded. From this investigation it appears that when commercial apparatus, as ordinarily used for making the Brinell test, is employed, and the test is carried out with ordinary care and precaution, it is reliable within an error of five Brinell units above or below the actual hardness. In other words, if the hardness of two pieces of metal is tested, and the difference on the Brinell scale is more than ten hardness units, it is certain that there is an absolute difference in the hardness of the pieces tested. With regard to the conditions under which the tests should be made, it may be stated that the pressure should be gradually applied during a time of two minutes or more, and the pressure should be kept on the test piece for a period of at least five minutes.

As has already been pointed out by Mr. Brinell himself, and as mentioned in an article on "The Brinell Method of Testing the Hardness of Metals," published in MACHINERY, engineering edition, September, 1908, this method of testing the hardness of metals offers a convenient means of ascertaining, within close limits, the ultimate strength of iron and steel. This, in fact, is one of the most interesting and important results of this method of measuring hardness. In order to determine the ultimate strength of iron and steel, it is only necessary to establish by experiments a constant coefficient which serves as a factor by which the hardness numerals are multiplied, the product being the ultimate strength. The coefficients, as usually stated, give, when multiplied by the hardness numerals, the ultimate tensile strength of the material in kilograms per square millimeter. Of course, coefficients can easily be worked out by means of which the hardness numerals can be multiplied so that the strength can be obtained in pounds per square inch.

In Capt. Grard's paper, this relation between hardness and tensile strength was exhaustively dealt with, and the following coefficients are given for different grades of steel:

Steels, extra soft	$K = 0.360$
Steels, soft and semi-hard................	$K = 0.355$
Steels, semi-hard	$K = 0.353$
Steels, hard	$K = 0.349$

It will be seen that these coefficients differ by but a slight amount and it was suggested by another member of the congress of testing materials that a uniform constant be adopted by the International Association for Testing Materials, which would be used for calculating the tensile strength directly from the results of the hardness tests. (A complete treatise on the Brinell hardness testing system was published in the September, 1908, number of MACHINERY, engineering edition. This article is reprinted in MACHINERY's Reference Book No. 62, "Testing the Hardness and Durability of Metals").

* * *

The oily superintendent is a slick proposition.

STANDARDIZATION OF AUTOMOBILE DRAWINGS*†

SIZE OF SHEETS, PROJECTIONS, LETTERING, ABBREVIATIONS, CROSS-SECTIONING, ALTERATIONS, DIMENSIONS, ETC.

The following items should be considered in connection with the standardization of automobile drawings:

1. Size of sheets. 2. Arrangement of views on the drawing and method of projection. 3. Character and weight of the lines on a drawing. 4. Style of lettering and numerals, and the size of same. 5. Abbreviations for names of materials. 6. Cross-sectioning. 7. Method of making records of alterations. 8. Placing of finish marks on drawings. 9. Methods of dimensioning. 10. Methods of noting working limits or tolerance. 11. Location of general notes on the sheet. 12. Length of undercut. 13. Checking instructions. 14. Notation for tap and die sizes. 15. Nomenclature of parts.

At the Chalmers Motor Co., Detroit, Mich., an effort has been made to develop a logical system of making drawings along the lines outlined. There is a need for general standardization of automobile drawings. This industry is no longer a matter of a few scattered factories—there are hundreds of plants concerned with the making of drawings for identical parts; yet there are probably not five men in the Society of Automobile Engineers who use the same system for making drawings. Nevertheless, there is a constant changing about among the draftsmen and members of the society. They go from one factory to another, and every time a change is made it is necessary for these men to become familiar with an entirely new system of drawings. This increases the chances for error and causes a loss of time. It forces a man to fill his mind with detail matters about drawings when, as a matter of fact, he ought to be concerned with matters of design only.

In addition, almost every company in the country has some parts made outside of its own factory. This is particularly true of forgings, brass castings and pressed steel parts. There are some manufacturers of these parts who handle the work for as many as fifteen automobile factories. Here is a chance for error on account of each factory sending a drawing of a different size, made to a different scale, with notes and instructions made out in a different manner, on different parts of the sheet. It is hardly fair to blame the workman for failing to read correctly one of these drawings, if it is different, as it often is, in every respect, from other drawings which he has been handling previously. No matter, however, who is at fault, the error is there, and it may impede production for a considerable length of time. Hence, there is little use to argue further as to the need of standardization of automobile drawings; it remains merely to discuss the methods now in use and to determine which methods ought to be adopted by all. The following is a record of the practice of the Chalmers factory, as already mentioned.

Size of Sheets

First, in the matter of the size of the sheets, five sizes are used. The first is the standard letter size, 8½ by 11 inches. All other sizes are developed from the first size; that is, all are multiples of 8½ by 11 inches, or of one of those dimensions. No. 1 sheet is always made with a wide blank margin at the left, on the short dimension and a narrower uniform blank margin on the other three sides. The drawing or sketch is placed on the paper to read lengthwise of the sheet. Sheet No. 2 is 11 by 17 inches, with a wide blank margin at the left, on the short dimension, and a narrower blank margin on the other three sides. The drawing is made to read lengthwise of the sheet. Sheet No. 3 is 17 by 22 inches, sheet No. 4, 22 by 34 inches, and sheet No. 5, 34 by 44 inches, with the same arrangement of margins.

These are the sheets which have been used up to this time. However, a change has been considered as follows: To use only sheet No. 2, which is 11 by 17 inches, drawing large objects to a reduced scale on this size sheet, with a statement of the scale used on the sheet margin, so that the drawing will be readily understood. The new method would do away with the necessity of having different sized sheets, and all of the books for shop use would be made up with one size of sheet. In making drawings of such parts as crank-cases, cylinders, etc., they would be drawn to a reduced scale with the machinery dimensions only placed on the sheet. Pattern drawings would, of course, be made full-size, and would be kept in the drafting-room for factory reference. One or two large drawings might also be placed in the tool-room or at some other convenient point, for reference after a job is started. All of the drawings in regular use, however, would be 11 by 17 inches.

In connection with the arrangement of the sheets, a standard stamp should be adopted. A stamp 9½ inches long by 2 inches wide, with space for name, notes, material specifications, heat-treatment, material, by whom drawn, traced, checked, and approved, standard parts, date, and the symbol number, should be used. This stamp is always placed in the lower right-hand corner and along the margin of the sheet. The upper right-hand corner has a space 2⅝ inches wide and as long as necessary, running down the right-hand margin of the sheet, and divided into three portions. This is the revision table; in this space all notations of corrections, the date of correction, by whom made, and the dimension or part corrected are recorded. This table has all of the changes made on any particular drawing, so that it can be referred to at any time; no matter how unimportant the correction, it is always recorded here.

Method of Projection

The second item is the arrangement of the views on the drawing and the method of projection. For simple drawings, three views are about all that are necessary, with perhaps the addition of the necessary sections. No matter how simple the piece, three views should always be shown. The third angle projection is used; this is the best, because it gives the person handling the drawing a clear understanding of the front, top and side elevations.

Character and Weight of Lines

The third point is the character and weight of lines on a drawing. All full lines should be at least 0.030 inch heavy. All dotted lines should be 0.020 inch, with a mean length of dot of 3/16 inch and a spacing not in excess of 1/16 inch. All of the borders should be 0.060 inch heavy. It is, of course, understood that plenty of ink should always be used.

Style and Sizes of Letters

Fourth, the style of letters and numerals and their sizes should be considered. The best practice is to have all letters or notations on drawings made in upper case type, vertical form, and of about 0.020 inch uniform weight of line. For letters, too, plenty of ink should always be used. All notes and instructions on the drawings should be underlined with practically the same weight of line. This not only makes the notes more emphatic, but also has a tendency to keep all of the lettering uniform. Every word should be started with a capital letter approximately 1/8 inch high, the balance of the word being written with smaller sized capital letters, approximately 3/32 inch high.

Abbreviations

No abbreviation should be made so short as to be confusing. When necessary, the word should be written out in full. Mistakes as to materials are about the most serious that can occur; here one cannot be too careful to obviate the chance of error. The following abbreviations are used:

For iron casting—"I. Cast."

For malleable casting—"Mal. Cast."

For steel casting—"St. Cast."

For brass casting—"Brs. Cast."

For bronze casting—"Brz. Cast."

For aluminum casting—"Alum. Cast."

* Abstract of paper by George W. Dunham to be presented before the Society of Automobile Engineers at its Winter meeting in New York, January, 1913.

† The following articles on drafting-room practice and kindred subjects have previously been published in MACHINERY: "The Printing Press in the Drafting-room," January, 1912; "The Drafting-room System of the American Locomotive Co.," June, 1911, and the articles there referred to. See also MACHINERY'S Reference Books No. 2, "Drafting-room Practice"; No. 8, "Working Drawings and Drafting-room Kinks"; and No. 33, "Systems and Practice of the Drafting Room."

The abbreviation for forgings is "Forg."; for steel stampings, "St. Stamp."; for pressed steel, "Press. St." In describing sheet metals always begin with the word "Sheet." This is no abbreviation at all, but it is best to use the full word, since it precludes all possibility of error.

Cross-sectioning

For all detail drawings, a cross-sectioning is used as if the material were cast iron, with lines 0.015 inch heavy, spaced 1/16 or 0.025 inch apart. On assemblies, however, the standard cross-section of various materials should be used. The different characters of sectioning are confined to assembly drawings.

Recording Alterations

The method of making records of alterations should be standardized, because workmen shift about a great deal, and all alterations should be uniform. When several different systems of noting alterations are used, it is impossible for a man to understand all of them without considerable explanation, and, of course, no man likes to confess ignorance of a drawing if he is used to working with drawings. When a figure is changed, a lower case letter should be located alongside the figure changed. This letter should be surrounded by a circle on the tracing; then the same letter should occur again in the upper right-hand corner where notation of alterations is made. Here the letter should be followed with the figure as it originally read, followed by the date and initials of the man who made the correction. In this manner all changes can be so recorded as to enable one to find the dimension as it was prior to the change, and also to discover when and who made the change. If this system were uniform for all automobile drawings, there would never be any confusion in regard to alterations.

Finish Marks

Next we come to the matter of placing finish marks on drawings and to the right lettering to be used. The Chalmers Motor Co. uses the capital "F" with the foot of the letter resting on the line indicated as finished. However, a very good practice in use in other shops, is the placing of a lower case "f" with the cross bar on the intersection of the body of the letter and the line to be finished. Of course care should be taken to see that the letter is always placed at right angles to the line, otherwise the intersection will be less noticeable, and the letter may be overlooked. The method of showing the amount of finish on the drawing is followed by some, but this is inadvisable, as the amount of finish is dependent on the methods used in the shop and changes as the routing system may be altered from time to time.

Methods of Dimensioning

All dimension lines should be 0.015 inch heavy, and should be placed outside of the views, as far as possible. Elevations and end views of an object to be dimensioned should be tied together with projection lines of the same weight as the dimension lines, with the dimensions placed between. All diameters of holes occurring in the body of the drawing should be carried out for dimensioning with full projection lines. Never place the diameter of a hole inside the hole itself, except when the hole is very large. Numerous diameters should never be marked transversely across the face, with the dimension lines intersecting a common center.

All dimensions should read from the bottom and right-hand side, as far as possible. It is not necessary in motor car work to add the customary inch marks to the figures. Section through threads should be shown with two parallel lines approximately the depth of the thread. The customary method of showing threads by inclined lines should be avoided. This has a tendency to blur a drawing badly.

Tolerances

There should be an understood allowable variation or tolerance in rough forgings and castings where a dimension is shown in a common fraction; on finished work where a common fraction is given; and on finished work where a decimal is given. Very close limits or tolerances should be shown by writing the maximum and minimum dimensions allowable, in decimals. These decimals should be written in full, and not with plus or minus marks as is often done. They should be uniformly written, one above the dimension line and the other underneath. For example, for a piece of one and one-half inch diameter, with a minus variation of 0.003 inch, 1.500 should be written above the dimension line and 1.497 underneath.

Notes

Notes should be grouped in one part of the sheet, either in the left- or the right-hand lower corner, as may be thought best. If this manner of making notes is followed generally, workmen will become accustomed to look for notes in a certain part of the drawings. This will eliminate the chance of overlooking important notations, often with embarrassing results.

Length of Undercut

The twelfth item is the diameter and length of undercut at the end of a threaded part or ground shoulder. In most work the undercut is just sufficient to permit the grinding wheel or thread tool to clear itself, and in the case of a ground dimension it is generally necessary to allow at least ⅛ inch in length—sometimes more, if conditions will permit. For threading operations it is well to allow 1/8 inch, although 3/32 inch has been used very successfully.

Checking Instructions—Tap and Die Sizes—Nomenclature

Thirteenth comes the matter of checking instructions. These should be carefully outlined and rigidly followed.

The checker should be instructed to check for general appearance of the drawing. If this is done, the condition of the work turned out of the drafting-room will be kept up to the highest standard. Undoubtedly the quality of the drawings has a very decided effect on the quality of the work in the factory.

All drawings should be checked very carefully for design. If there is any question in a checker's mind as to the design, he should call the matter to the attention of the chief draftsman at once.

All drawings should, of course, be checked for accuracy, and for working limits.

Particular care should be taken that all figures necessary to make the piece are on the drawing.

The finish marks should be carefully checked.

All drawings should be checked for threading and grinding reliefs.

Instructions for hardening, tempering, annealing, plating and polishing should be checked with the utmost care.

Material specifications and treatment require most careful checking.

The general notes should be gone over.

There should be a check on standard parts going with any particular part.

The name and, finally, the number should be checked.

The fourteenth point concerns tap and die sizes. Tap and die sizes should be given together with the pitch diameter and tolerance, wherever possible.

The nomenclature of parts is now under discussion in the nomenclature division of the standards committee of the Society of Automobile Engineers, and this is a matter to which reference can be made first when this committee has completed its work.

* * *

PROPOSED BUREAU OF FARM POWER

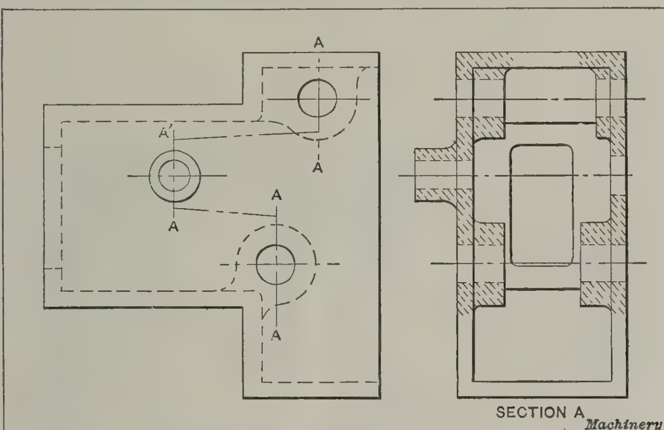
A bill has been brought into the House of Representatives (No. 25,782) by Mr. Henry T. Rainey, with the object of establishing a Bureau of Farm Power in the Department of Agriculture. It is the purpose of the bill to create a bureau which will investigate and report to the Department of Agriculture upon all matters pertaining to the methods of furnishing power on farms, and on all labor-saving machinery adapted for use on farms. This bureau would investigate such subjects, for example, as the use of electricity, gasoline, and steam in propelling farm vehicles, in operating plows, reapers, mowing machines, thrashing machines, and other farm machinery. In general, the bureau should make reports upon all such devices which would tend to lessen the amount of labor necessary in agricultural pursuits, and the expense of producing and marketing farm products.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

DENOTING SECTIONS ON DRAWINGS

In denoting the points at which sections are made it is customary to place different letters at each point and refer to these letters in the title of the view showing the particular section, thus: section at *AB;* section on *ABC;* section through *ABCD.* The method employed by the writer is to use one letter only for any particular section. Every break and the ends of a section are denoted by the same letter, as shown in



Method of Denoting Sections on Drawings

the accompanying engraving. The section is then referred to simply as section *A*, section *B*, etc.

J. COULSON

[The illustration shows a feature of drafting practice not used by draftsmen as much as it could be advantageously, that is, showing the cross-sections of a piece with dotted lines instead of full lines. This use of dotted cross-sections enables the object to be drawn in full lines as though not sectioned, and thus to show in the same view sections on any parallel plane without interfering with the remainder of the drawing. The dotted sectioning is shown in the cross-section at the right in the above illustration.—EDITOR.]

BURNISHING THREADING DIES

In the July number of MACHINERY a contributor recommends the passing of a master threaded plug through dies as a means of smoothing the threads of the dies. This operation is to be performed both after cutting the thread, while the die is still in its soft state, and after hardening. Lard oil is used as a lubricant, but no mention is made of an abrasive.

If one might judge from the effect of running a hardened spindle in an ordinary journal under dry conditions, the effect of the treatment outlined, on the threads of the die, might be thought to be similarly disastrous; because before the plug could act as a burnisher the oil would necessarily have to be squeezed from between the thread surfaces. In the opinion of the writer the removal of 0.001 to 0.0015 inch would tend to tear the thread. If the material is not removed, but simply compressed, the stresses set up in this way would certainly increase the tendency to distort in hardening.

It is also said that another advantage is gained in that the lead of the threads, distorted in the hardening process, is corrected. Now, as the die has been gashed or fluted at the time of the second burnishing operation there would be a tendency for the die to cut the master plug. At any rate, its influence on the master plug would, perhaps, be greater than the influence of the master plug upon the die thread; thus the pitch of the plug would be altered, it seems, at the same time that a correction, or rather a partial correction, of the lead of the die thread was made. Hence this advantage seems of doubtful value, and would almost require the making of a new plug for each die made, which would scarcely pay.

It would seem that the burnishing should rather be left to be done by the work to be cut by the die itself; or, let the die be used at first on a piece of soft material, such as cast iron. It is well known that cast iron has a burnishing effect. In lapping, for instance, a cast-iron plate merely kept wet with benzine is not only a burnisher, but a comparatively fast abrasive. The writer has before him at the moment of writing several dies in which the threads are quite smooth and bright. The only burnishing process to which they have been subjected is use.

Manchester, England. FRANCIS W. SHAW

THE DROP WORM-BOX

An article in the May number of MACHINERY prompts the writer to record some troubles experienced by him in connection with the drop worm-box form of trip motion. The accompanying engraving Fig. 1 shows the most common form, provided with a slight improvement. As pointed out in the previous article, the worm-box often fails to release when the feed shaft runs in the direction denoted by arrow *A*, the tendency being for the worm to cling to the worm-gear.

As a means of obviating this difficulty, the former contributor suggests placing the reversing motion in the worm-box, arranging it in such a way that the feed shaft always

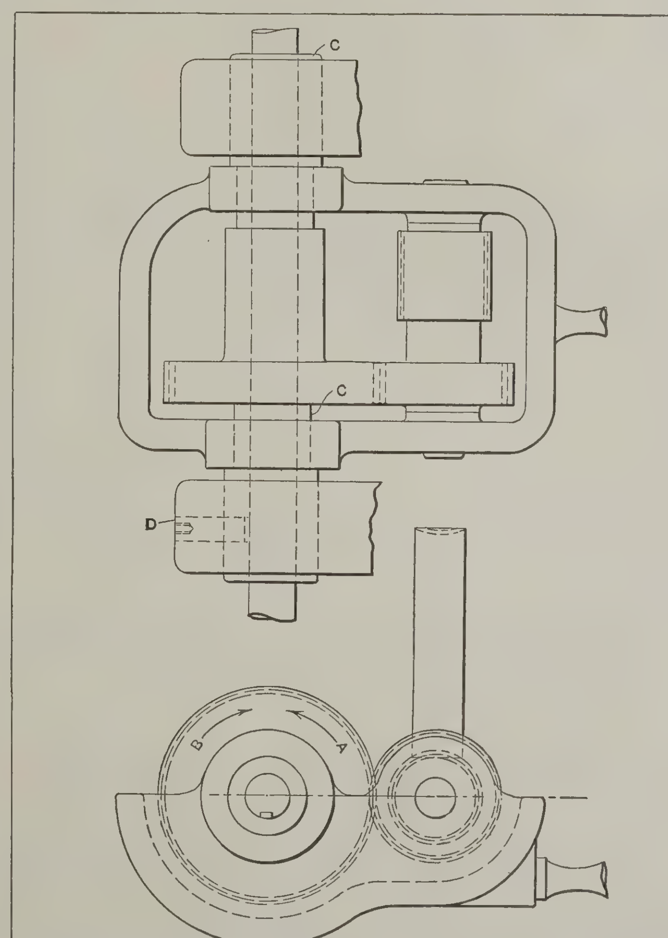


Fig. 1. An Improvement in the Ordinary Design of a Drop Worm-box

would turn in the direction of arrow *B*. This arrangement, however, is not always possible, since the reversing mechanism may have other duties to perform, as in the case of a turret lathe having a turret and a cross sliding saddle, both of which need to be reversed at times. Hence, some means of overcoming the difficulty other than by placing the reverse in the worm-box is necessary.

One method adopted by the writer made use of a sufficiently powerful spring to depress the worm-box after releasing. In Fig. 1, however, is shown how the difficulty was met without

using the spring. Usually the worm-box is mounted directly on the feed shaft, in which case the reaction of the pressure increases the friction on the feed shaft to a sufficient extent to squeeze out the oil film, thus increasing the coefficient of friction. The shaft itself then tends to pull the worm-box upwards, in addition to the direction of pressure at the teeth of the gear. By pivoting the worm-box on bushings at *C*, the friction between the shaft and worm-box is entirely eliminated. In the case in question the trouble entirely ceased with this construction, and springs were not needed.

An additional advantage of this method of pivoting is that the endwise adjustment for allowing the parts of the trip motion to be placed as required is provided. The method of holding bushing *C* is by means of pins *D* having small tapped holes in order to make possible their withdrawal.

Another case in which trouble was met with is shown in Fig. 2. In this case the worm-box contained a two-speed arrangement as shown. The sliding gears were moved by the shipper and rod shown by the dotted lines at the bottom. As the apron in which the worm-box was fitted was sliding along the bed, the endwise friction gradually tended to force the gears to disengage. The sliding gears were simply mounted directly on the feed shaft at that time. By imposing bushing *B*, which fits endwise between the bosses inside of the worm-box, this difficulty was overcome. Key *A* engages with a

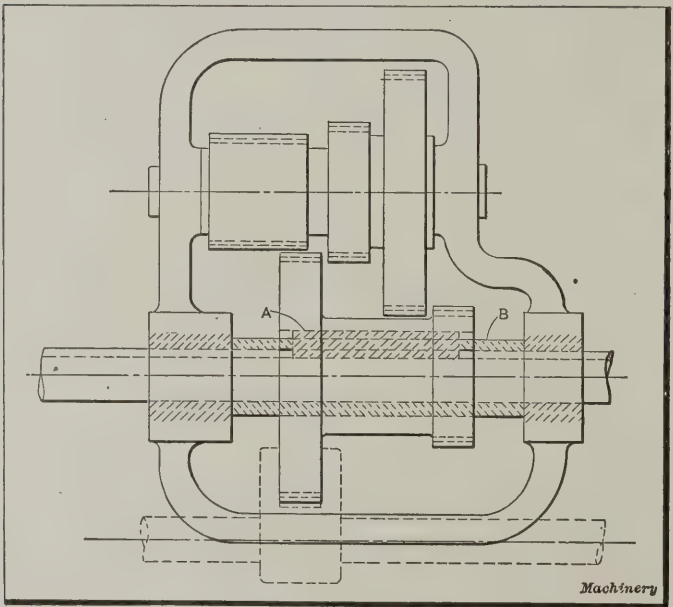


Fig. 2. Method of Overcoming the Tendency of the Gears in the Gear-box to disengage

groove in the feed shaft and in the sliding gears, and fits in bushing *B* in a slot cut clear through it. Previous to applying the bushing *B* the shipper which slides the gears was locked by friction. The faces of the shipper which make contact with the large gear, however, were badly cut up.

J. Coulson

TO ANNEAL AND HARDEN HIGH-SPEED STEELS

Place the piece to be annealed in an iron pot or pipe, pack steel chips around it, ramming them tight, and lute the cover well with fire clay, heat to a lemon yellow and hold the heat six to eight hours. Place the box in charcoal ashes and leave until cold.

Tool bits and small tools made of "Cyclone" special high-speed steel can be hardened successfully by heating to a yellow white heat and quenching in a good size piece of beef suet; plunge the piece into the suet and leave until cold; it will be found hard and tough.

To anneal "Blue Chip," "Novo" and "Rex" high-speed steels, pack the piece in an iron box or pipe with slacked lime rammed tightly around it and lute the box with fire clay. Heat to a yellow and hold the temperature one hour, and then bury the box in charcoal ashes until cold; or, if a blacksmith's forge is used with charcoal for fuel, leave it to cool down with the fire.

Another method is to pack the piece to be annealed in an iron pot or pipe with cast-iron chips and charcoal dust, or burnt molding sand, half-and-half. Ram the mixture well around the article, taking care that there is at least an inch of packing material around each piece. Lute the cover with fire clay and heat very slowly to an orange color. Hold the heat fifteen minutes and bury the box in slacked lime or charcoal ashes until cold. These formulas have all been tried and have given excellent results.

W. C. Betz

New Britain, Conn.

PRACTICAL METHOD OF MANUFACTURING DOUBLE-ANGLE END-MILLS

A great deal of trouble is often experienced when manufacturing small double-angle end-mills by ordinary methods. It is difficult to align the teeth properly, because of the necessity of resetting the machine when milling the second angle.

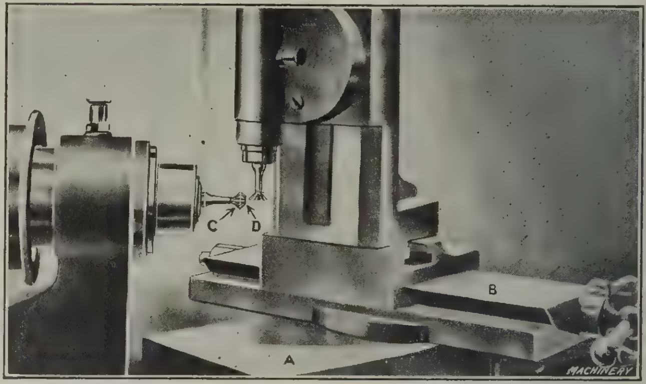


Fig. 1. Milling the Teeth in Double-angle End-mills

The grinding of these end-mills is just as difficult, because of the necessity of raising or lowering the emery wheel to obtain the proper clearance for each angle. In the following is described a method of manufacturing double-angle end-mills without the use of special machinery, so that both angles may be milled at one setting with the same milling cutter without readjustment. This, of course, insures the proper alignment of the teeth. The grinding operation of both angles is performed in the same way.

In Fig. 1 is shown a No. 4 Elgin bench lathe with milling attachment, as manufactured by the Elgin Tool Works, Elgin, Ill., set up for performing the milling operation. The spindle of the milling attachment is set in a vertical direction and the milling cutter is set central with the work. The lower slide *A* is set at the right angle to mill the cutting surface of

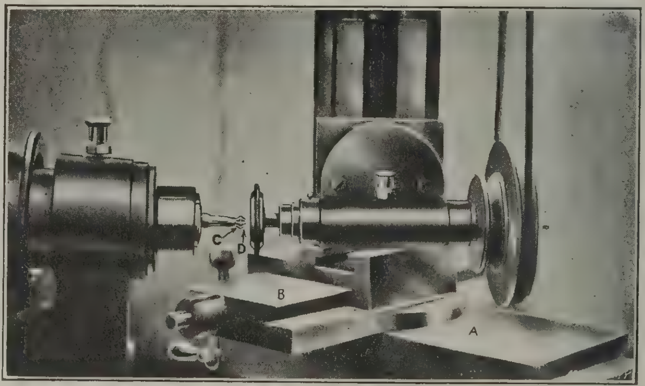


Fig. 2. Grinding the Teeth in Small Double-angle End-mills

the teeth at *C*, while the top slide *B* is set for milling the teeth at *D*. Both cuts are taken on the rear side of the work.

In Fig. 2 is shown the grinding operation, which is done in much the same way, except that slide *A* is used for grinding the teeth at *D*, and slide *B* for grinding the teeth at *C*. The spindle of the milling attachment in this case is set in a horizontal direction, with its center line below that of the cutter, so as to provide proper clearance for the teeth. The emery wheel is dressed flat on the top with a short angular surface on each corner. These surfaces correspond to the angular surfaces on the cutter, thus making it possible to grind both

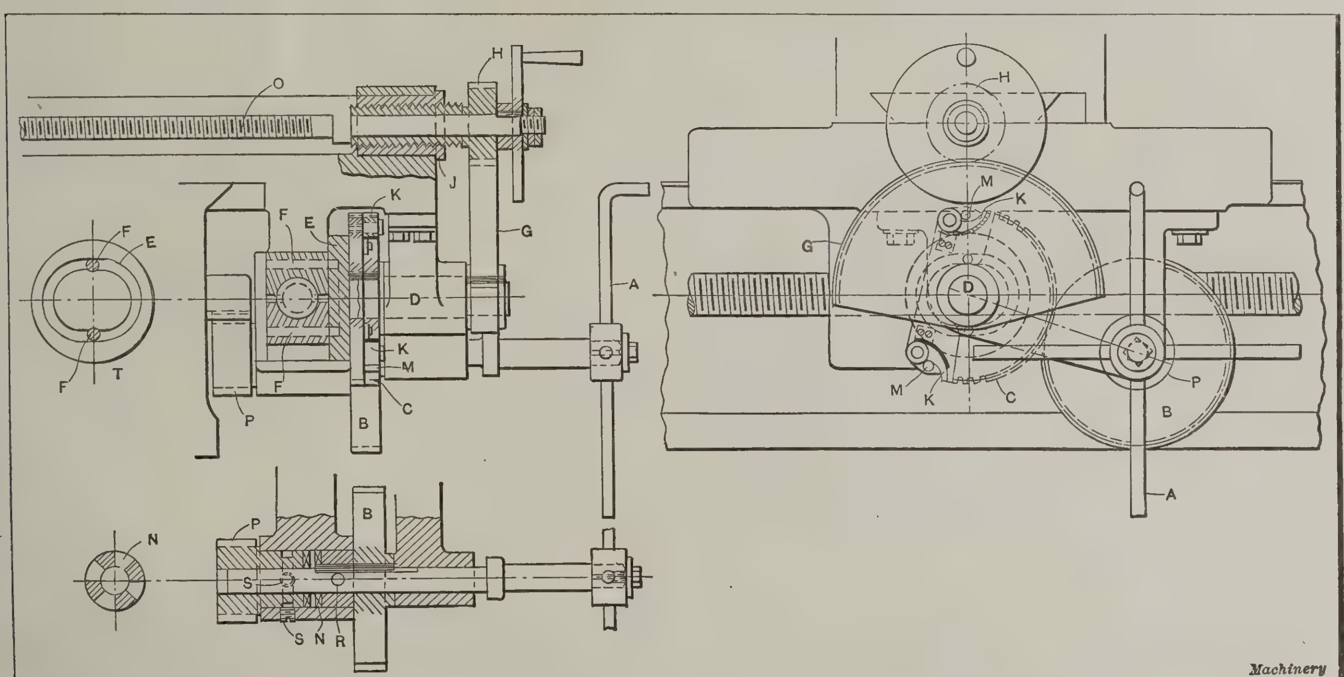
angles at the same setting of the wheel. As the spindle of the attachment is parallel with the axis of the lathe spindle, the extreme sharp point of the cutters can also be blunted by the wheel without resetting by setting the pulley of the grinding attachment over and turning the attachment into a traverse spindle grinder.

Left-hand cutters may be made by this method as well as right-hand. The illustrations show the making of a double 45-degree angle end-mill. Regular angular cutters may be made in the same way by substituting an arbor chuck for the taper chuck being used. The lathe-head index plate is used for the indexing, and as the slide-rest is graduated, it is a simple matter to duplicate the work at any time.

Chicago, Ill. MILTON C. TAYLOR

NOVEL CONSTRUCTION OF APRON MECHANISM FOR SCREW-CUTTING LATHE

The accompanying illustration shows an arrangement used in the apron of a screw-cutting lathe, by means of which only one handle *A* is needed to manipulate the carriage when cutting threads. When one cut is finished it is only necessary to turn handle *A* about one-quarter of a revolution, and the tool is withdrawn from the work. The half-nuts are also unclasped from the lead-screw at the same time, and by pushing handle *A* inwards, the rack-pinion is brought into mesh with the rack so that the carriage can be moved back and another cut begun. To bring the tool back into position, simply pull out the handle and turn it back about one-quarter of a revolution. This both clasps the half-nuts on the lead-screw and brings the tool back to the work.



A Novel Design of Mechanism for Screw-cutting Lathe

When handle *A* is turned, gear *B* turns sector *C*, which is keyed to shaft *D*, on the end of which is cam *E*. The two pins *F* passing through the half-nuts fit in a slot cut in cam *E* and open the nuts. The sector *G* is also turned; this meshes with gear *H*, which is threaded into bushing *J*, fastened to the carriage. Hence, screw *O* is withdrawn and the tool-slide with it. When the half-nuts are opened, sector *C* is in such a position that spring catch *K* only is in engagement with gear *B*. Hence, if this gear is turned further, the catch simply slips so that the handle can be turned around and the carriage brought back with the rack-pinion in engagement with the rack without moving the half-nuts or withdrawing the tool any further. The spring catch *K* fits against pin *M*, so that when gear *B* is turned back it pushes against the catch and brings the sector into mesh with gear *B*, thus closing the half-nuts and bringing the tool in to the work. There are two of these spring catches, one at each end of the sector, so that the carriage can be moved either way, according to whether a right- or left-hand thread is being cut.

In the illustration, the sector is shown in the position it occupies when the nut is closed and the tool is in engagement with the work. In the lower left-hand view is shown a section through the rack-pinion shaft. When the handle *A* is first turned the teeth of clutch *N* are out of engagement with the clutch teeth in the rack-pinion, so that *B* is turned without turning this pinion. When handle *A* is pushed in, however, the shaft and clutch *N* are moved along until the teeth of the clutch engage with the clutch teeth in the rack-pinion. Clutch *N* is fastened to the shaft by pin *R*, and screws *S* hold pinion *P* in position, allowing it simply to revolve on its shaft. When the saddle is moving along when cutting the threads, clutch *N* is out of engagement with the rack pinion, and pinion *P* only revolves. At *T* is shown the slot in the cam for the pins in the half-nuts.

Manchester, England. W. R. OAKES

SYSTEM FOR ALTERING DRAWINGS

In the course of his work in the drawing-room the writer has often had occasion to change large portions of assembly drawings or complicated details. This requires a great deal of time and energy. Below is described a system which has been used to great advantage in cases of this kind.

Suppose that the design of a machine has been changed, which will require the erasing of some details and the drawing of new ones in their places, or making an entirely new drawing, which may not be convenient at the time. First of all make a good Vandyke negative from the tracing; then using a black crayon, mark out every line that is not required in the new drawing, taking care to mark out the lines on both sides of the negative, as otherwise they are likely to show up later. Then make a good black-line print from the Vandyke, using a paper with a smooth surface; this print will now show blank places where the lines were marked out with crayon. Now draw the new parts in ink just the same as if the tracing were altered, and make a blueprint from this black-line print. This will be as good as one made from a tracing. The write print is now filed with the tracings as an original drawing.

One of the chief advantages of this system is that the original tracing is kept intact, and in case it has to be referred to in the future, one does not have to depend on finding an original record-print, but can refer directly to the tracing. From personal experience the writer has found this system to save at least half the time required to change a tracing, and, whereas a tracing can seldom be changed more than once, under this system as many changes as required may be made.

This system is also useful in connection with drawings

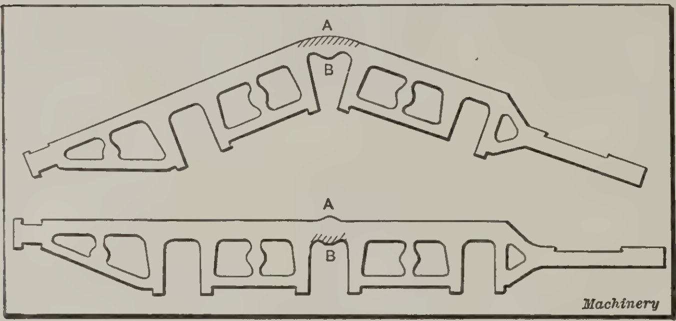
that are changed continually according to specifications. In this case, make the tracing complete in every respect, including dimension lines, but no dimensions. Then make from this a black-line print and fill in on the latter all the dimensions and notes necessary for the shop. Make a blueprint from this print and file the black-line print as a tracing. This does away with the possibility of losing the record-print when marking up blueprints, as is often the case.

Philadelphia, Pa. EDWARD ROBINS GLENN

[See also an article entitled "Changing Drawings Quickly," published in MACHINERY, October, 1907.—EDITOR].

SHORTENING A CAST-STEEL LOCOMOTIVE FRAME

Locomotive frames are usually made of steel castings and weigh from two to four tons each. They are from 25 to 30 feet long, and the top rail has a rectangular section of from 5 by 7 to 6 by 9 inches before finishing. Sometimes, owing to variations in the methods of casting, or improper shrinkage allowance in the pattern, these castings are either too long or too short to true up when machining. It is simple enough to lengthen a frame under a steam hammer, but it is not



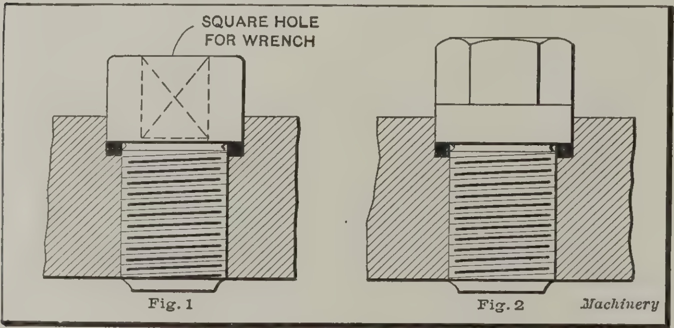
Method for shortening a Cast-steel Locomotive Frame

possible to shorten it by this means. The usual method for shortening a frame is to heat it between two of the pedestal legs, as at *A* and *B* in the illustration; then, by cooling the edge *A* and bending the frame across the anvil, the metal will upset at *B*. The frame is then heated again and cooled at *B*, after which it is straightened. The metal will be upset at *A*, thus shortening the frame. In the two heats a reduction of from ½ to ¾ inch may easily be obtained. It is evident that if the bending were done in the opposite direction, relative to the parts being cooled while bending, the frame would be lengthened instead of shortened.

Rochelle, Ill. J. H. MAYSILLES

AN EXAMPLE OF POOR DESIGN

The designer is often blamed for poor designs when he has done his very best to compromise between the conflicting practical requirements, and between conflicting orders issued



Figs. 1 and 2. An Example of a Poorly Designed Screw for Hydraulic High-pressure Work, and the Design used to replace it

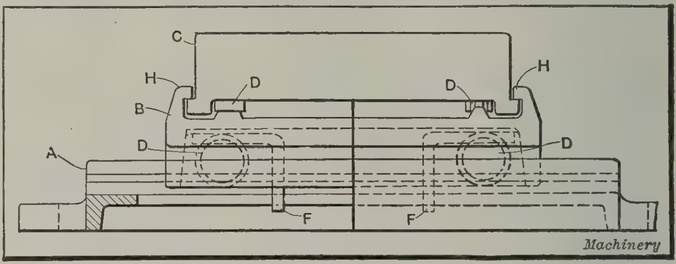
to him. In some cases, however, we find objectionable designs due to either lack of judgment or an effort to unduly reduce the first cost.

An intensifying hydraulic pump failed to reach the desired pressure on account of leakage. The leak was through the stop-screw on the delivery valve on the high-pressure side. With the idea of a quick repair, the screws on the suction side and the high-pressure side were changed. In tightening the leaking screw on the suction side, however, it broke off. The screw was designed as shown in Fig. 1, and the cause of the defect is easily seen. The section of metal at the bottom of the head is very thin and the leakage took place in this square hole in the head of the screw. The screw was replaced with the type shown in Fig. 2, which was made from a solid bar. The screw shown in Fig. 1 was of cast brass, which is objectionable for hydraulic high-pressure work because it is liable to be of a porous texture.

London, England A. L. HAAS

A TAPPING FIXTURE

The accompanying illustration shows a tapping fixture which is easily operated and which can be used for a wide range of work. It consists of a baseplate *A*, bolted to the table of



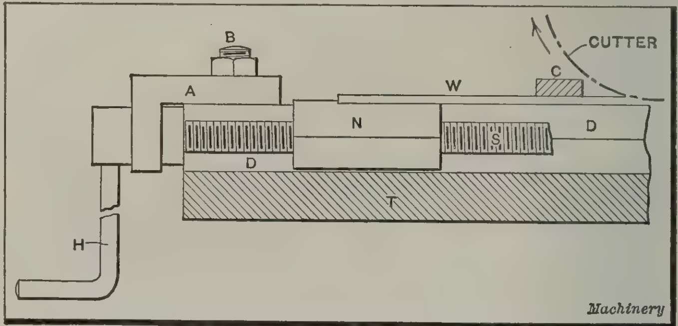
A Convenient Tapping Fixture

a drill press with a tapping attachment, and a center plate *B* and top plate *C*, which are each provided with two plain and two grooved rollers *D*, rolling in tracks at right angles to each other. In this way it is possible to move a piece of work clamped to the upper plate to any position, without having to shift it on the table itself. Stops *F* are provided to prevent the plates from over-running. The overlapping projections *H* are provided so that the plates cannot separate when subjected to pressure.

M. W. W.

MILLING FIXTURE FOR THIN STOCK

About one hundred feet of rectangular-section steel rods was required for a set of models, the section of the steel being 0.088 by ⅞ inch. As this section was not available as a standard size, and as it was impossible to get so small a



A Simple Method of Milling Flat Stock

quantity rolled, it was decided to mill down ⅛ by ⅞-inch drawn steel, which was on hand, to the required size. This was done in a milling machine with the aid of the simple fixture shown in the accompanying engraving. In this illustration, *T* is a section of the milling machine table, through one of the T-slots *D*. The screw *S*, a standard stock part in the shop where this work was done, was provided with a handle *H* and a bearing *A*, which was also a stock part. This bearing was bolted to one of the other slots. The screw when so arranged operated a cast-iron nut *N* the entire length of the T-slot. Nut *N* was provided with a lip or shoulder rising 1/16 inch above the table for the purpose of driving the strip to be milled under the cutter. The lengths in which the flat steel rods were required were slightly less than the travel of the nut, which made this arrangement possible. Two clamps *C*, one of which is not shown, were placed at the front of, and behind, the cutter, and fastened so that the pieces to be milled would just slide under them as the work was being milled. By beveling the entering end of the strip to be

milled on top and feeding the piece lightly until it had reached under the second clamp, which held down the work on the side already milled, no trouble was experienced from the lifting up of the work. Had this occurred it would have been necessary to feed with the cutter. A spiral cutter with nicked teeth was used. Of course, the width of the slot in the milling machine table was less than the width of the strip. In this case the slot was 9/16 inch wide.

Middletown, N. Y. DONALD A. HAMPSON

A FIXTURE FOR SQUARE GRINDING

In the manufacture of high-grade automobiles, the square shaft is replacing the old-style feather key to a very considerable extent, especially in the transmission and heavy driving parts. There are also some parts of the motor in which the square hole and shaft has an advantage; one piece in particular is the valve push-rod, perhaps better known as the

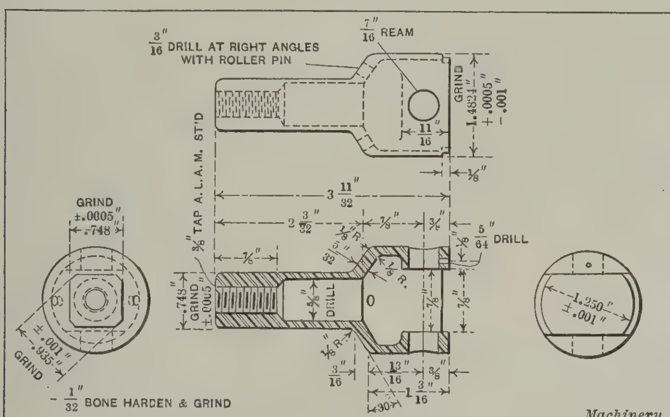


Fig. 1. The Valve Push-rod to be ground

valve tappet, shown in Fig. 1. This push-rod is made from machine steel, carbonized and hardened so that it is necessary to grind all of the working parts. The square part is 0.748 inch across the flats and has an allowable variation of only 0.0005 inch; this requirement, of course, necessitated the making of a very accurate fixture.

The first operation is that of grinding the large diameter, and rough grinding the corners of the square. This is accomplished in the usual manner, that is, by using a long center to enter the bottom of the hole of the large end and an ordinary center in the square end. The next operation is the grinding of the square body which must be perfectly concentric and parallel with the large diameter. The fixture for accomplishing this operation is shown in Fig. 2. It worked successfully, and was quickly and easily operated.

One of the greatest difficulties encountered in grinding fixtures, is that of preventing emery dust from collecting on the working parts, and considerable care was taken to design and make this fixture as nearly dust-proof as possible, regardless of the extra first cost. Another difficulty to overcome was the distance the tailstock was required to travel to allow the push-rod to be removed from the chuck. The size of the square also necessitated the making of a special tailstock, which will be described later. In designing this fixture, the question of future use, as well as that of accuracy and production, was considered. It frequently happens in the manufacture of automobiles that slight changes in the parts necessitate a complete new fixture unless some provision has previously been made. By making new collets, this fixture may be used for many purposes. The entire fixture was made as small and compact as possible. It has been the writer's experience that a neatly designed and well made fixture receives much better care in the hands of the ordinary workman than one that is poorly designed, unhandy and roughly made; and it is upon the care such tools receive that their continued accuracy and usefulness depends.

Referring to Fig. 2, the casting *A* is bored taper to receive the bronze bushing *B*, slotted through on one side to allow for adjustment, which is accomplished by lock-nuts *C* drawing the bushing *B* into the tapered hole in the casting. Spindle *D* has a very important function to fill—that of indexing—and is made from hardened and ground tool steel. To insure the greatest degree of accuracy, the indexing holes in the spindle must be protected from emery dust; consequently, they are placed under cover as much as possible, and are also protected by dust cap *E*, which is made from machine steel and fitted closely on the threaded portion of the spindle *D*. This cap is also closely fitted to the end of casting *A*, the latter having a groove cut in it to receive the felt washer *F*. In the forward end of cap *E* is another felt washer *G*, which in connection with the washer *F* makes it almost impossible for any dust to get into the bearing or indexing holes.

To retain the correct relation of the roller pin hole in the push-rod, Fig. 1, to the square body, the locating plug *H* is fitted into the bushing *I*, which is pressed firmly into the spindle *D* and passes through one side of cap *E* and chuck *J*. As this plug *H* is made to fit closely in the roller pin hole, Fig. 1, it is evident that the hole will be held in the correct relation to the square body.

The chuck *J* is of the ordinary spring collet type, keyed to the spindle *D*, and is operated by the handwheel *K* and draw-in bolt *L* which are held together by tapered pin *M*. Handwheel *K* is also used for indexing the spindle. The front end of the handwheel bears against spindle *D* so that when it is turned in the proper direction, it draws the chuck back into the spindle, thus closing it on the work. Felt washers *N* and *O* are inserted in the dust cap *P*, forming a perfect protection for the working parts in this end of the fixture. The indexing device is of the ordinary spring plunger type and is held in the boss *Q* on the casting. The indexing device consists of a spring *R*, bushing *S*, stop-pin *T*, plunger *U* and knob *V* for operating.

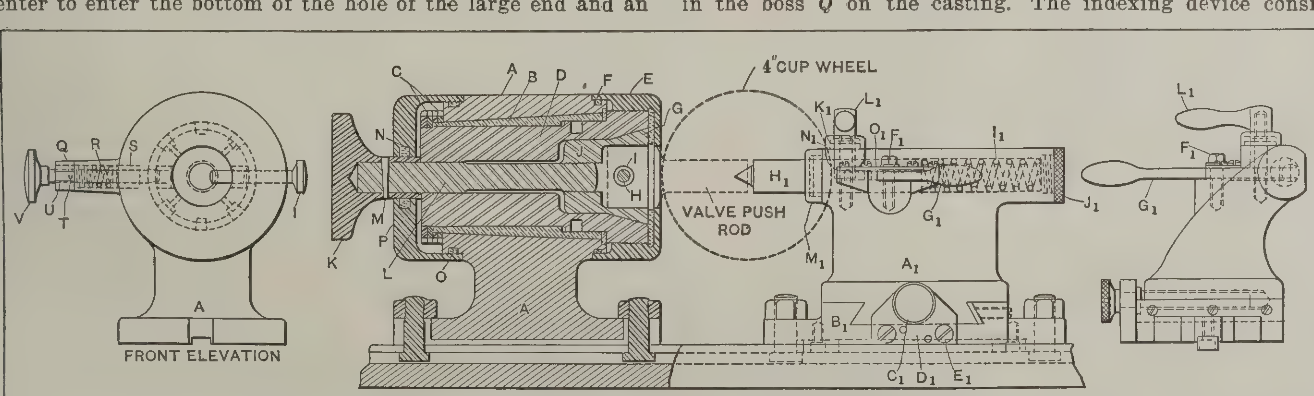


Fig. 2. Fixture used in Grinding the Square Body of the Valve Push-rod shown in Fig. 1

Some difficulty was experienced in obtaining parallel sides on the square body, as the work was performed with a cup grinding wheel on a plain grinding machine (an old style Landis grinder) having no table adjustment. The dovetailed base of the tailstock A_1 shown to the right in Fig. 2, overcame this difficulty and gave good results. The upper part of the tailstock fits in a dovetailed groove in the base B_1 and is adjusted to the desired position by the screw C_1 held in the block D_1, the latter being fastened to the base by screws E_1. The fulcrum pin F_1 is placed in the lever G_1 in such a position that an angular movement of the lever of about 52 degrees gives a 1½-inch lateral travel of center H_1.

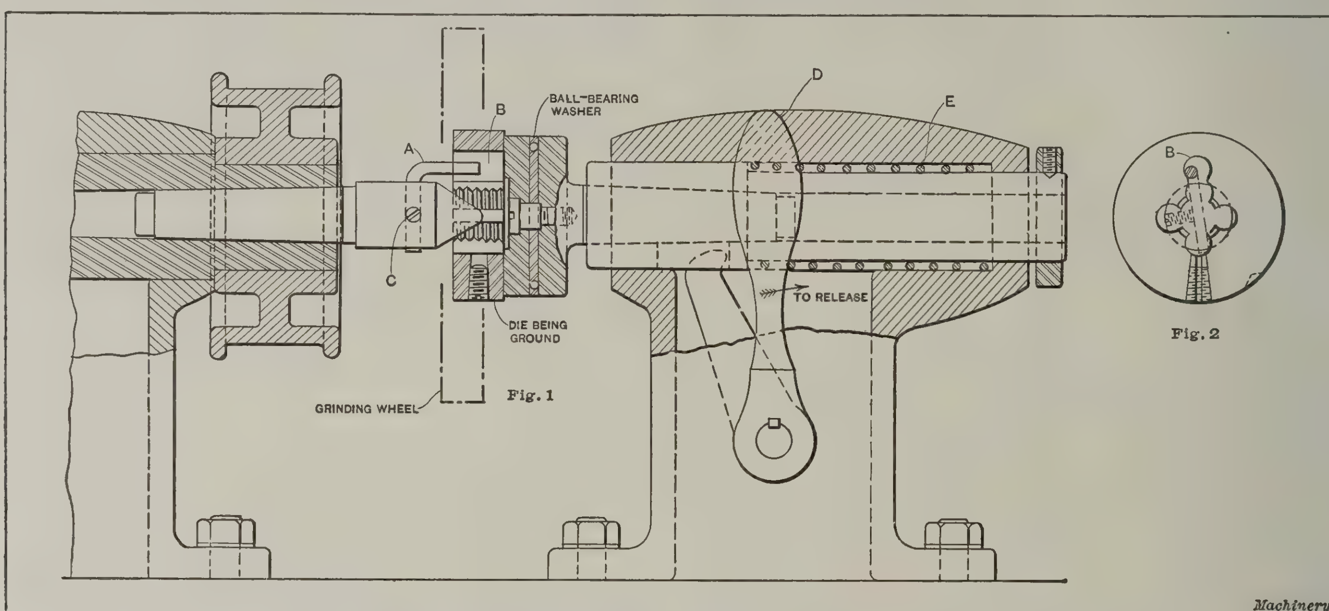
The tension spring I_1 is sufficiently strong to keep the

proper pressure on the valve push-rod, and it is retained in the spindle by a cap-nut J_1. The center H_1 can be locked in any position by clamp-block K_1 and handle L_1. The dust-caps M_1 and N_1 and plate O_1 protect the working parts of the tailstock spindle from dust. As the square body of the valve push-rod to be ground is ¾ inch, it necessitated the flattening of one side of the center bearing in the casting, and also the off-setting of the center point on the movable center H_1. This fixture has been in use for two seasons, grinding about 50,000 push-rods with good results, and is still in good condition.

Lansing, Mich. E. H. Pratt

METHOD OF GRINDING THREADING DIES

The accompanying engraving shows a method which has been successfully used for grinding the outside of threading



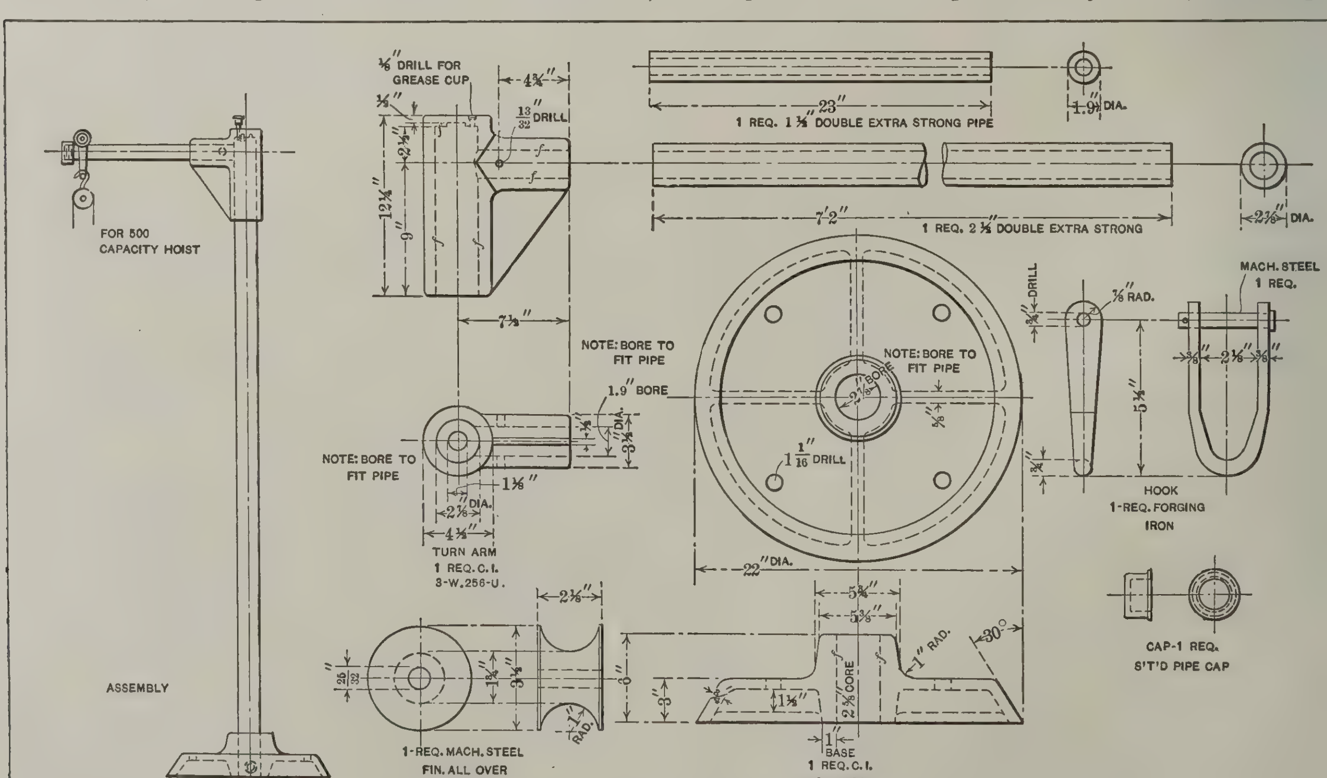
Figs. 1 and 2. Method of Grinding Threading Dies on the Outside after Hardening

dies after hardening. Fig. 1 shows the arrangement with the die in position in the machine, while Fig. 2 shows an end view of the die, indicating how it is driven. The steel wire A, which is about 5/32 inch in diameter and bent so as to enter the hole B in the die, acts as a driving dog. It is held by set-screw C in the center.

When placing a die in the machine, the operator pulls the tailstock center by means of lever D, thus compressing the spring E. With his left hand he then places the die against the driving center and immediately releases lever D, allowing the tailstock pad or center to bear against the die by the action of the spring. The tailstock pad is provided with a ball-bearing washer to eliminate friction. The die is now held in position for grinding. Server

HOIST FOR LATHE CHUCKS, FACEPLATES AND HEAVY WORK

The accompanying illustration shows assembled and detail views of a handy and substantial hoist of cheap construction, which has been found convenient for handling heavy work, large chucks, faceplates, etc., on the lathe. It is bolted to the floor, back of a large lathe, or whatever machine it is used in connection with. It is especially valuable where it is impossible to use a portable or jib crane, and being of



A Handy Hoist for Lifting Lathe Chucks, Faceplates, etc.

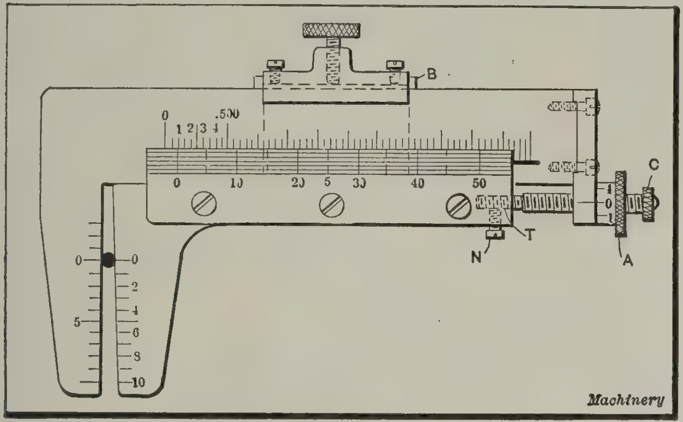
cheap but substantial construction, it can be used for a large range of work.

The hoist consists mainly of two castings, the base and the

bearing for the revolving arm. The upright and arm are of extra strong pipe, and the forged yoke with the steel roller completes the device.
M. W. W.

THE VALUE OF A DECIMAL GAGE

The use of numbers in wire gage measurements may originally have been considered a convenience, but when another "number" gage differing from the original in the sizes designated by the numbers was added, the system became complicated. The basis of these different number gages is that each succeeding number designates a dimension differing by some fractional part of an inch from the preceding one, but each originator of a gage made the difference from each succeeding number different from the others, so that if we now compare the sizes and numbers of the different wire gages we find that no two are alike. There might, in former years, have appeared to be a reason for these different wire gages, with the numbered plates having slots corresponding to a letter or number designating the size of the wire, but since the micrometer and vernier scales have come into more common use, wire manufacturers generally prefer, when an order is given, to have the order specify the diameter of the wire in thousandths of an inch. Then why not discontinue the old gage numbers entirely?



A Convenient Decimal Wire Gage

In a catalogue before the writer, the standard wire gage of a large wire company gives No. 1 as 0.2830 inch; the same company's steel music wire gage No. 1 is 0.0156 inch. The B. & S. jewelers' wire gage No. 1 is 0.001 inch. Why should there be this difference in the designation of the sizes of wire? Whether the wire be brass wire, or music wire, or jewelers' wire, why should not the diameter corresponding to the given number be the same?

Now, why could not a new system be adopted in which, for example, No. 50 would mean 0.050 inch in diameter, and No. 200 would mean 0.200 inch in diameter? The B. & S. jewelers' wire gage is based on this system, and is the only practical system of wire gages in use. Many years ago, the writer made and sold a decimal wire gage to a number of manufacturing concerns based on this system of decimal identification number. This gage, as shown in the accompanying illustration, was adapted for measuring wire from the very smallest size up to 0.500 inch and was especially useful for inspecting wire in the stock-room. It was more easily used on wire than the ordinary micrometer and could be read to 0.00025 inch with accuracy.

This measuring instrument, as shown, has hardened taper jaws, the taper being such that the distance across at graduation 10 is 0.010 inch larger than that at 0; the gage bar is graduated as indicated, each graduation being 0.050 inch. A vernier scale is provided so that measurements as close as 0.010 inch can be read directly on this, and finally the graduations on the taper jaws give the dimensions in 0.001 inch; hence, it is possible to use this gage as graduated to measure wire of any size from 0 to 0.500 inch in diameter. The nut and screw at the right end of the gage are for the purpose of quickly and definitely locating the vernier at the reading required. The screw upon which the locating nut revolves has 20 threads per inch; thus one revolution of the nut agrees with one graduation on the bar.

Assume that it is required to set the gage to read ⅛ or 0.125 inch. First move the sliding jaw so that its zero line is opposite the second line from 0 on the bar, and from that reading continue to move the sliding jaw until 20 on the vernier scale coincides with the nearest line on the gage bar. The reading of the vernier, then, is the 0.120 inch. Now if we insert a piece of ⅛-inch wire between the taper of the measuring jaws we find that it will enter between the jaws until the graduation marked 5 is reached, the desired dimension being $0.120 + 0.005 = 0.125$ inch. Now if the piece inserted should only enter halfway between the 5 and 6 graduations on the jaws, it would be one-half of a thousandth inch too large. If it should enter as far as between the graduations 5 and 4, it would be one-half of a thousandth inch too small.

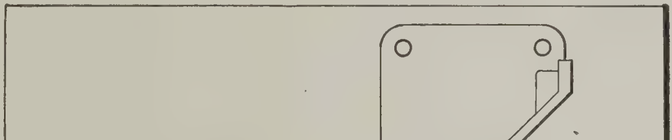
As another example, assume that we first set the zero of the sliding jaw opposite the three-tenths graduation on the bar, then move the vernier scale until line 15 coincides with the nearest graduation on the bar, and insert a wire that would enter between the jaws to the graduation corresponding to 7; the dimension of this wire would then be $0.300 + 0.015 + 0.007 = 0.322$ inch.

The adjusting nut A at the right end of the gage is graduated with five graduations. This makes it possible to set the vernier rapidly and accurately, as each graduation is equivalent to a 0.010-inch movement of the sliding jaw. The screw C on which the nut revolves is stationary and as there is a thread of different pitch at the end T of this screw, an accurate setting for the correct reading of the nut can be obtained. A set-screw N with a brass shoe at its end is employed to bind the adjusting screw in place. The gib B and gib screws on the top of the bar are to hold the sliding jaw tightly, so that it will move without lost motion. The set-screw on the top fastens the slide in the desired position.

Springfield, Mass. FRANCIS W. CLOUGH

MODIFIED FORM OF MILLING FIXTURE

The accompanying illustration shows a knee or angle plate which differs from the average type. Instead of having two flat faces as usual, this angle plate has one flat face, while the other is provided with a V-groove; wings are formed at the edges of the V, and these are planed off so that the knee can be placed with the V-side as a base, whenever flat work is to be clamped to the plain flat face. Lugs are cast upon these wings which are drilled for bolts for clamping purposes. An example of the work for which the fixture is adapted is shown at A in the illustration. Any part having a cylindrical stem and a slot, groove, or keyway cut across the end can be securely held in this plate while milling. Unless the work has a very long stem it can be done better and quicker by using this device than by gripping it in a vise and feeding in a vertical direction.



Modified Form of Angle Plate and Type of Work for which it is adapted

Middletown, N. Y. DONALD A. HAMPSON

SHOP RECEIPTS AND FORMULAS

A DEPARTMENT FOR USEFUL MIXTURES

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

HIGH-PRESSURE HYDRAULIC JOINTS

When oil is the fluid conveyed in a high-pressure hydraulic pipe line, glue makes an excellent material for applying to the threaded pipe connections, caps, etc. It will set and become hard very quickly. It is necessary to have the parts clean before the glue is applied.

Toronto, Canada. J. CRANFORD SMITH

HARDENING SOLUTION FOR NOVO STEEL

The following receipt for hardening "Novo" and "Novo Superior" steel will be found useful: To one quart of kerosene oil add one pound of table salt, thus making a saturated solution. Heat the steel to a bright cherry red, rub cyanide of potassium on the parts to be hardened and heat again to a bright cherry red. Then dip the steel into the solution until cold.

Bristol, Conn. IRVING E. SCHUBERT

ENAMEL FOR INSULATED WIRE

The following is a satisfactory solution for coating wire with an enamel insulation. It consists of seven parts by weight of tri-acetyl-cellulose $[C_6H_7\ (C_2H_3O)_3\ O_5]$; ninety parts chloroform ($CHCl_3$); and three parts phenol (C_6H_5OH); thyme (a compact under shrub); and castor oil, added as a softener. This solution can be saponified, though not very easily, by a solution of potash. It can be more readily saponified, however, by the use of alcoholic potash. This enameling solution is much less inflammable than celluloid. It is colorless, but can be rendered visible by adding an aniline dye.

Pittsburg, Pa. H. M. NICHOLS

CEMENT FOR FILLING HOLES IN CAST IRON

The following is a good mixture for a cement for filling holes in cast iron, and may be well known to many: powdered cast iron, 40 parts; powdered sal-ammoniac, 1 part; powdered sulphur, ½ part. These ingredients are thoroughly mixed together and placed in an air-tight receptacle in a perfectly dry condition until wanted. When a hole in a casting is to be filled, take what appears to be the required quantity of the mixed powder, moisten it with water to the consistency of paste or putty, and fill the hole or depression, smoothing it up and allowing it to set.

When very deep depressions are to be filled, add to the above mixture an equal weight of fresh "vulcanite" Portland cement before dampening. After the water has been added, so that the mixture has the desired consistency, add non-volatile oil to the extent of 8 per cent by weight of the dry mixture used, and work the mass until the oil is fully emulsified; then apply the paste, finishing with a facing of the original mixture containing no Portland cement. This will produce a filler which will not shrink in setting.

St. Louis, Mo. C. H. CASEBOLT

OILS AND FATS AS HARDENING MEDIUMS FOR STEEL

Oils and fats produce, as a rule, less hardness in steel than does water. The hardness which they produce is usually accompanied by toughness. Thus such tools as are liable to crack in hardening, and where the greatest possible hardness is not required, are usually hardened in oil or fat. According to the *Metallarbeiter*, petroleum hardens more sharply than any other oil; then follows glycerine, which is too little known in this connection; then the lighter mineral oils; and at the foot of the list come the vegetable oils, as, for example, linseed oil. Among the fats, melted tallow and whale oil are the most used, the former giving a greater degree of hardness than the oils.

No matter what substance is used, however, one must not lose sight of the fact that there must be sufficient of it to permit the article being hardened to be moved quickly to and fro in the hardening medium, just as when water is used, so that the bath will not get hot. In most cases there is usually too little oil employed; the lack of success is then attributed to the use of the oil or fat, instead of to the fact that too little of it was used. R. G.

PRODUCING A BLUE COLOR ON NICKELED STEEL

By the use of the well-known bath of hyposulphite of soda and acetate of lead it is possible, by simply dipping, to produce a blue color on various metals. This is used for the purpose of producing an imitation steel finish on different metals. As is well known, the action is very satisfactory, and the articles thus treated look exactly as though they were made of steel that had been blued by annealing. Although this color can be produced on all metals, it is best brought out on nickel and nickel-plated articles. The brilliant white color of the nickel constitutes a good background for the thin blue coating; and for this reason the color is especially lively.

If this blue color is to be produced on unpolished nickel, it is recommended to color directly after plating, in order to prevent the surface getting spotted. With polished nickel, great care must be taken in cleaning. For this reason it is desirable to rub the nickel with rouge (crocus powder), as this can be readily removed from the metal and contains less mineral oil than "Vienna chalk."

For those who do not know the dip process thoroughly, it might be stated that the liquid for producing the blue color consists of 226 grams (8 ounces) each of sodium hyposulphite and lead acetate, and nine liters (8 quarts) of water. The solution is used boiling hot. The color is first yellow, then purple, and at last blue. When the right color is obtained, the articles are rinsed and dried, and then lacquered—otherwise the color will fade.

Dresden Germany. ROBERT GRIMSHAW

THE CHEAP BLACKENING OF BRASS

The following solution for blackening brass is nothing new; in fact, it has been known for a long time. Owing to its cheapness, ease in working and adaptability for many purposes, it has been deemed advisable to bring it again to notice, Many platers, of course, will recognize it as an old solution known to the plating industry for many years, but they may not have realized its advantages for some classes of work. The solution is made as follows:

Water	1 gallon
Sugar of lead	8 ounces
Hyposulphite of soda	8 ounces

The solution is used as hot as possible and the brass work, is simply dipped in it and allowed to remain until black. This takes about a minute or less. The articles are then rinsed in cold water, then in hot water and dried. If scratch-brushed dry, the black deposit will have a high luster.

When dipped into the solution, the surface of the brass article becomes yellow, then blue and finally black. The article should not be taken out until all the surface has become blackened. The deposit on it is sulphide of lead. The articles should always be lacquered as the black deposit is likely to oxidize and fade if not; but if coated with lacquer, it seems to be quite permanent.

For a cheap class of goods that require a black finish, this solution can frequently be used to a good advantage. It requires no electric current, being used as a dip. The color, to be sure, is not coal black, but resembles a graphite black more than anything else and has a slight gray shade. It is sufficiently black, however, to answer many purposes and it is so easily applied that it can be used on cheap goods with only a slight increase in cost.—*Brass World.*

* * *

Always provide some means for holding bolts from turning while the nuts are being screwed on, if a wrench cannot be used on the head of a bolt.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

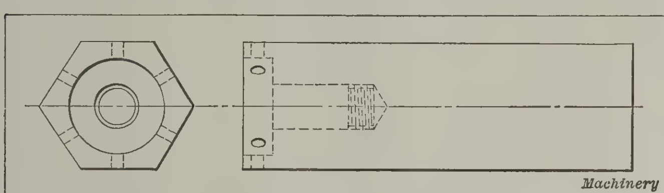
MARKING ON BLUEPRINTS

The most simple and at the same time probably the most effective method of marking on blueprints is to use a common soap-stone pencil, similar to those used in machine shops and tool-rooms. The end of the pencil should be ground to a sharp point on an emery wheel. Lines and letters made in this manner cannot be distinguished, when first made, from those originally on the blueprint, and will stand an almost indefinite amount of wear before becoming obliterated.

Indianapolis, Ind. F. B. HAYS

A SIMPLE DRILL JIG

On a number of special capstan-head screws, six holes were to be drilled, as indicated by the illustration, which shows the jig used for the drilling operation. This jig was made from a piece of hexagon steel rod. Instead of tapping out

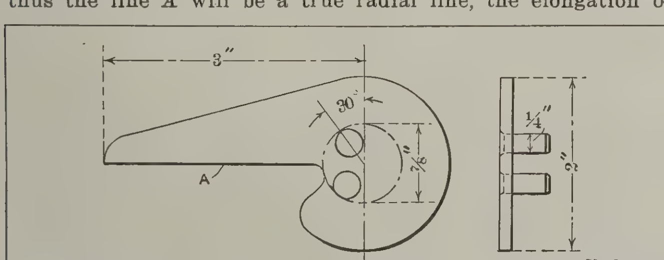


the full length of the hole for the screw, only a few threads were cut at the bottom, which saved time in handling the product to be drilled. In this instance the heads of the screws extended far enough out of the jig so that they could be turned by hand. This jig was casehardened and has proved itself good for long service. Jigs of this type are quickly made, and the cost is so small that even for experimental work it often pays to make such a jig.

Middletown, N. Y. DONALD A. HAMPSON

MILLING CUTTER TOOTH TESTING GAGE

The gage shown in the accompanying illustration is intended for testing the radial direction of the faces of formed milling cutters, especially gear tooth cutters. The two pins shown bear on the inner side of the hole in the cutter, and thus the line *A* will be a true radial line, the elongation of



which passes through the cutter center. Gear cutters should be tested, from time to time, with this gage to make sure that the faces of the teeth are in a radial direction, as, otherwise, the shape of the gear tooth being cut will not be an exact duplicate of the original gear cutter form. J. S. B.

REPAIRING LATHE CHUCK SCREWS

The square heads of chuck-jaw screws sometimes become so badly worn that their keys will no longer fit them, and it becomes difficult to use the chuck. To order a new screw sometimes means quite a delay. The writer has used the following method successfully: Remove the jaw, take out the screw and heat it to a cherry red; then, with a few sharp blows, upset the square end of the screw until it is large enough to file to its original size; take care not to injure the threads of the screw during this operation. Then file the head of the screw to fit the chuck key. After hardening, the screw is as good as new. W. H. ADDIS

Lafayette, Ind.

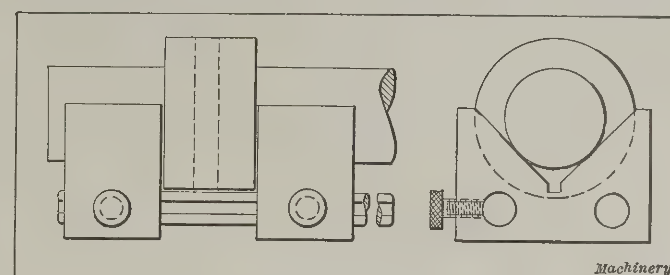
LATHE FILE HANDLES

The writer generally saves all ends cut off from new belts and cuts them up into pieces, about 1¼ inch square, into which he drills a hole, about No. 40, ⅝ inch deep. These pieces are used by the tool- and die-makers when they want a handle for a small file. Usually they drive a piece of leather onto the file tang and then shape it to suit their requirements. The toolmakers prefer these to wooden handles.

St. Louis, Mo. JAMES S. GLEW

CONNECTED V-BLOCKS

The accompanying illustration shows two uniform V-blocks which are connected so as to be used as one unit. Blocks so

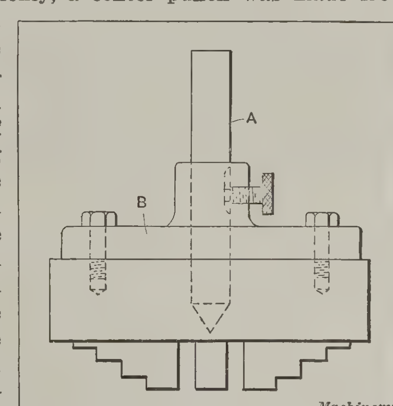


connected are handy for work of the kind shown in the illustration; in fact, they form a very effective jig, or rather jig replacer.

Manchester, England FRANCIS W. SHAW

AN ACCURATE CENTER PUNCH

The writer had a number of different sizes of rods to center, and to do this work quickly, a center punch was made from a three-jaw universal chuck, as shown in the illustration. A faceplate *B* was made and bolted to the back of the chuck, for carrying the punch *A*. In one side of the center punch a flat was milled for the end of a screw which prevented the punch from dropping out. The chuck was set over the end of the shaft, and the jaws were tightened with a chuck wrench, and then the punch struck with a hammer. This method of centering was very quick and accurate.



Superior, Neb. J. N. BAGLEY

CUTTING COARSE INTERNAL THREADS IN THE LATHE

In cutting coarse internal threads with a cutter held in a bar which is clamped rigidly in a fixture fastened in the T-slot of the compound rest, it is impossible to have the cutter cut one side of the thread at a time. To accomplish this result, engage the split nut on the lead-screw to the full capacity of its engagement for a few cuts; then engage the nut a little less than full, holding it there by the hand so that the carriage will lag a little behind the previous cut. Continue doing this for a few cuts, and then engage the split nut to its full capacity, and so on. Lead-screws which are provided with an Acme thread allow the accomplishment of this "trick" without any trouble.

It might be considered bad practice to only partially engage the split nut, because of the uneven wear on the nut and screw, but this does not seem objectionable to me, as the engagement is so nearly full that the consequent wear is very slight. In the general run of shop work, nuts having a coarse thread to be cut are the exception rather than the rule, so that this kink would not be frequently employed.

Los Angeles, Cal. JOHN A. WOOD

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

CAVEATS NOT GRANTED BY PATENT OFFICE

F. A. G.—Are caveats no longer granted by the United States Patent Office?

A.—Section 4902 R. S., authorizing the filing of caveats for inventions was repealed by act of Congress June 25, 1910, the new law taking effect July 1, 1910. Since this date there has been no provision of law for the filing of a caveat in the United States Patent Office, and it is no longer permissible for an applicant to file a caveat for the purpose of obtaining further time in which to mature his invention.

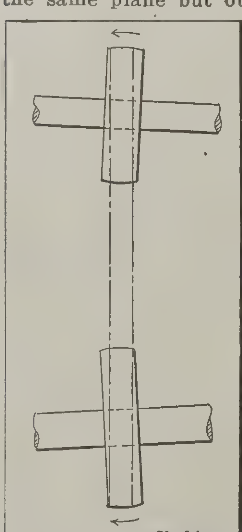
ALLOWABLE SHAFT DEFLECTION FOR GEARING

D. E. W. Co.—In calculating the size of shafts carrying gears how much should be allowed as the maximum permissible deflection? We are unable to find anything printed on this subject that is at all satisfactory and we are therefore appealing to you. Any information that you can give us on this subject will be very much appreciated.

A.—None of the available authorities specifies the allowable shaft deflections for gearing. The general rule is to mount all gears close to the bearings so as to minimize the bending moment, and most designers apparently proceed on the assumption that the deflections are negligible when the shafts are sufficiently strong to stand the torsional stresses and the gears are mounted close to the bearings. Data from practice followed when gears are not set closely to the bearings is requested.

WHY BELTS RUN TO THE HIGH SIDE OF PULLEYS

T. J. C.—It is common experience noted by all mechanics that an open belt running over pulleys mounted on shafts in the same plane but out of parallel, runs to the "high side." Why is this so?



Illustrating the Tendency of Belts to run to the High Side of Pulleys

A.—A belt runs to the high side of the pulleys because of the direction of motion of the parts of the belt between them. As the free part of the belt winds onto the leading side it tends to follow the same line of motion around the pulley face, and if the shafts are out of parallel the belt path becomes at first a helix which if continued would run off the pulley on the high side. The illustration of an exaggerated case shows the belt leading to the left or high side of the pulleys, the edges of the belt being projected in a straight line to emphasize the drift to the side. When the pulleys are crowned, the crowning counteracts the tendency of the belt to run off unless the shafts are badly out. The crown of the pulleys, by the way, acts in the same manner on both sides of the belt when the shafts are parallel. Both sides of the belt crowd toward the center which is the highest part of the pulleys, and it is thus that crowning prevents belts running off the pulleys.

SOLUTION OF A TRIANGLE

F. B.—In the triangle shown in the accompanying illustration, angle A and side b are known. It is also known that the length of side a is to the length of side c, as 10 is to 8. What is a simple method for solving this problem? I have looked for a solution in various textbooks in vain.

A.—The sides of a triangle are to each other as the sines of the angles opposite the respective sides. Hence, in the triangle shown,

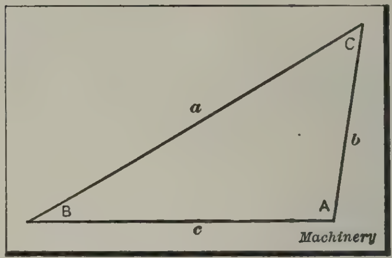
$$\frac{\sin A}{\sin C} = \frac{a}{c}$$

From this we get

$$\sin C = \frac{c \sin A}{a}$$

but, as

$$\frac{a}{c} = \frac{10}{8}, \text{ we have } \frac{c}{a} = 0.8$$



Solution of a Triangle

and, therefore, $0.8 \times \sin A = \sin C$. The angle A being known, angle C is thus determined, and the triangle is solved in the same manner as any triangle in which one side and the angles are known. (See MACHINERY's Reference Book No. 54, "The Solution of Triangles," page 49.)

* * *

METALS USED FOR STEAM TURBINE BLADES

In an article in *La Technique moderne*, M. P. Breuil deals with the metals used in the construction of steam turbine blades, the data given referring to continental European practice. In the Zoelly turbine, blades made from 5 per cent nickel steel are used, while Harlé & Cie. prefer steel with 32 per cent nickel. The advantage of this steel, however, might be considered doubtful, as Rateau has found steel with 25 per cent nickel unsuitable for turbine blades. The opinions of French manufacturers of special steels differ widely as to the contents of nickel. It does not seem as if the influence that nickel has on metal used for turbine blades has been fully investigated, and there is considerable uncertainty as to the behavior of the metal in a turbine blade. The bronzes, as well as the monel metal, which are used for turbine blades by some of the manufacturers, soften considerably at temperatures above 570 degrees F., and have a relatively low elastic limit, but they have the advantage of being but little affected by corrosion.

Attention is further called to the fact that on the side of the admission of steam the first blades work in high temperatures, with dry steam at great velocity; the blades further back are subject to lower temperatures and lower velocities of steam, but the steam is wet, and there is, besides, the friction of metal particles carried away by the steam. The guide blades are stationary, and are not subject to the action of centrifugal forces like the rotor blades. It appears, therefore, that different metals ought to be used for each of these three classes of blades, but in all cases the metal used must possess great resistance to chemical and mechanical corrosion, and be easily machined by ordinary shop processes.

As to the chemical corrosion of metals by hot steam there are practically no reliable data. From investigations of the action of salt water on metals it would appear that aluminum and manganese bronzes and monel metal would give good results, but it is quite possible that chemical corrosion is altogether very slight as compared with physical, and the material used ought to be chosen on the basis of resistance to the latter, with respect to which nickel steel appears to have very high qualities, with its breaking strength of 80,000 pounds per square inch, elastic limit of 57,000 pounds per square inch, hardness (Brinell) of 180, and elongation of 20 to 22 per cent. It is, moreover, naturally hard, not brittle, and comparatively cheap. There are no data as to its probable behavior at high temperatures, but having a low percentage of nickel it would probably behave like other steel, and would reach the minimum of its elastic limit and elongation at about 570 degrees F., without, however, becoming brittle. The firm of Wickers Maxim makes turbine blades of laminated bars with a steel core and nickel surface, the nickel layer being extremely thin.

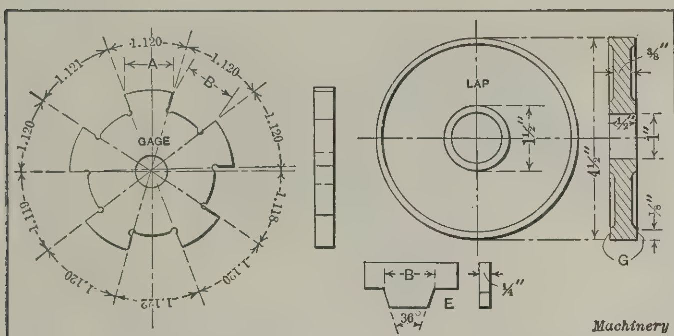
* * *

As an example of the importance of having the walls of shops and factories painted in light colors in order to increase the light in the workroom, it may be of interest to note that in one case where the intensity of the illumination in a saw-tooth roof building was 9.7 foot-candles in the center of the building, it was 13.5 foot-candles at a distance of three feet from the whitewashed walls, showing an increase of nearly 50 per cent due to reflected light from the walls.

MAKING A HUB CLUTCH GAGE

BY J. M. HENRY

In the following article is described a successful method for making a hub clutch gage of the type illustrated in the accompanying engraving. The first difficulty met with is that of distortion in hardening, which, however, may be overcome by using "Ketos" or "Paragon" oil-hardening steels, in which case it is possible to machine the gage to within 0.002 inch of the finish size, and finish it by lapping. For the lapping, a disk lap is used, and the operation is performed in a milling machine.



The Gage to be lapped, the Disk Lap, and the Templet

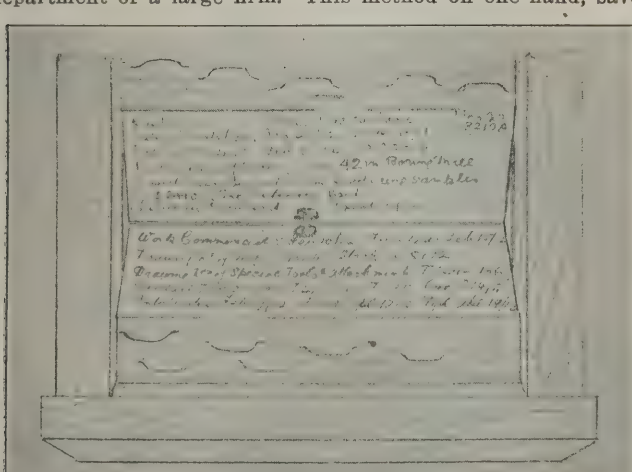
The disk lap is turned as shown in the engraving, and placed on an arbor in the milling machine. It is trued up on the sides *G* to insure its running parallel with the ways so as to be completely in contact with the work. The gage is then mounted on the index centers and one side of the lap is set central with it. The blank is indexed around until it just touches the lap, a sounder being used to determine when this takes place. The lap is now charged with emery and oil, the machine is started, and the gage rapidly passed by the lap a number of times. After having lapped the first surface, the gage is indexed around to the next lug and the operation repeated, thus continuing around the gage until having lapped one side of the lugs. The opposite side of the lap disk is then set central with the gage, and the gage indexed around the opposite way until the other side of one of the lugs touches the lap, after which the lapping is continued until the dimension *A* is correct on all the lugs. A templet *E* is used, from time to time, to test the accuracy of the spacing.

* * *

UTILIZING BOTH SIDES OF INDEX CARDS

BY CARD INDEX

The accompanying illustration shows how both sides of the cards used in a card index were utilized in the tool-designing department of a large firm. This method on one hand, saved


Card Index, in which Both Sides of the Cards are utilized

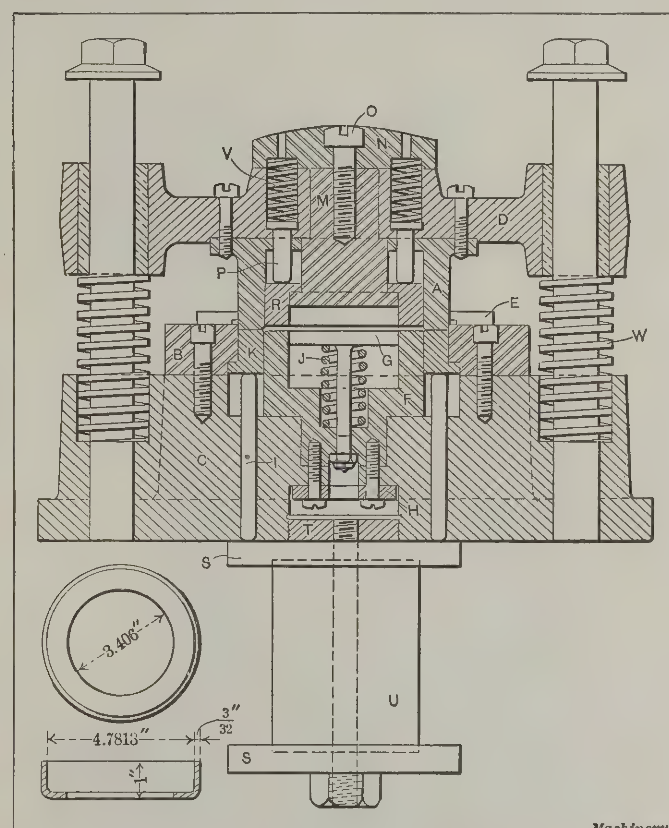
extra cards, and on the other, made it possible to record all the necessary information relating to each item on one card. On the back of the card the information was entered upside down so that when the cards were pressed towards the front of the drawer, the information entered could be easily read. In the engraving two separate cards are shown for convenience, but it is understood, of course, that all the information pertaining to one subject is entered on the two sides of the same card.

A COMBINATION DIE

BY A. J. DUDLEY

The shell shown in the lower left-hand corner of the accompanying engraving is a retainer for the ball races of an automobile clutch. This retainer is a sheet-metal stamping made in a powerful trimming press having a 5-inch stroke. The style of die used is a combination die which produces the shell complete in one operation within the limits of tolerance required—0.001 inch for all dimensions except for the height of the shell. The blank for the shell is approximately 6⅝ inches in diameter. The material is hot-rolled steel, 3/32 inch gage, fed into the die in the form of a strip.

In the illustration, *A* is the blanking punch and drawing die, made of tool steel, hardened and ground; *B* is the blanking die which is secured to a cast-iron die-block *C*. A stripper *E* is secured to die *B* by screws (not shown). The drawing punch, and die for the center hole in the shell, is shown at *F*, and the retaining plate for this punch at *H*. Punch *F* is also made of tool steel, hardened and ground. A knockout *G*, op-



A Combination Blanking and Drawing Die and Work for which it is used

erated by a helical spring *J*, ejects the waste center blank. Some difficulties were first experienced with this knockout owing to the sticking of the blank, but this was overcome by placing a small knob in the center of the knockout (and a corresponding recess in the face of punch *M*) which deflected the blank enough to prevent it from sticking. Punch *M* does not operate until nearly at the end of the stroke. At *K* is shown the shell stripper which also acts as the spring pressure pad during the drawing operation. This is supported by four pins *I* resting upon the flange *S*. A powerful rubber spring *U* effects the stripping of the finished shell from punch *F*.

Another pressure pad and stripper is provided at *R*. It is supported by pins *P* and helical springs *V* and bottoms on the inside flanges of punch *A*. The buffer plate *N* acts as a retainer for punch *M* and is provided with vent holes to release the air pressure produced by pins *P* and pad *R*. Heavy square helical springs *W* open the die after each stroke, the rubber spring *U* assisting in this operation during part of the stroke.

Owing to the limited height available between the bolster plates of the press, it was impossible to use an adapter—hence, the necessity for spring operation. The die has worked successfully for several months, but it has been found necessary to lubricate it copiously when in operation.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

COCHRANE-BLY UNIVERSAL SHAPER

Diemakers and toolmakers are often obliged to use a number of machines for making a die or jig, especially if the shape is at all complicated or irregular. This means that the work must be reset in each machine, which not only requires extra time but often makes it difficult to secure accuracy between the different surfaces, thereby increasing, in many instances, the amount of hand work necessary for fitting and finishing. The Cochrane-Bly Co., of Rochester, N. Y., is now manufacturing a universal machine that has been designed to perform quite a variety of operations at one setting of the work; therefore it is especially adapted to the making of dies, jigs or to general tool-room work. This machine is known as a universal shaper, but, in reality, it is a shaper, slotter, milling and drilling machine combined.

Fig. 1 shows a view of the right-hand side and Fig. 2 the left-hand side with the circular table in position. This machine consists principally of a column supporting the knee and table, a shaper ram, a milling and drilling spindle, and suitable speed- and feed-changing mechanisms. The milling spindle and shaper ram have universal adjustments so that tools can be presented to the work at any desired angle. Fig. 4 shows the heads in a vertical position drilling a die, and Fig. 3 shows the shaper ram set in a horizontal position.

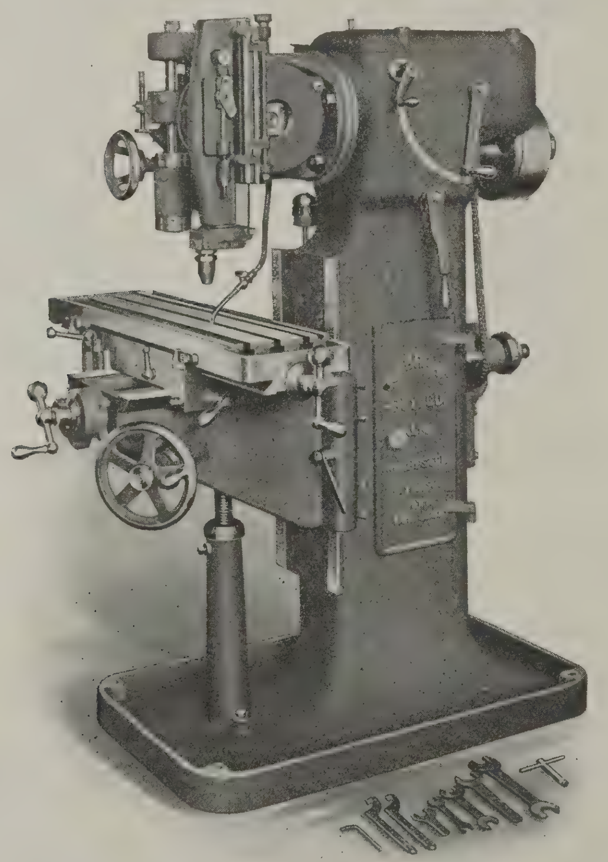


Fig. 1. Combined Universal Shaper and Milling Machine for Die, Jig and General Tool Work

The drive is from a constant-speed clutch pulley at the rear; this transmits the power through a double cone of spur gears to the main head, which carries bevel gears for driving both the shaper ram and milling spindles. The cones of spur gears provide means for varying the speeds, and their arrangement is shown by the sectional view, Fig. 5. The speed changes are effected by means of a driving key A which is shifted into engagement with any one of the five upper gears, thus giving five speed changes for the shaper ram and milling spindle. The position of this key is controlled by the large lever seen in Fig. 1 near the top of the column. The end of this lever swings around a graduated quadrant which shows the number of ram strokes per minute for any one of the five positions. The key in the gear cone, as well as the gears and shafts, is hardened, and all bearings are provided with bushings. The clutch pulley, when idle, runs on roller bearings, and the clutch is engaged or disengaged by the vertical lever seen at the side of the column in Fig. 1.

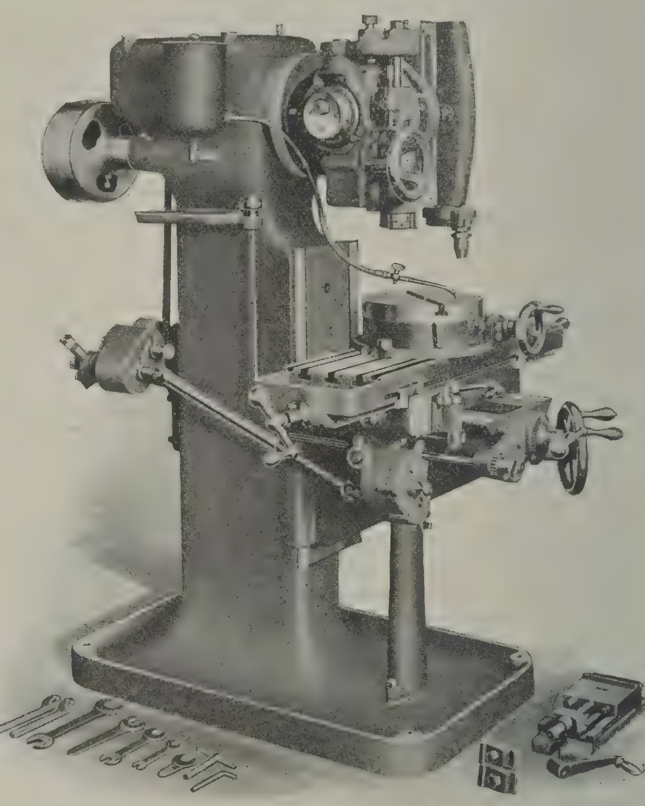


Fig. 2. Universal Shaper equipped with Circular Table Attachment

The main head has a bearing in the column and is locked in position by three bolts which engage a circular T-slot. The entire head, including the shaper ram and milling spindle, can be revolved about a horizontal axis (after loosening the clamping bolts) by turning a small crank which is located at the upper end of the graduated quadrant previously referred to (Fig. 1). This crank operates the worm B, Fig. 5, which,

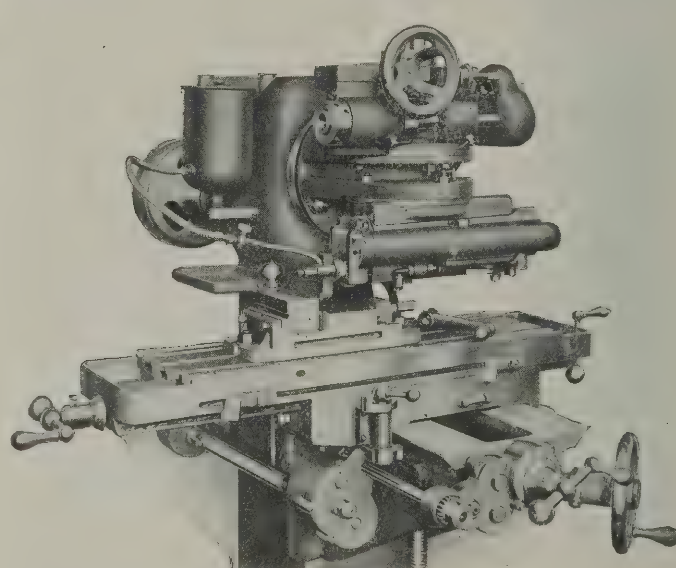


Fig. 3. Shaper Ram set in a Horizontal Position

in turn, engages a worm-wheel attached to the inner end of the main head. The shaper and milling heads each have an independent adjustment about an axis at right angles to the main head, which makes it possible to locate them at any angle. All three heads have large circular bases which are graduated to degrees.

The milling spindle is driven by bevel and spur gears from the main head and runs either right or left. It has a slide movement of 3½ inches for drilling and boring, which is controlled by a handwheel operating through worm-gearing. A micrometer screw-stop, reading to thousandths of an inch, is provided to facilitate accurate adjustments. The spindle is fitted with taper bronze bushings and adjusting collars to take up wear.

The shaper ram is driven through bevel gears and a crank-and-link mechanism. It has a quick return and the stroke can be adjusted from zero to six inches. The tool-head of the ram swivels and can be set to work at any angle. The ram is equipped with a mechanism (illustrated in Fig. 6) which provides a positive relief for the tool on the upward or return stroke. The clapper is held firmly against the tool-head during the cutting stroke by means of a knuckle-joint mechanism, and it is released at the end of the stroke by a relief dog, which strikes the lower roll or tappet shown in the illustration. The clapper remains in the released position on the return stroke and it is thrown into the working position again when the dog engages the upper roll. These rolls are adjusted for any length of stroke by means of a right- and left-hand screw which is turned by a knurled knob at the top.

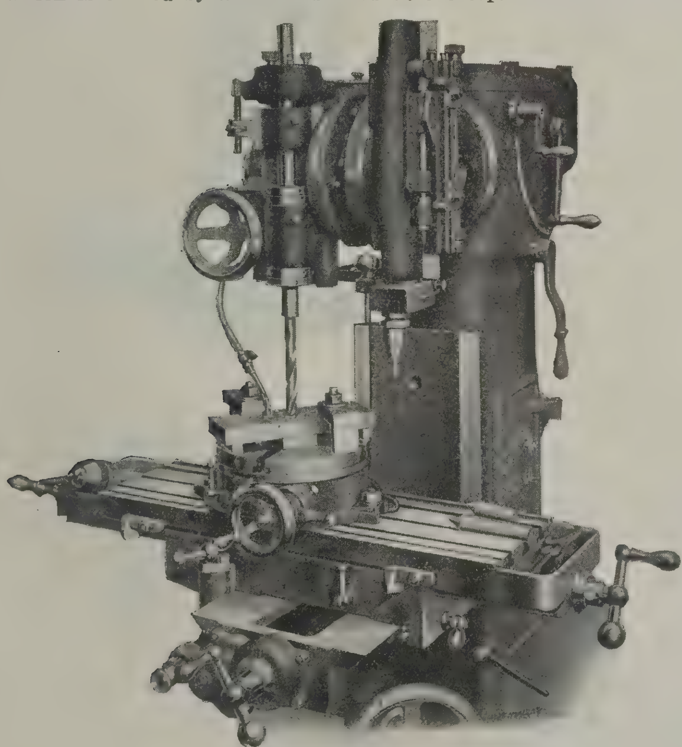


Fig. 4. Drilling a Die with Milling Spindle

Power feed is provided for the longitudinal and transverse movements of the table and also for the circular table, if desired. The feeding motion is derived from a sprocket *C*, Fig. 5, which is connected by a silent chain with the feed-box, seen at the rear in Fig. 2. From this point the motion is transmitted to the front of the machine by a universally jointed, telescoping shaft in the usual manner. When the milling spindle is being used, the feed is continuous, whereas an intermittent feed, which takes place on the return stroke, is required for the shaper ram. Either a continuous or intermittent feed is obtained from the rear feed-box, which is shown in detail in Fig. 7. For a continuous feed, the drive is through spur gears, and for an intermittent feed, a crank-and-ratchet mechanism is brought into action, provision being made for disengaging either the gear or crank mechanisms.

Tool-holders for various styles of shaping tools are interchangeable in the tool-head. Three forms of tool-holders are illustrated in Fig. 8, which also shows a set of standard slotting tools such as are carried in stock by this company. The slotter tool-holder *A* takes all shapes of slotting tools having 3/8-inch square or 7/16-inch round shanks, and it is used when shaping out small dies, for broaching and for cutting

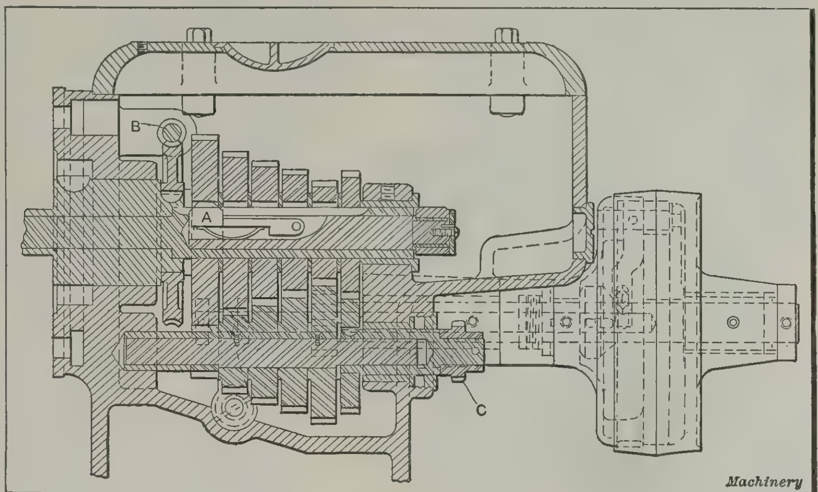


Fig. 5. The Constant-speed Clutch Pulley and Speed-changing Mechanism

internal keyways, etc. The shaper toolpost *B* holds lathe or shaper tools of ½-inch or ¾-inch size, and is used when the machine is working either as a horizontal shaper (as shown in Fig. 3) or as a vertical shaper. The extension holder *C* takes ⅜-inch square bits and can be used for inside or outside shaping operations.

The table of this machine has a working surface of 28 by 9 inches and there are three ⅝-inch T-slots for clamps. The feed-screws are accurately cut and are provided with ball thrust bearings. There are also compensating nuts for taking up wear and large graduated dials reading to thousandths of an inch. The saddle has a bearing on the knee 12 inches wide, and provides a way 18¼ inches long for the table. Both of these slides are fitted with taper gibs. The saddle carries the feed mechanism and the feed-control handle is mounted at the front. The knee has a bearing 10 inches wide and 13½ inches long on the column, and is fitted with an adjustable gib and locking screws. The thrust on the elevating screw is taken by a ball bearing. The circular table is 12 inches in diameter and is furnished with or without power feed. It is graduated in degrees and is revolved by a handwheel, the dial of which reads to five minutes. Provision is made for disengaging the worm-gear, when it is desirable to revolve the table quickly by hand. The column is cast in one piece and has sufficient metal to absorb all vibration. The head of the column containing the driving and speed-changing gears, forms an oil-tight box so that these gears run in a bath of oil.

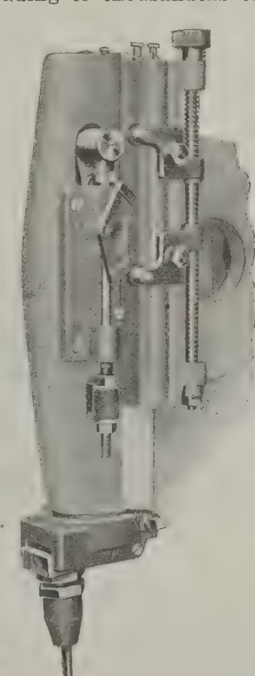


Fig. 6. Detail View of Shaper Ram showing Relief Mechanism

The machine has been designed throughout to provide convenient operation, all control levers being within reach of the operator from the front of the machine. The durability of the construction has also received careful consideration, the spindles, shafts and driving gears being hardened and all bearings bushed. While this machine was designed to be accurate and sensitive on fine work, the driving mechanism is sufficiently powerful to permit taking heavy cuts for removing stock rapidly.

Some of the principal dimensions of this machine are as follows: Longitudinal travel of the table, 22 inches; transverse movement, 10 inches; vertical adjustment, 18 inches; angular adjustment of the main head, 360 degrees; maximum stroke of shaper ram, 6 inches; maximum distance from end of ram to table, 15 inches; number of speeds, five; number of strokes per minute, from 25 to 150; angular adjustment, 30 degrees each way from the center; maximum distance from end of milling spindle to table, 16 inches; maximum distance from center of spindle to face of column, 13½ inches; number of taper, No. 9 B. & S.; size of hole through spindle, 17/32 inch; angular adjustment, 45 degrees each way from the center; number of speed changes, five; variation, from 55 to 330 revolutions per minute; micrometer stop adjustment, 3½ inches. The shaper ram has an intermittent feed varying from 0.002 to 0.032 inch per stroke, and the milling spindle has six feed changes varying from 0.004 to 0.048 inch per revolution. The net weight of the machine is 2000 pounds; the height over all, 65 inches.

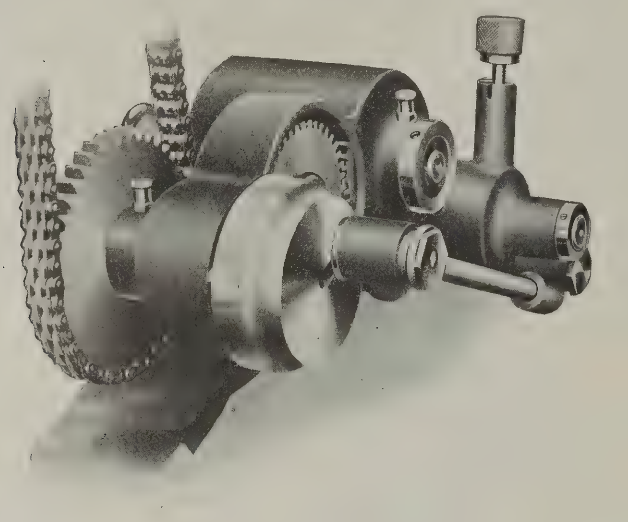


Fig. 7. Mechanism for Obtaining Continuous Feed for Milling and Intermittent Feed for Slotting

The equipment includes an oil tank and hose; shaper, slotter and extension tool-holders; a spud-bar for the milling spindle; a set of slotter tools; wrenches, etc. The following extra equipment can also be furnished, if desired: A circular table with or without power feed; a milling machine vise; draw-rods for the milling spindle; spring collet with bushing and nut; drill chuck; expanding milling arbors; milling machine center; center for circular table; sleeves for the spindle, and a self-contained motor drive.

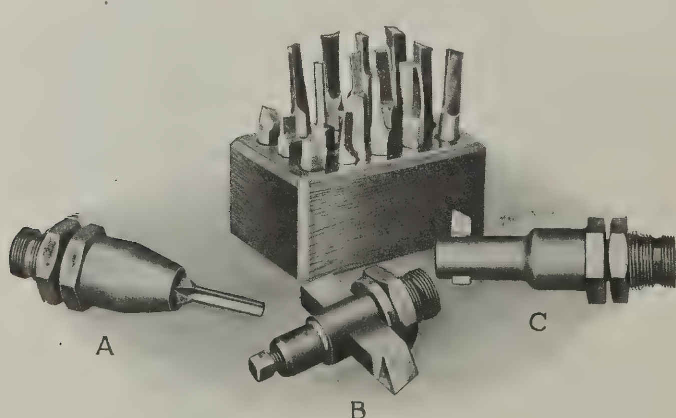


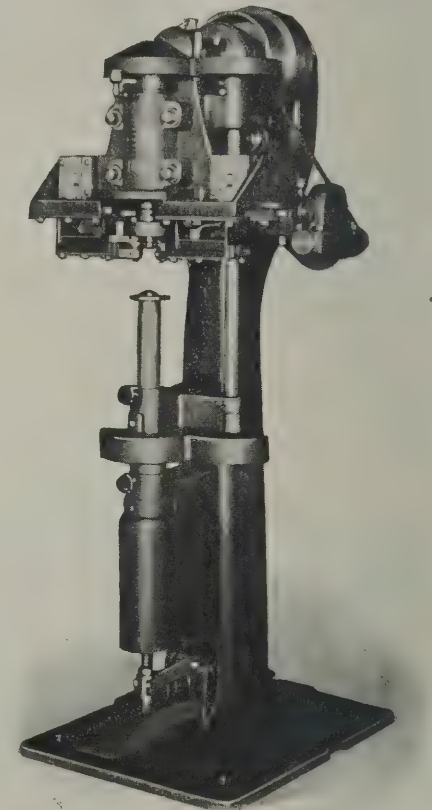
Fig. 8. Set of Slotting Tools and Different Tool-holders

The full universal features of this machine, in conjunction with the various tools which can be used, make it possible to machine a large variety of such work as blanking and forging dies; punches; forming tools, such as are used in turret lathes, automatic machines, etc.; jigs, especially when shaping, milling and boring operations are required; and similar classes of work. While the machine was designed more particularly for the tool-room, the universal features make it possible to handle with the regular equipment and standard tools, a large variety of wōrk which ordinarily would require several machines of different types and also special tools and fixtures.

NEW SQUARE CAN DOUBLE SEAMER

A new automatic double seamer has recently been designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is adapted for square, oval and oblong work and will seam cans ranging from ¾ inch to 5½ inches in height. The rate of production depends somewhat on the size of the can, and the expertness of the operator, and varies from 12,000 to 20,000 ends in ten hours.

The machine is driven by an automatic friction clutch encased in the two-step driving cone. A hand brake arranged on the end of the driving shaft, automatically engages and releases after the work is done and insures stopping the spindle in exactly the same position after every cycle. By referring to the accompanying illustration, it will be noted that the lower spindle drive is positive, the lower spindle starting and stopping in unison with the upper spindle. This insures a perfectly straight body after double seaming.



Bliss Automatic Double Seamer

All movements are automatic so that the operator has nothing to do but place the can on the chuck and depress the treadle. This causes the lower spindle to rise and engages the clutch, thus starting the driving shaft which is connected to the chuck spindle by bevel gears, and bringing the double seaming rolls into action. The can is automatically revolved the required number of times, and the double seamer rolls, after going through their motions, are automatically retired, the clutch is automatically disengaged, the chuck is stopped, the lower plate is dropped and the can released. The weight of the machine is 1100 pounds.

STANDARD MACHINERY CO.'S PRESSES

The press shown in the accompanying views represents a new line that has just been brought out by the Standard Machinery Co., 7 Beverly St., Providence, R. I. The particular machine illustrated has a net weight of 13,500 pounds. It is heavily back-geared with cut steel gearing, and is equipped with this company's instantaneous roller friction-clutch. This clutch allows the machine to run continuously or to be automatically stopped after each revolution either by hand or foot. The clutch grips the instant the treadle or handle is depressed, instead of allowing the flywheel to turn from one-half to a full revolution before coming into engagement. After engagement, there is less than 1/32 inch travel on the periphery of the balance wheel. Another noteworthy feature of the clutch is that it enables the press to be stopped at more than one point in a revolution. Most of the clutches applied to these presses are made to stop on the up stroke and down stroke, which adapts the machines for heavy forming, embossing or

similar operations in connection with which it is essential to have the dies dwell after striking.

This machine is extra heavy and rigid in design. It is fitted with stay-rods and is of the open-side and open-back type. The construction of the upper and lower connections as well as the adjusting and clamping device is worthy of note. The lower connection consists of a forged steel ball fitted into a hemispherical center in the ram. On the upper part of this ball there is a bronze retainer which is also hemispherical on the lower part. The upper part of the lower connection is threaded and fits into the upper connection. The clamping is effected by the four screws shown in the upper connection. This connection is split through the center and each of the screws passes through to the opposite side. Around each screw there is a bronze bushing. These bushings and the holes in the upper connections are threaded, and in order to clamp the upper connection to the lower, after the ram is adjusted to the proper height, the screws are tightened and the bronze bushings, which are fitted to the threads of the lower connection, are forced against the shank of the lower connection. This gives a positive grip which will not slip. The bronze bushings around the clamping screws prevent the lower connection from being marred or bruised. The upper connection is bronze-bushed around the wrist-pin and the latter is five inches in diameter.

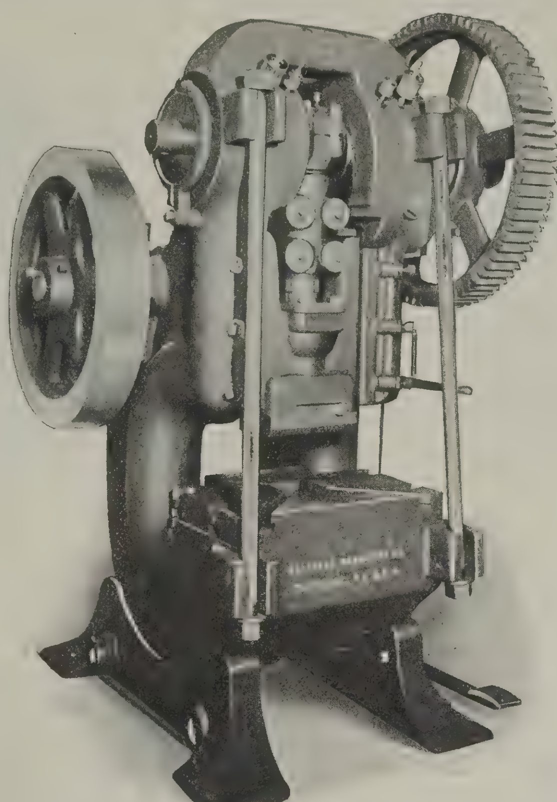


Fig. 1. Heavy Back-geared Press built by Standard Machinery Co

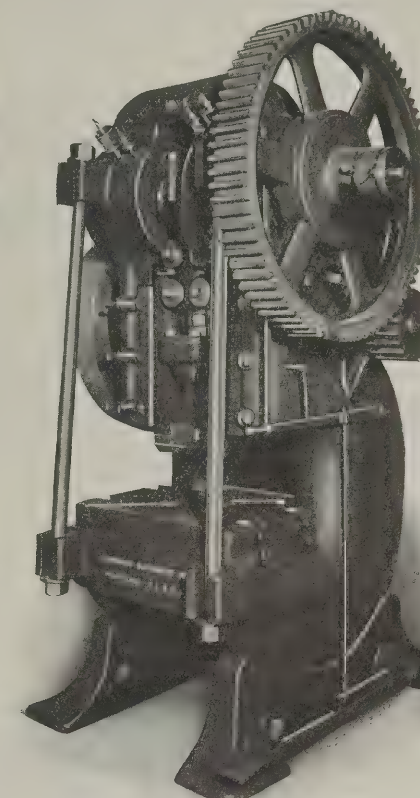
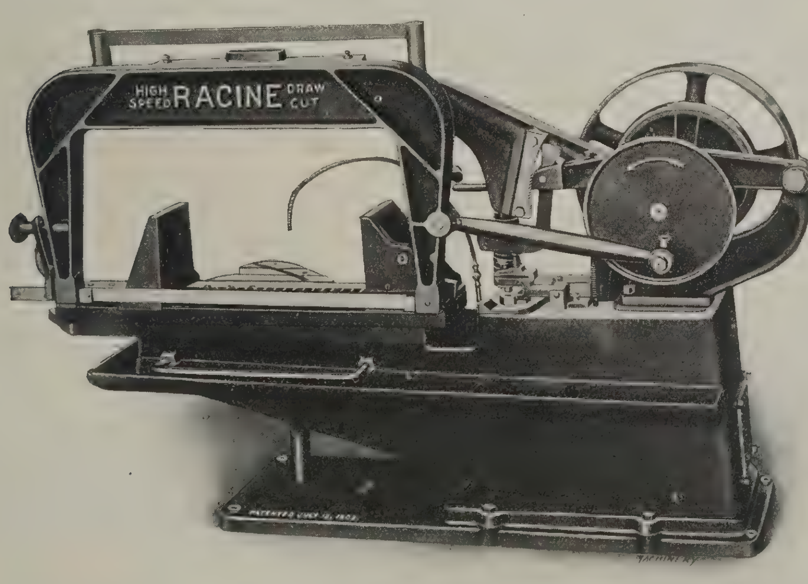


Fig. 2. Another View of Standard Press

The boxes of the main bearings can be adjusted for wear and the press is arranged, on the left side of the crankshaft, to permit the attachment of a roll or dial feed. The bolster plate is fitted with T-slots so that die-holders and dies of various sizes can be attached. The hole in the bed is generally made to specifications. The boxes for the back-gear shaft are bronze lined and have large oil grooves. The pinion is of cut steel and the driving or clutch gear is made of special "gun iron." The machines are equipped with a tight-and-loose pulley drive in addition to the balance wheel, when so specified. The main frame is liberally proportioned to endure all kinds of shocks incident to cutting and embossing operations. This particular line of presses is not only made single back-geared but double back-geared and either plain or motor driven.

The weight of the press is 13,500 pounds and the weight of the flywheel, 900 pounds. The gear ratio is 1 to 4½. The stroke of the press is 3 inches; diameter of the crankpin, 5 inches; adjustment of the slide, 6½ inches; distance from the slide to the bolster plate, with the stroke down and adjustment up, 7 inches; distance between the uprights, 16 inches; width of bed from front to back, 18 inches; width from right to left, 30½ inches; and the overall height, 8 feet 6 inches.

RACINE METAL-CUTTING MACHINE



Racine Twelve-inch Metal-cutting Machine

The Racine Tool & Machine Co., Racine Junction, Wis., has brought out a new 12-inch metal cutting machine. This machine, which is illustrated herewith, is intended for machine shops, steel warehouses, structural steel works, etc., and is designed to do rapid and accurate work. It will cut 6-inch round machinery steel in 20 minutes and 12-inch I-beams in 10 minutes. The capacity is given as 0 to 12 inches, although the machine can be furnished to take stock measuring 12 to 15 inches. The blades used can vary in length from 17 to 24 inches.

The blade is lifted clear of the work on the return stroke by means of an automatic device. This prevents the blade from dragging on the non-cutting stroke, thereby greatly increasing the life of the blade and the output of the machine. There is a quick-acting vise which swivels to an angle of 45 degrees and can be adjusted so that the entire length of the blade can be used. With a 24-inch blade, stock measuring 11 to 12 inches can be cut at an angle of 45 degrees. The blade holders are made from a 1- by ⅜-inch flat bar fitted into a

milled slot which holds the blade secure with the work. There is also a blade tightener which enables the operator to vary the tension without using a wrench. A cutting compound is supplied to the blade by a geared, circulating pump. The saw frame automatically holds itself at any height, which is very convenient when placing stock in the machine. When the machine is cutting to its full capacity, only about ¾ horsepower is required for driving.

CINCINNATI FRICTION-DRIVEN SWIVEL-HEAD LATHE

The latest development of the Cincinnati Precision Lathe Co., Fosdick Bldg., Cincinnati, Ohio, is a bench lathe equipped with a swivel-head which can be located at any angle with relation to the ways of the bed. This machine, a general view of which is shown in Fig. 1, has a friction drive similar to the one employed on this company's precision bench lathe which was illustrated in the department of New Machinery and Tools for May, 1912. The swivel-head has angular graduations on the base for setting it in any required position, and it is securely held by an eccentric bolt at the left end and a hardened bolt at the front or right end. The position of the head is accurately maintained by a hardened and ground circular ring inserted in the upper base and fitting closely in a circular slot in a plate that is bolted to the lathe bed. This swivel-head, in conjunction with a combination external and internal toolpost grinder and a double swivel slide-rest, makes the machine a universal precision grinder and lathe.

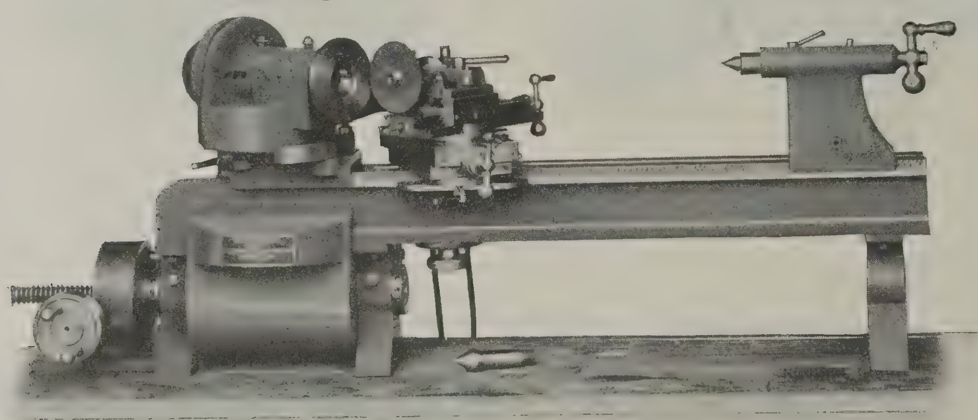


Fig. 1. Swivel-head Lathe arranged for Face Grinding

Fig. 1 shows the position of the headstock and slide-rest for face grinding. The head is set at an angle of 30 degrees, and each swivel rest is also set to the 30-degree position, thus giving a total angle of 90 degrees. Fig. 2 shows the machine arranged for angular grinding, the operation in this case being that of truing the lathe center. Fig. 3 is a rear view of a lathe equipped with a standard head and serves to show

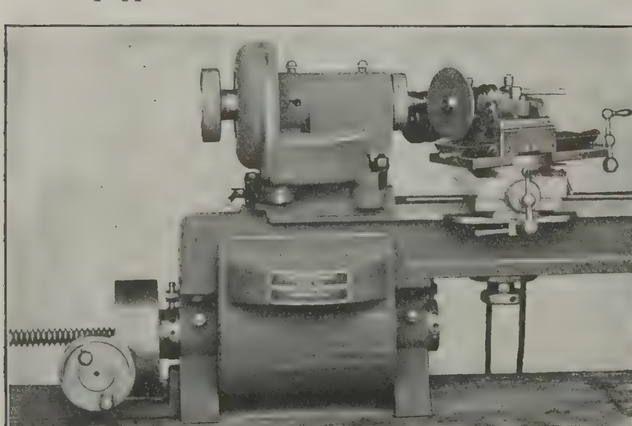


Fig. 2. Angular Grinding on Swivel-head Lathe

the clutch lever (which is also applied to the swivel-head type) for controlling the starting and stopping of the spindle. The friction driving wheel (which is also clearly shown in this view) is first located on the horizontal driven disk for the required speed, as shown by a speed indicator on the outer edge of the hand adjusting wheel. The main spindle can then be engaged instantly for operating at this speed, by a downward pressure on the clutch lever previously referred to, whereas an upward movement of this lever disengages the

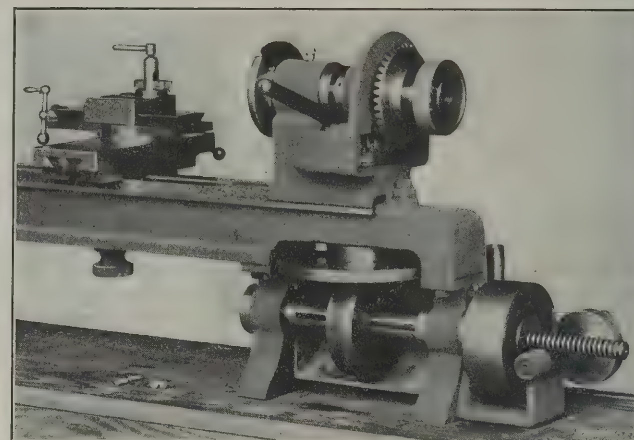


Fig. 3. Rear View of Lathe having Standard Head

spindle. The application of this device makes a countershaft unnecessary for operating the lathe. For the operation of a grinder, a combination countershaft for the lathe and grinder is employed.

The construction of the spindle control clutch is shown by the sectional view, Fig. 4. There is a hardened taper member *A* which, when raised by lever *B*, forces four hardened pins outward against a split ring *C*, thus bringing the latter into engagement with the miter gear *D*. As soon as this engagement takes place, all the working parts of the clutch are revolved with the gear and vertical driving spindle in the center. This engagement is effected with a very slight pressure on the hand lever and the weight of the lever is balanced by a small spring as shown, which causes the inner or forked end to "float" in the circular lifting slot, thus eliminating friction and wear.

The split ring *C* is slightly under size in its released position so that there is no friction at this point when the clutch

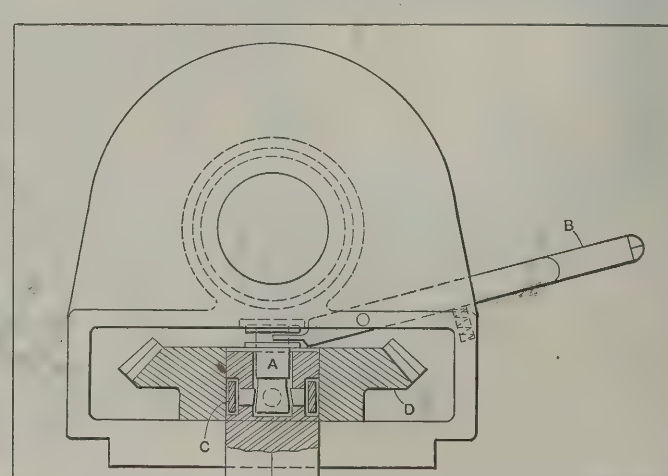


Fig. 4. Clutch for Starting and Stopping Lathe Spindle

is disengaged. The entire clutch mechanism is constantly lubricated and the application of the clutch is uniform and powerful. Moreover, the gear is engaged in such a way that its alignment is retained. The clutch handle is located conveniently for the left hand of the operator, so that the ma-

chine can be stopped and started easily and quickly. Provision has also been made for starting and stopping, independently of the driving belt, by placing the friction driving disk into a slight depression in the center of the horizontal driven disk. When the driving disk is in this position, the entire machine is stationary, excepting the driving friction shaft which, in this case, acts as a self-contained countershaft.

This friction drive eliminates a cone pulley and permits spindle bearings that are practically continuous. The direction of rotation is easily reversed, and wear between the friction members is taken up by means of eccentric bushings which enable the driving shaft to be raised or lowered parallel with the face of the driven disk. The location of the belt pulley makes it possible to apply power from beneath the bench, as well as from the side or overhead. The grinder can also be driven from beneath the bench, if desired. This lathe has a swing of 8 inches; a 32-inch bed; and a maximum distance of 15 inches between the centers. With the constant-speed driving pulley revolving at 1000 revolutions per minute, speeds ranging from 850 to 2500 revolutions per minute are available.

AJAX RECLAIMING ROLLS

The reclaiming rolls illustrated in Fig. 1 were designed for re-rolling scrap iron and steel, in order to reclaim the large amount of material which is thrown on the scrap pile and sold at scrap prices. The waste represented by the scrap heap is a very important item on railroads, but by means of these rolls, all discarded parts, such as truss rods, arch bars, draw-bars, center pins, etc., can be reclaimed by heating and re-rolling them into round or flat stock from which bolts, car fittings or similar parts can be made. These reclaiming rolls are built by the Ajax Mfg. Co., Cleveland, Ohio.

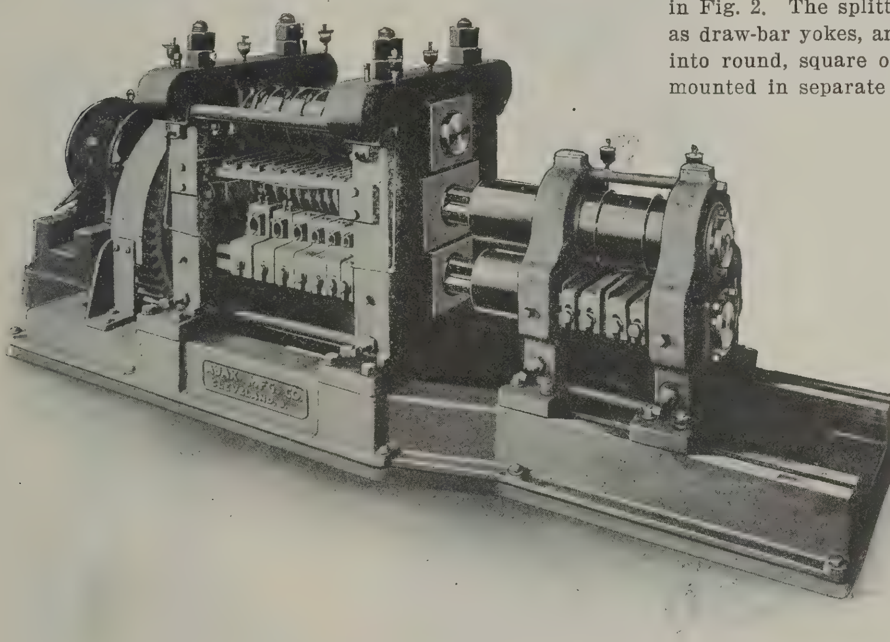


Fig. 1. Ajax Reclaiming Rolls for Re-rolling Round, Square or Flat Bars from Scrap Iron or Steel

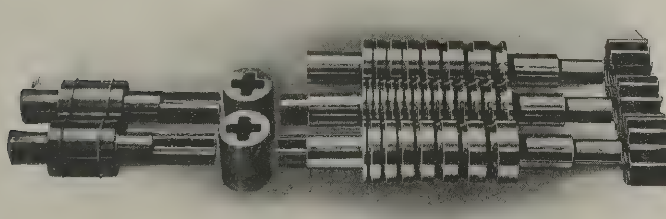


Fig. 2. The Three Reducing Rolls and the Splitting Rolls for Splitting Flat Stock Longitudinally preparatory to Re-rolling

The machine shown in Fig. 1 is a "three-roll-high" type and is provided with an auxiliary or secondary set of rolls for splitting flat stock longitudinally preparatory to re-rolling it in the main reducing rolls. The scrap bars are ordinarily cut into lengths varying from two to five feet. The length depends upon the section, and is decreased as the size of the bar increases. These bars are heated in suitable furnaces and are then started through the rolls. The first pass reduces the bar to an elliptical shape and it is then rolled round on the return pass. This process is repeated until the stock is reduced to the required size.

The rolls used in this machine are turned from forged steel of special analysis and are mounted in phosphor-bronze bushed bearings. A set of three main reducing rolls for rounds, and a pair of splitting rolls with the crab connection, are shown in Fig. 2. The splitting rolls shear lengthwise such flat stock as draw-bar yokes, arch bars, etc., and thus facilitate re-rolling into round, square or flat stock. These two sets of rolls are mounted in separate housings, as shown in Fig. 1. The yoke over each of the main housings insures ample strength and rigidity. The smaller housings are seated on T-slot ways so that the splitting rolls can easily be removed. The baseplate of the machine is cast in one piece. Two sets of main reducing rolls are furnished, one being for rounds and one for squares or flats, as may be specified. The solid bearings of the main rolls can be adjusted vertically by means of double wedges. The main housings have bronze adjusting pieces which are located against the sides of the bearings and provide lateral adjustment for the main rolls. These bronze pieces are slightly tapered and adjustment is effected by shifting them in or out.

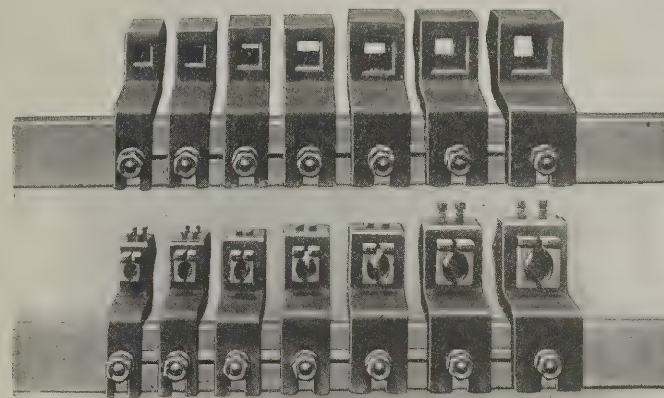


Fig. 3. The "In-and-Out" Guides for Round Stock

The main reducing rolls are 12 inches in diameter and 40 inches long between the housings and are grooved to reduce 2-inch rounds from 1¾ inch down to ½ inch, inclusive. The range of the main rolls for producing flats depends upon the nature of the scrap, although an idea of the capacity can be obtained from the foregoing figures. A steel channel or trough should be provided back of the machine for receiving the bars when they finally leave the rolls. Against the side of this channel the bars are straightened and allowed to cool.

The machine is equipped with suitable "in-and-out" guides for either round or flat stock. Fig. 3 illustrates sets of in-and-out guides for round stock. The first pass is through an "in" guide (see upper view) between the upper and middle roll, and the bar, rolled to an elliptical shape, comes out through an "out" guide. The bar is then returned through an "in" guide (see lower view) between the bottom and middle roll and comes out round. This process is repeated until the stock is reduced to size. The main rolls have a peripheral speed of approximately 300 feet per minute.

Ample heating capacity should be provided for heating the scrap stock, and two furnaces are recommended, one being a heating chamber for bars up to four feet long and the other for bars up to eight feet long. These furnaces should be

placed in front of the rolls and at right angles. The production of these rolls varies according to the nature and size of the scrap bars and the size to which the bars are re-rolled. The heating furnace equipment also affects the production so that it is difficult to give an accurate estimate. The average production, however, ranges from six to eight tons in ten hours, and the fuel cost averages about $6.00. The operating crew consists of from four to five men, including a roller and assistant roller, a heater, a helper and a man to carry the re-rolled bars to the cooling and straightening tables. The power required to operate the rolls, when driving by belt from a lineshaft, will range from 20 to 40 horsepower, whereas if a direct-connected motor drive is employed a 50-horsepower motor is recommended.

BEAUDRY POWER HAMMER

Beaudry & Co., Inc., 141 Milk St., Boston, Mass., have brought out a new design of power hammer. This new hammer is applicable to general forging work and it is especially adapted for plating and drawing steel, or for use in the manufacture of cutlery, edge tools, files, agricultural implements, spindle and general toolmaking or any forging operations requiring an extremely quick blow. The hammer can be operated at a high rate of speed and is designed for continuous service.

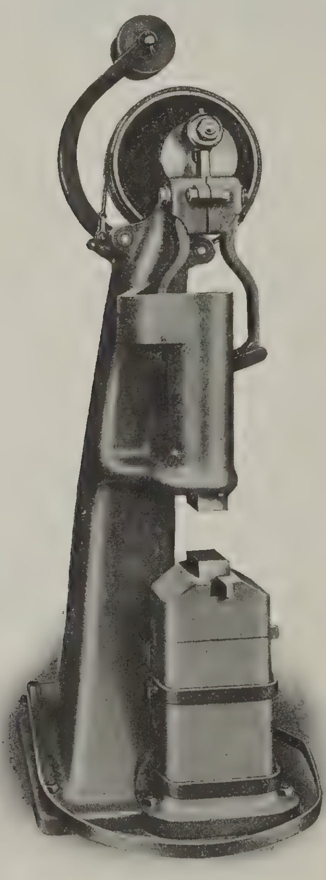


Fig. 1. Beaudry "Peerless" Power Hammer

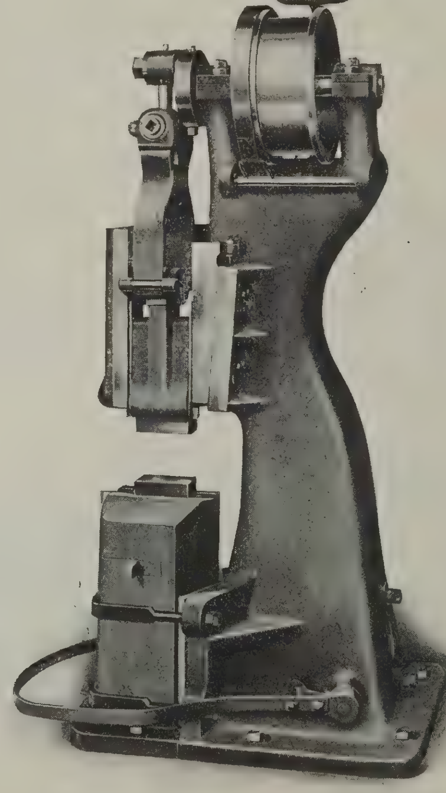


Fig. 2. Side View of Beaudry Hammer

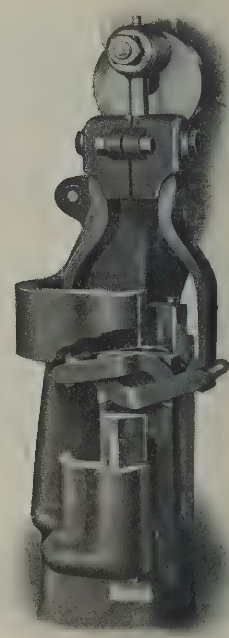


Fig. 3. Sectional View of Hammer

Front and side views of this hammer are shown in Figs. 1 and 2. The ram is connected by means of spring arms and two long steel links which are arranged to occupy a minimum space and, at the same time, give a maximum freedom and lift of the ram, as well as an elastic and cushioned but powerful blow. The tension on the spring arms and links is maintained and adjusted by means of tension nuts in a spring box. These working parts are clearly shown in the sectional view, Fig. 3.

The hammer is started, stopped and regulated by a foot-treadle extending around the base. By varying the pressure on this treadle, any desired speed or force of blow is instantly obtained. The idler pulley for the driving belt, and the brake band, are reversible so that the hammer can be run in either direction. The anvil is a separate casting and a wood filler is inserted between it and the frame to eliminate vibration. The anvil is secured to the frame by strap bolts and, as shown in Fig. 1, it is offset so as to clear the main frame casting, thus allowing long bars to be held on the dies in any position. The anvil has an independent and adjustable shoe die.

The frame is cast in one piece, is very rigid and occupies little floor space. The ram is of steel and is carefully fitted into heavy V-shaped guides. It is adjustable on the connecting-rod for varying the height above the dies and is at all times almost entirely contained within the guides, thereby insuring accurate alignment of the dies and a true, square blow. The ram guides are cast solid with the frame and to one of them is fitted an adjustable, composition, taper gib for taking up wear. The steel crankshaft is of large diameter, has long bearings and runs in babbitted bushings chambered for oil. The crankpin is adjustable for varying the length of the stroke.

The steel connecting-rod operates on a hard, bronze sleeve and is connected with the spring box. The latter is also of steel and into it are fitted the two spring arms to which the links are hooked. These spring arms are held in place by tension nuts, which, as previously mentioned, serve to maintain and vary the tension on the arms. The spring arms are forged from Swedish steel and are carefully tempered. The links are steel castings.

The brake (which is clearly shown in Fig. 2) will hold the hammer in any position. The treadle working in conjunction with the belt-tightening pulley and band brake, serves to instantly stop or start the hammer. The belt pulley is large and has a wide face, thus giving the driving belt ample contact area. This new hammer is made in seven different sizes. The ram of the smallest size weighs 25 pounds, and the largest size, 200 pounds; whereas the approximate weights of the smallest and largest hammers are 1200 and 4400 pounds, respectively.

WAHLSTROM AUTOMATIC DRILL CHUCK

Where a drilling job requires the use of a number of different sized drills, a lot of time is lost in changing from one size to another. The Wahlstrom automatic drill chuck, made by the Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y., and illustrated in Figs. 1 and 2, has been designed to avoid this waste of time. Reference to Fig. 2 will show that this chuck consists of a body D surrounded by a shell E. This shell is knurled on the outside and when it is desired to change drills, it is merely necessary to grasp the shell and

hold it against the drive of the drill press. This opens the jaws so that one drill can be removed and another inserted in its place. When the change has been made, the shell is released and the new drill is in position ready for use.

The drill is secured in the chuck by means of three rockers *A* which are pivoted in jaws *B;* the latter are carried in the body of the chuck. When the shell is held back in order to open the chuck, it is twisted against the tension of spring *F*, a suitable stop being provided between the body of the chuck and the shell in order to stop the chuck when it has been opened to its maximum capacity. When a drill is inserted and the shell released, the tension of the spring *F* twists the shell around in relation to the chuck body. In so doing, the jaws *B* are forced in toward a common center through their bearing on three eccentric surfaces on the inner side of the shell. This brings the rockers *A* against the shank of the drill and holds it in position ready for use. When the drill is fed up to the work, the rockers *A* swing on their pivots and the eccentric faces of these rockers are forced in against the shank, the gripping being in direct proportion to the force which is required to drive the drill.

Fig. 1. The Wahlstrom Automatic Drill Chuck

In the design of any drill chuck acting upon this principle, it is necessary that the eccentricity shall be very small in order to secure the required grip. This has been the reason for the limited range of previous types of chucks which have been designed along these lines. In the present case, the provision of the jaw extensions *C* have made it possible to greatly increase the capacity. Reference to the two end views shown in Fig. 2 will make it clear that when the jaws are reduced for the smaller sizes of drills, the jaw extensions *C* are located between the jaws and the eccentric surfaces of the shell. This is the case until the jaws have been opened to about one-half of their capacity. In this position the jaw extensions come up against the shoulders in the shell as shown, and the jaws then come into direct contact with the eccentric surfaces of the shell. They are in this position until the chuck has been opened to its full capacity.

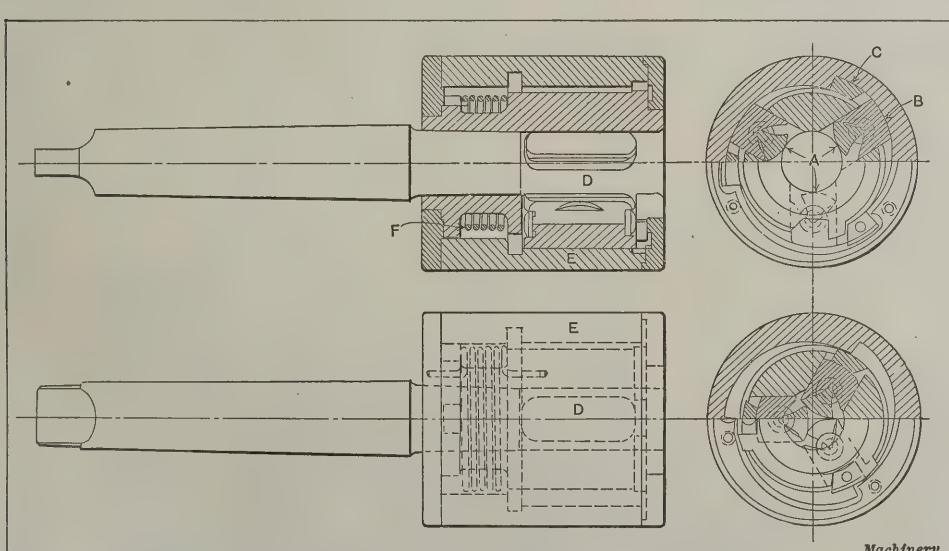


Fig. 2. Cross-sectional View showing Arrangement of Gripping Mechanism

This chuck is suitable for all kinds of drilling, reaming, tapping and counterboring operations where straight shank tools are used. In the case of tapping, it is necessary to grind three flat surfaces on the shank of the tap to provide the necessary drive for backing out the tool. The range of the chuck shown in the illustrations is from a ¾ inch drill down to a No. 33 drill. The chuck will also be placed upon the market in a larger and smaller size. It is constructed entirely of high carbon tool steel with the exception of the jaws *B* and rockers *C;* these are made of high-speed steel. The ¾ inch chuck is commonly made with a No. 3 Morse taper shank, but any other taper can be furnished.

THE WAHLSTROM OIL CUP

Difficulty is sometimes experienced with small oil cups from two causes: first, the cups are difficult to install in cramped positions; and second, the covers in use render it difficult to fill the cups without spilling considerable oil.

The Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y., has recently placed a cup upon the market designed to eliminate these difficulties. Instead of applying a hexagon at the base, which requires the use of a wrench to screw the cup into place, the Wahlstrom oil cup has been provided with a slot *A* as shown in Fig. 1. This makes it possible to use an ordinary screw-driver when installing the cup. This is generally a more convenient method and it has a further advantage of not marring the outside of the cup. The type of cover used is pivoted at *D*. This enables the cover to be lifted as shown in Fig. 2, thus providing plenty of room for adding fresh oil or for the admission of a screw-driver when installing. The provision of this pivoted cover also makes it easy to use a wire to clean out the oil channels, should they become clogged.

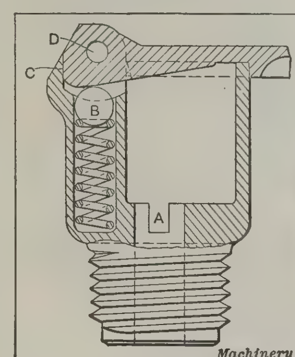


Fig. 1. Cross-sectional View of the Oil Cup

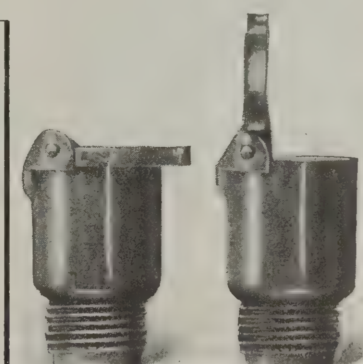


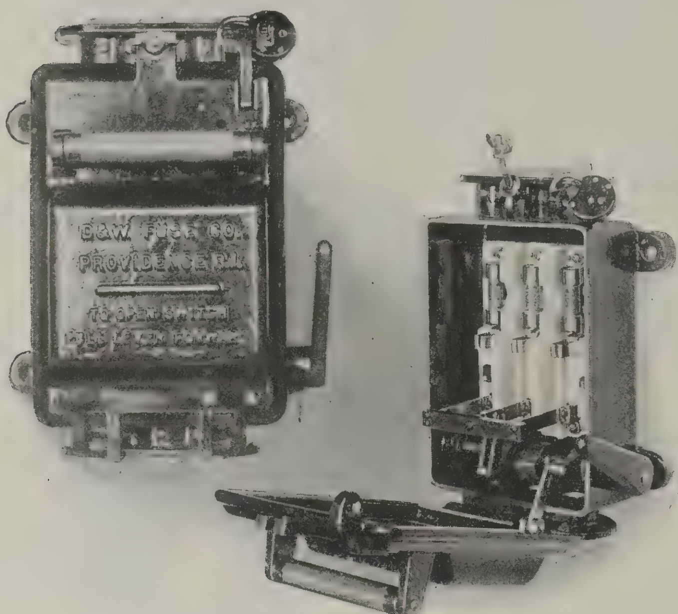
Fig. 2. Oil Cup with Cover Closed and Open

Reference to Fig. 1 will show that there is a spring and ball *B* located in a hole at the left-hand side of the cup. This spring serves the double purpose of holding the cover down when the cup is supposed to be shut, and also of holding it up when the cover is lifted to add fresh oil. In the latter position, the ball *B* is in contact with the surface *C*. The use of this spring does away with the necessity of holding the cover up with one hand while oiling. Where cups are located in close places, this cover design is particularly useful in that it allows the spout of the oil can to be used to lift it. The cup is also made practically dust-proof by the liberally proportioned flange on the cover, which comes down over the top of the cup as shown in the cross-sectional view. These cups are made in seven regular commercial sizes with diameters ranging from ¼ inch to ½ inch.

COMBINED SWITCH AND FUSE BOX

The D. & W. Fuse Co., Providence, R. I., has brought out a new line of fused switch boxes for 250-volt, direct-current circuits. These boxes are particularly adapted for mill service

since they can be locked after the fuses are installed, thereby preventing any tampering with the connections or increasing the capacity of the fuses. They can also be used as a switch, as the circuit can be opened or closed at will, by simply moving the lever located at the side of the box, as shown in the accompanying views. When the cover is opened, as illustrated to the right, the circuit is also opened which makes it impos-



D. & W. Combined Switch and Fuse Box with Safety Lock

sible to re-fuse the circuit when the switch is closed. The construction of these boxes is simple but substantial, and they will last indefinitely. They are provided with rubber gaskets which make them waterproof, provided the terminal wires are "taped in" at the bushings or protected by outlet hoods when conduit connections are made. To facilitate installing these boxes, removable porcelain bushings are used, through which the cable terminals can be readily passed.

THE HALE LOOSE PULLEY

The Cleveland Clutch Co., Cleveland, Ohio, is manufacturing a loose pulley that is quite different from the usual form. The pulley proper has a large hub which fits over a bearing sleeve that is locked to the shaft by a set-screw. When placing the pulley on a shaft, the bearing sleeve is first fastened in position. The pulley is then slipped over the sleeve and the side retaining cover or plate is screwed on. Fig. 1 shows the pulley assembled, and Fig. 2 illustrates the different parts,

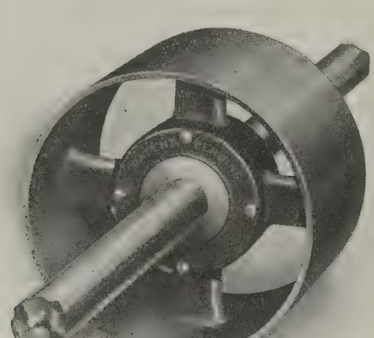


Fig. 1. Hale Loose Pulley

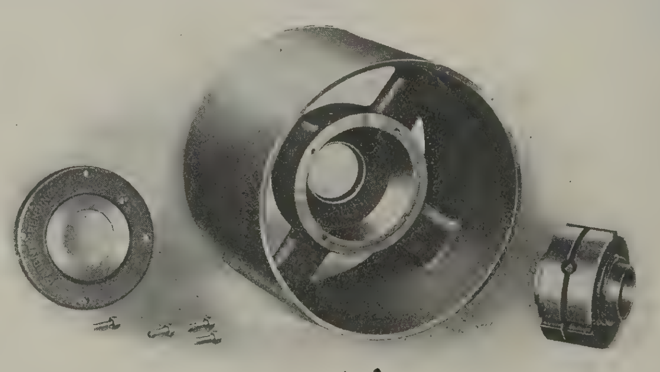


Fig. 2. Parts of the Hale Loose Pulley

the retaining cover being to the left and the bearing sleeve to the right.

One of the noteworthy features of this pulley is the efficient method of oiling the bearing surfaces. The oil is not wasted and the lubricant always remains on the bearing, regardless of whether the pulley is idle or revolving at high speed. The particular pulley illustrated is a 12-inch size and has an 8½-inch face, and the friction surface has the same area as that of an ordinary loose pulley of the same dimensions. The principal features claimed for this pulley are, that it is self-oiling; durable; dust- and dirtproof; oil-tight; economical in the use of lubricant; prevents oil from being thrown on the belt; eliminates wear of the shaft; keeps the lubricant constantly on the bearing; is easily mounted on a damaged shaft; and, when once oiled, requires no attention for months.

ELECTRIC PRECISION GRINDER

The portable, electric, precision grinder shown in Figs. 1 and 2, is the product of the Chicago Pneumatic Tool Co., 1014 Fisher Bldg., Chicago, Ill. This electric grinder is known as the "Duntley No. 6," and is adapted to a large variety of work, being designed for both external and internal grinding. A commendable feature is the adjustable frame, which is milled convex on its lower surface, and rests on a concave shoe, as shown in Fig. 1. When the grinder is applied to a

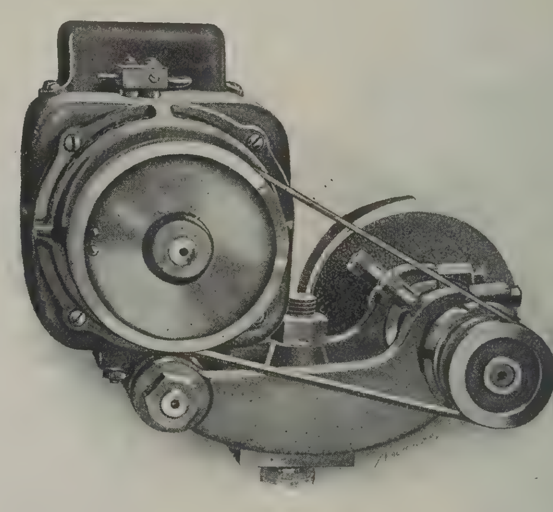


Fig. 1. Chicago Pneumatic Tool Co.'s Electric Grinder

lathe, this concave shoe rests on the tool-post base and is clamped to it by the bolt and nut shown. The center of the grinding wheel arbor is brought in line with the center of the work, by simply pushing the frame back or forth on the concave shoe and then tightening the clamping bolt when the grinder is set in the desired position. This adjustment makes it possible to use this grinder on lathes having a swing of from 16 to 42 inches, inclusive.

The arbor for external grinding carries a 5-inch wheel (see Fig. 1) and is provided with a split-sleeve bearing, which is tapered on the outside, and can be accurately adjusted for wear. The heads of the cap-screws for fastening the straps which hold the arbor sleeve to the frame, extend only a slight amount beyond the arbor housing itself. This is an important feature, as it permits the emery wheel to be worn down to a small diameter, and allows sufficient clearance between the grinder and the tailstock of the lathe—this is a requirement not found in most grinders of the tool-post type.

The arbor for the internal grinder (see Fig. 2) runs in

Hess-Bright ball bearings, which are located at the ends of the arbor and provide a support close to the wheel and driving pulley. The arbors for external and internal grinding can be

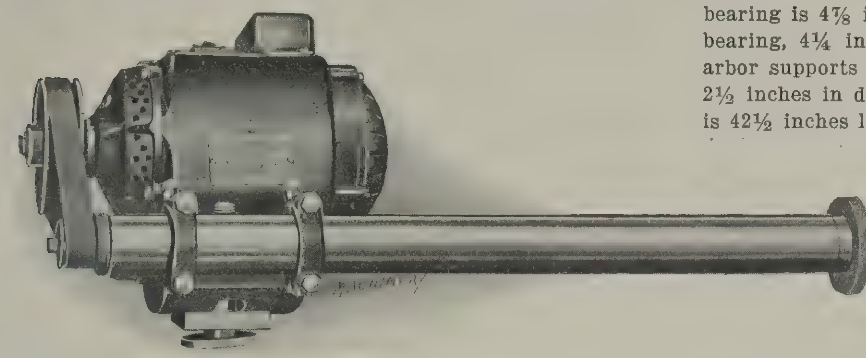


Fig. 2. Grinder illustrated in Fig. 1 arranged for Internal Grinding

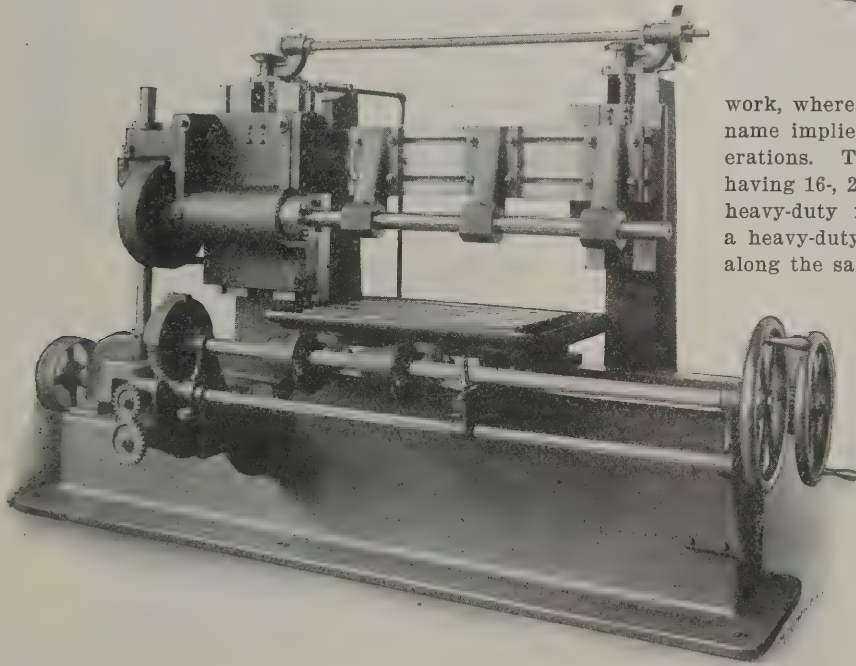
changed in a few minutes by simply removing the cap-screws of the straps which hold the arbor sleeve to the frame.

The motor is mounted on a hinge-pin, permitting it to be swung back to tighten the belt. Pulleys of the desired size to give the proper wheel speeds are furnished, and the motors can be obtained in a variety of types for either direct current or alternating current of the single, two, or three-phase systems.

SPECIAL BEAMAN & SMITH MILLING MACHINE

The milling machine shown herewith has been designed by the Beaman & Smith Co., Providence, R. I., for milling the ends of crankshaft bearings on crankcases. It has a horizontal bed upon which is mounted a work-table that can be traversed laterally on its saddle and longitudinally along the ways of the bed. Two uprights are attached to the bed which support the spindle-saddle and cross-rail. The cross-rail is attached directly to the spindle-saddle and it can be raised or lowered by hand. The horizontal shaft connecting the vertical adjusting screws, carries at the right-hand end a dial graduated to thousandths of an inch to facilitate setting the cutters accurately to depth.

The spindle is driven by a single pulley seen at the left of the machine from which power is transmitted to the spindle through shafting and gearing. The table has a hand movement of 32 inches in line with the spindle, and a cross-move-



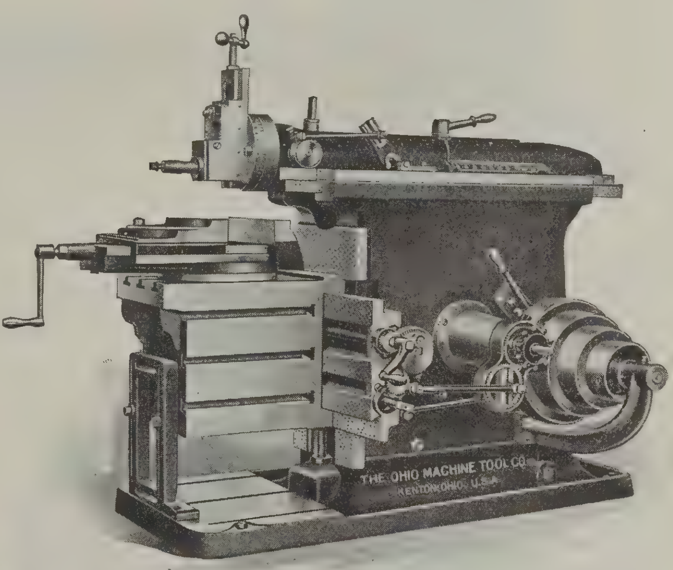
Special Machine for Milling End of Crankshaft Bearings on Crankcases

ment of $11\frac{1}{2}$ inches. There are positive geared feeds for the cross-movement and five changes are available, ranging from $1\frac{1}{2}$ to $6\frac{1}{2}$ inches per minute.

The table has a working surface 18 inches wide and 32 inches long, and it is surrounded by a large oil channel. The spindle is of crucible steel and runs in boxes of hard bronze which can be adjusted to compensate for wear. The front bearing is $4\frac{7}{8}$ inches in diameter, 6 inches long, and the rear bearing, $4\frac{1}{4}$ inches in diameter and $5\frac{1}{2}$ inches long. Three arbor supports are provided having phosphor-bronze bearings $2\frac{1}{2}$ inches in diameter and $5\frac{3}{8}$ inches long. The arbor itself is $42\frac{1}{2}$ inches long and $1\frac{7}{8}$ inch in diameter. The machine is driven by a 4-inch belt, and the ratio of the gearing is 2.7 to 1, giving a spindle speed of 250 revolutions per minute. Lubricant for the cutters is provided by means of a pump. The distance between the uprights is 44 inches, and the minimum and maximum distances from the center of the spindle to the top of the table are, $10\frac{1}{2}$ and $16\frac{3}{4}$ inches, respectively. The weight of the machine is approximately 10,300 pounds.

OHIO STANDARD AND HEAVY-DUTY SHAPERS

The Ohio Machine Tool Co., Kenton, Ohio, has brought out two types of shapers. One is known as the "standard" shaper and is intended for ordinary tool-room and machine shop



Ohio 24-inch Heavy-duty Shaper

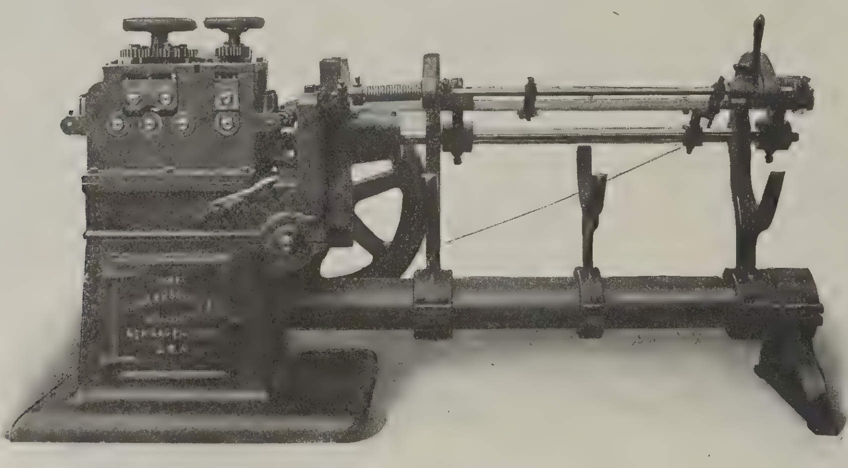
work, whereas the other is a "heavy-duty" type which, as the name implies, is designed especially for heavy machining operations. These shapers, in both styles, are built in sizes having 16-, 20- and 24-inch strokes, and there is also a 28-inch heavy-duty machine. The accompanying illustration shows a heavy-duty 24-inch size. The standard type is constructed along the same lines but is lighter in weight.

The bull gears of these shapers are of large diameter and the crank-arms are extra long and heavy, in order to transmit power to the cutting tool with a minimum of vibration. The 20- and 24-inch sizes have a variable, automatic, vertical power feed for the table. The vertical power feed for the head, which is shown applied to the machine illustrated, is a special attachment. This device feeds the tool either up or down and gives feed variations ranging from 0 to 3/16 inch. It is actuated by a tumbler movement that is positive in its operation. The standard 20-inch machine has a keyseating capacity of three inches, and the heavy-duty type, $3\frac{1}{2}$ inches; whereas the 24-inch sizes in both types have keyseating capacities of $3\frac{5}{8}$ and $4\frac{5}{8}$ inches, respectively. Motor drives are applied to any size shaper and on the 20- and 24-inch machines, the motor is attached to the back of the column. By having these two types, the manufacturers can supply a shaper adapted to the requirements of the shop in which it is installed.

SHUSTER STRIP-METAL STRAIGHTENER AND CUTTER

The accompanying illustration shows an automatic strip-metal straightener and cutter built by the F. B. Shuster Co. of New Haven, Conn. This machine is larger than similar types previously built by this company and embodies several improvements. It is designed for straightening and cutting to accurate lengths (from the coil) such metal as brass, copper, steel, iron, etc. The machine has a capacity for widths up to three inches and will take stock up to 1/8 inch thick. The particular machine illustrated will cut lengths up to four feet but it can be built for any length desired.

There are five straightening rolls and a pair of feed rolls, all of which are enclosed by the housing instead of being outside, which is the construction of the smaller sizes. All the rolls are geared and the upper ones are adjustable to suit the shape and temper of the stock passing through the machine.



Shuster Automatic Strip-metal Straightener and Cutter

This adjustment is effected by the handwheels shown on the top of the housing and can be made while the machine is in motion. There are suitable guides at the rear for taking care of various widths and thicknesses of metal.

This machine has a mechanism which stops the feeding of the material while it is being severed. When operating the machine, the metal is placed on a suitable reel at the rear, from which it passes through guides into the straightening and feed rolls. Continuing, it moves past the stationary dies and cutters out into the guide-bar until it strikes a gage previously set for the length to be cut. This throws the feed-releasing mechanism into operation, thus causing the feed to stop and the cutters to come into action. At the same time, the cover of the guide-bar is thrown off and the severed piece drops into the fork-shaped brackets shown. The extension of this machine is similar to that applied to the straighteners and cutters for round, square and hexagon stocks, except that the guide-bar is designed and grooved for strip metal.

LARGE NIAGARA DOUBLE-CRANK PRESS

The large double-crank press shown in Figs. 1 and 2 was recently designed and built by the Niagara Machine & Tool Works, Buffalo, N. Y. This press is adapted for a wide range of work, such as heavy blanking, shearing, forming, embossing, and cold-drawing operations. It is equipped with the Niagara combination friction clutch and brake. The friction clutch is of the multiple-disk type and the friction surfaces are lined with end-grain, hardwood blocks. The clutch is entirely encased and all projecting rotating parts which might endanger the operator when oiling the clutch, are eliminated. The clutch is operated by four sets of toggles and links which are made of steel.

The brake, which works in unison with the clutch, consists of two brake levers which are actuated by a pair of toggles. An interesting feature of the construction is that the pressure on the brake blocks is always equalized, thus avoiding transmitting the pressure of the brake arms to the shaft bearings. The clutch can be started by a foot treadle actuating an automatic device which will stop the press when the slide reaches the highest position. This self-acting device can be quickly thrown out of action and the motion of the press controlled by a hand lever. This lever permits starting and stopping the machine at any part of the stroke.

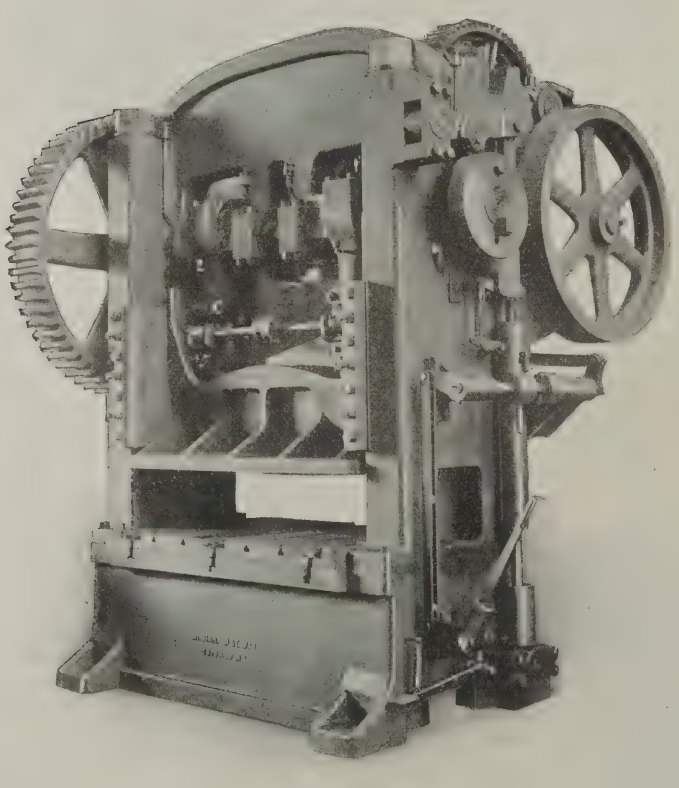


Fig. 1. Niagara Double-crank Press

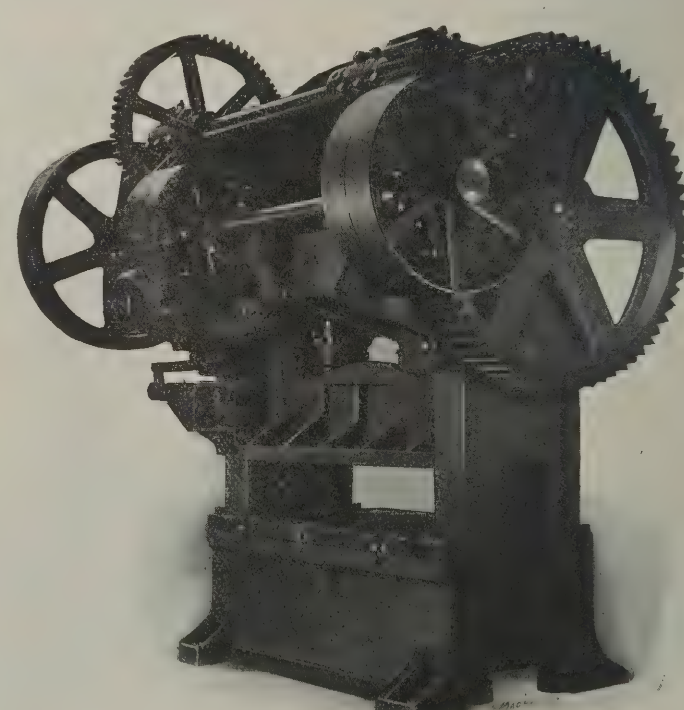


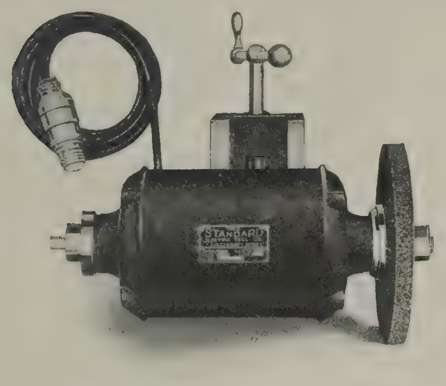
Fig. 2. Rear View of Niagara Press

To guard against breakage, in case the press is accidentally overloaded, there is a safety coupling on the pinion shaft. The housings and arch are held together by four steel tie-rods, 5½ inches in diameter, which are shrunk into place. The slide and gibs have the same means of adjustment common to

all large presses built by this company. The press measures 72 inches between the housings and weighs 60,000 pounds. It covers a minimum amount of floor space, as the drive is located overhead and outboard bearings are eliminated.

PORTABLE ELECTRIC GRINDER

The portable electric grinder shown herewith is made by the Standard Electric Tool Co., Cincinnati, Ohio. This grinder is mounted on an angle-plate and is attached to a lathe by bolting this plate to the toolpost rest. A shank can be furnished instead of the angle-plate attachment, if desired. There is a vertical dovetail slide on the angle-plate which gives an adjustment of four inches for locating the grinding wheel in line with the lathe centers. This grinder can be used for grinding rolls, shafts, bushings, and similar work. It is also adapted for surface grinding on the planer and can be used to advantage on the boring mill for certain classes of work. The bearings are made of phosphor-bronze and are dust-proof and adjustable. The motor is force-ventilated or air-cooled by a special fan mounted on the armature shaft. The armature and poles are built up of the best grade of soft, electrical, sheet-steel laminations, uniformly insulated. This grinder is made in one-half and one horsepower sizes.



Standard Portable Electric Grinder

BAKER BROS. HIGH-SPEED DRILLING MACHINE

Baker Bros., Toledo, Ohio, have added to their line of drilling machines the powerful high-speed, heavy-duty type shown in Fig. 2. A glance at this illustration will give one a better idea of the massiveness and rigidity of the construction than a whole page of description. The machine has a heavy box column and also a box-type, screw-elevating table. It has a single belt drive and the driving train is composed of all hardened steel gears. The shafts are large and are mounted in Hess-Bright ball bearings. A minimum number of gears consistent with the necessary speed changes are in mesh at one time. On the four direct speeds, only three pairs of gears are meshed simultaneously, and there are never more than five pairs engaged at one time.

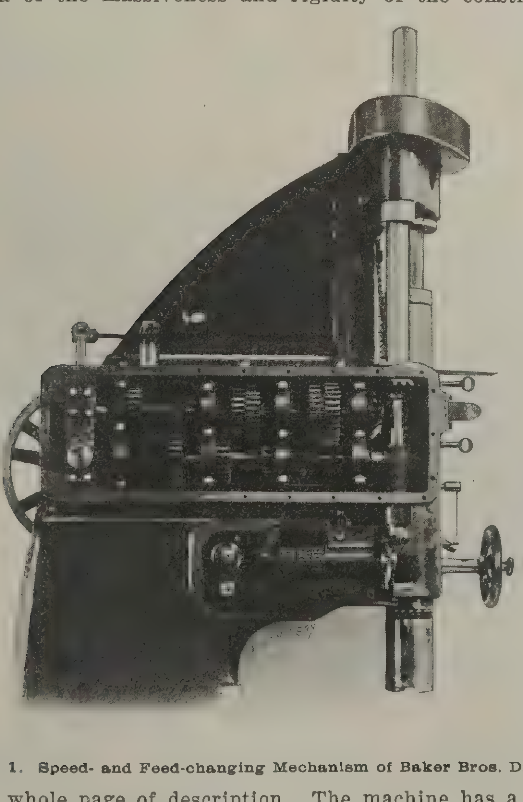


Fig. 1. Speed- and Feed-changing Mechanism of Baker Bros. Drill

There are twelve changes of feed ranging from 0.006 to 0.032 inch per revolution of the spindle. In addition, the feeding mechanism has an attachment which enables any one of the drilling feeds to be increased 3½ times, when the machine is to be used for reaming. All of the control levers are centralized and in convenient positions.

There are eight speed changes controlled by two interlocking levers in such a manner that all of the speed changes can be successively engaged; that is, the machine can be run on each of the eight speeds, beginning at the slowest and increasing to the highest, in eight seconds. A detail view of the machine is shown in Fig. 1 with the gear-case cover removed in order to show the arrangement of the speed- and feed-changing mechanisms. The spindle speeds range from 35 to 351 revolutions per minute and the changes are effected by sliding gears controlled by a lever at the front. There are no dive keys or tumbler gears in the driving train, and the entire mechanism is enclosed in an oil-tight case.

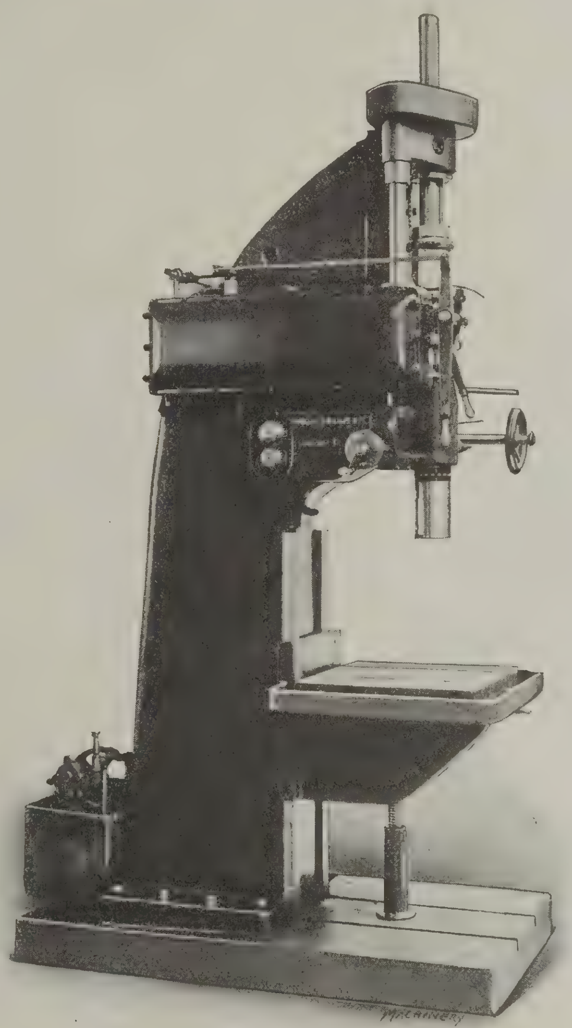


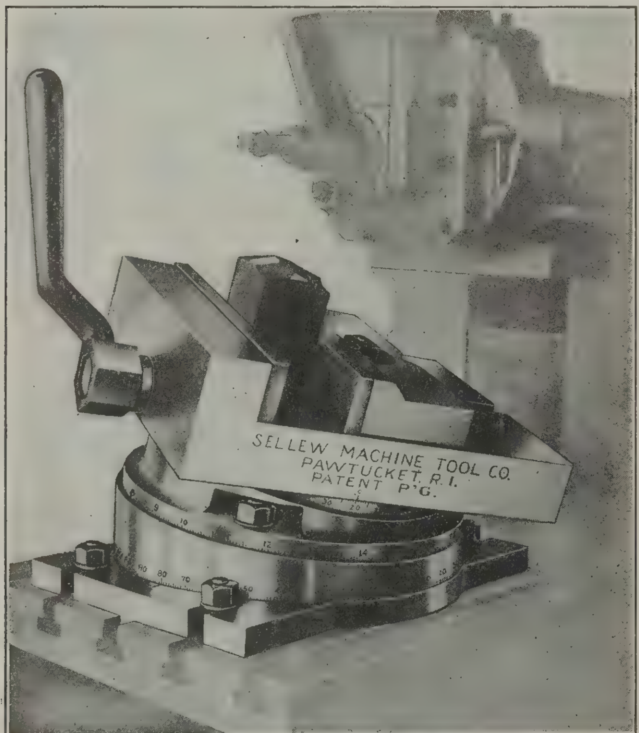
Fig. 2. Baker Bros. Heavy-duty Drilling Machine

The spindle has a vertical feeding movement of 20 inches and is equipped with a depth stop. All feed changes are obtained by means of a powerful dive key and quick-change slip gears. A safety device on the spindle feed shaft is provided to protect the feeding mechanism from injury and to provide uniform wear for the large worm-gear. The spindle has the usual hand lever feed and a quick-return movement. This machine has a capacity for driving 3-inch, high-speed steel drills in solid steel. The spindle is made from high-carbon, hammered, spindle steel forgings and has a minimum diameter of 3 inches and a maximum diameter of 4¾ inches. The thrust is taken on high-duty bearings having ¾-inch balls. The end of the spindle is bored for a No. 5 or No. 6 Morse taper.

The table has a working surface of 20 by 30 inches and a vertical travel of 30 inches. The maximum distance from the end of the spindle to the top of the table is 46 inches. The swing of the machine is 36 inches, that is, 18 inches from the center of the spindle to the column. The drive is by a 3½-inch belt running on an 18-inch pulley. An oil pump, tank and the necessary piping is provided in the equipment. The weight of the complete machine is about 4750 pounds. A compound table of the box knee type can be furnished if desired. The lateral and longitudinal screw adjustments of this type of table enable the work to be positioned quickly and accurately, the handles being so located that the operator can move both simultaneously. Micrometer dials are provided on the screws for accurate adjustment.

UNIVERSAL VISE FOR MACHINE TOOLS

The Sellew Machine Tool Co., of Pawtucket, R. I., is manufacturing a vise for use on shapers, planers, drilling machines, etc. This vise can be set in any plane within the range of its angular adjustment. It is exceptionally low and provides a rigid unyielding support for the work. The vise proper is mounted on two tapering or oblique disks, and by changing the relative positions of these disks, the angular adjustment is obtained. When the thin side of the upper disk is directly above the widest or highest part of the base, the vise is in a horizontal position. By turning the upper disk, any angle



Universal Vise applied to a Shaper

within the maximum represented by the combined angles of both disks, can be obtained. The entire vise can be adjusted about a vertical axis for machining compound angles in connection with tool and die work, and the vise proper can also be turned about an axis perpendicular to the top of the upper disk.

The two oblique disks are graduated on the peripheries so that direct readings can be obtained for the angular adjustments, and radial readings for the adjustment about a vertical axis. Graduations are also provided just under the vise itself to permit adjusting the latter a definite amount regardless of the position of the base. The use of oblique disks for obtaining the angular adjustment makes the vise simple in construction and unusually low. The vise also has a solid metal support direct from the base which makes it rigid, and is conducive to accurate work. It has hardened and ground jaws and is made, at present, in 10- and 12-inch sizes. The 10-inch size has a capacity of 6½ inches, and the 12-inch, a capacity of 9 inches. The weights of the two sizes are 185 and 225 pounds, respectively. One of these vises is shown applied to a shaper in the accompanying illustration.

SHOP AND DRAFTING-ROOM LAMP ATTACHMENTS

A simple form of adjuster for regulating the height of the drop light, is shown in Fig. 1. This fitting can be attached to any flexible cord and it enables the light to be raised or lowered and automatically held at any desired height. This adjuster is made entirely of porcelain and is without springs, latches or winding drums. It operates on the double-pulley tackle principle, there being removable and stationary pulley blocks. The upper stationary member is a disk-shaped block, whereas the lower member is a ball-shaped counterbalancing device. The upper block is held by supporting chains, thereby relieving the rosette and intervening cord of all strain. Any lamp and shade not weighing over two pounds can be balanced by placing the proper number of removable lead weights inside the counterbalancing member.

Fig. 1. Adjuster for Drop Lights

This adjuster can be quickly attached to a flexible cord, either before or after the light is in place. The lamp cord from the rosette is clamped in the upper block and continues downward around the sheave of the pulley member, up over the sheave of the upper block and then through a central channel in the counterbalancing ball. Each adjuster is provided with enough removable weights to balance a lamp and shade weighing one pound. The all-porcelain construction insures good insulation and the well proportioned cord channels and sheave surfaces reduce the friction and abrasive action. This adjuster can be applied to any twisted or solid flexible cord.

Another attachment for the electric lamp is shown in Fig. 2. This is simply a clip having a forked end engaging the neck of the socket, and a hook at the other end for catching

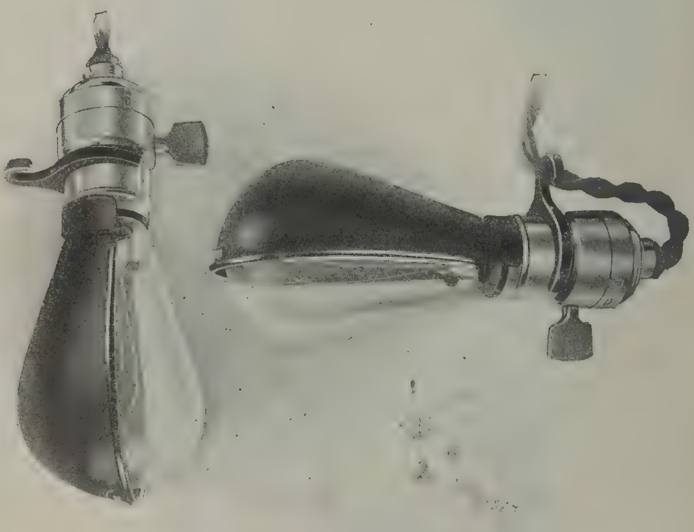


Fig. 2. Clip for Holding Lamp in Horizontal Position

the lamp cord (as shown in the view to the right) when it is desired to hold the lamp in a horizontal position. With this device, a drop-light having a side reflector, can be quickly set to throw the light downward as well as sidewise. The clip is made of a resilient insulating material and it can be applied by snapping the large end over the socket shell. This clip is made to fit any standard socket. Both of these devices are manufactured by the Sachs Laboratories, Inc., 103 Allyn St., Hartford, Conn.

THE ROBERTSON NO. 1 "ECONOMY" POWER SAW

The W. Robertson Machine & Foundry Co., of Buffalo, N. Y., is now building the hacksaw machine here illustrated. The compact design of the base of this machine will be appreciated in shops where floor space is at a premium. This is a No. 1 size, having a smaller capacity than the No. 2 power saw manufactured by this company. It cuts on the draw stroke and is equipped with the regular Robertson type of mechanical lift for the idle or return stroke. There is a quick-starting clutch and an automatic stop which comes into action when the cut is completed. The farme is mounted on a finished steel bar and has a bearing of 7 by 2 inches, which is provided with means of adjustment to compensate for wear. The machine has a capacity of 4½ inches in the vise and is driven by a 15-inch pulley of 2½-inch face. It uses either 10-inch or 12-inch saw blades and has a total weight of 180 pounds.

Robertson No. 1 Power Saw

REED-PRENTICE HIGH-SPEED GEARED-HEAD LATHE

The geared-head lathe shown in Fig. 1 is the latest product of the Reed-Prentice Co., Worcester, Mass. This lathe embodies several new and important features and is designed to give a high production with a minimum of power consumption. Formerly there was considerable friction in the bearing which supported the driving pulley, due to the high tension of the driving belt necessary because of the heavy cuts incident to the use of high-speed steels.

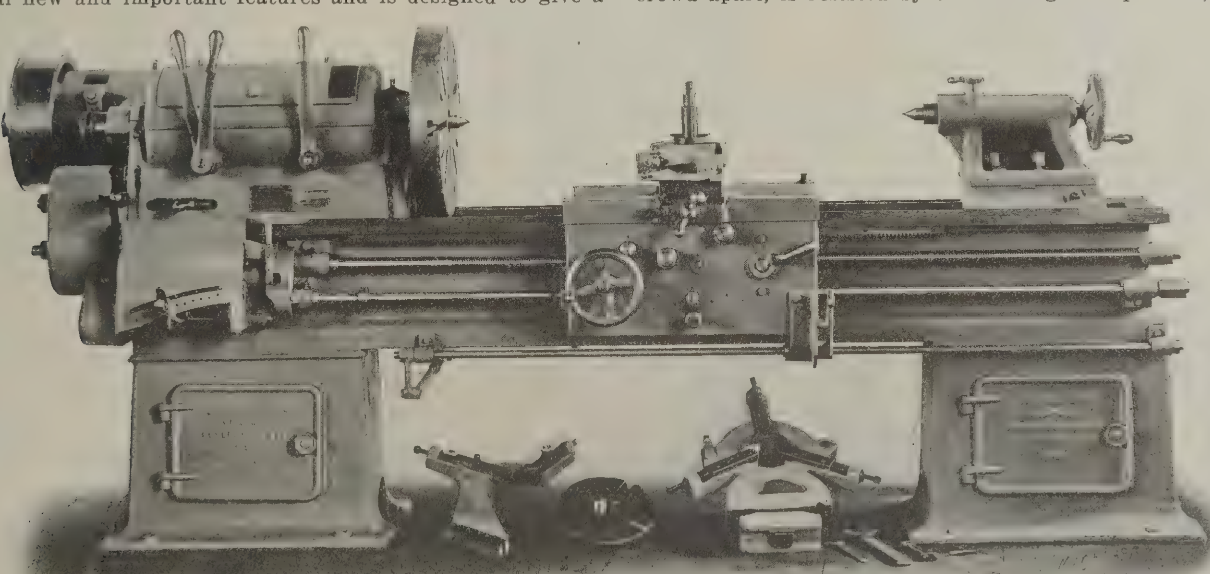


Fig. 1. Reed-Prentice 20-inch Geared-head Lathe

In the design of this new lathe, the hood *A* for the reversing mechanism (which is used principally for screw cutting purposes) and the support *B* for the pulley, are cast integral with the main head casting, as shown in Fig. 2. This gives a very rigid construction. The flanged pulley is mounted at the left end of the head, and ball bearings *C* of the "double purpose" type are used so that both radial and end-thrust loads will be provided for. The bearings are so designed that wear can be compensated for, although there is not likely to be trouble from this source. The bearings and balls are of the best alloy steel and are accurately made.

The pulley has offset or curved spokes in order to locate the rim and center of the belt, directly over the center of the supporting ball bearings. To prevent the driving belt from becoming oil-soaked and losing a large part of its pulling power, there is an annular ridge *D* on the hub of the pulley and in the center of the bearing recess, so that whether the pulley is at rest or in motion, the oil dropping into this recess will not work its way along the spokes to the face of the pulley and then onto the belt.

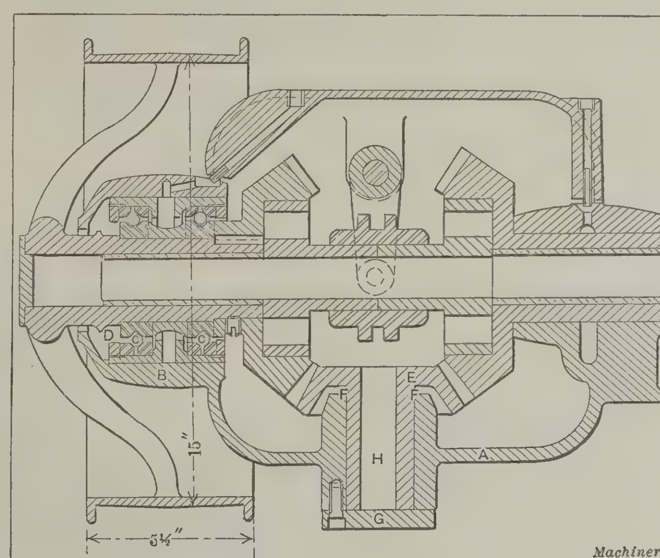


Fig. 2. Reversing Mechanism of Reed-Prentice Lathe

The method of mounting the intermediate bevel gear provides a very substantial support. When subjected to a working load, whatever tendency there may be for the bevel gears to crowd apart, is resisted by the bearing at a point *F*, close to the bevel faces and directly opposite the line of pressure. The thrust piece *G* is made oil-tight so that the hole *H* through the bevel gear can be filled with oil. This oil flows through a series of holes drilled through the hub of the gear and lubricates the bearing surface. The oil also forms a cushion be-

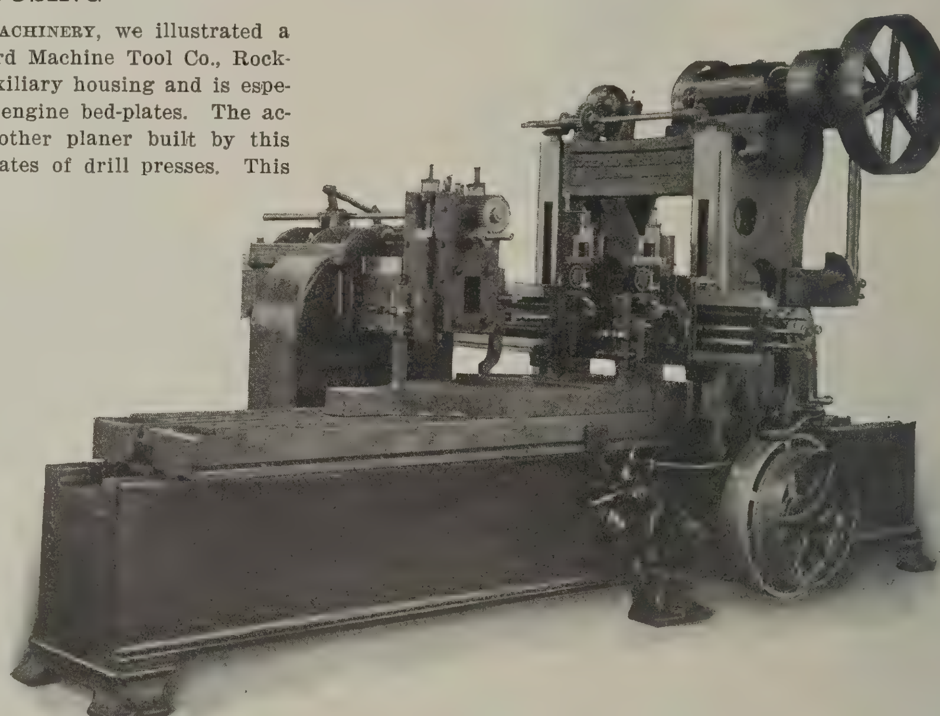
tween the walls and is said to eliminate, to a great extent, the metallic vibration between the revolving parts.

With this form of drive, any size or type of motor can readily be applied. The motor is fastened to a vertically adjusted bracket on the rear side of the leg and by means of the mechanical adjustment, the tension of the belt can be adjusted to any degree required. When equipped with a motor drive, the lathe is a complete unit having its power plant, reversing mechanism for thread cutting, and a complete range of thread and feed changes. The headstock is heavier than that of former designs and has several improvements. There is a larger hole through the spindle, larger centers and a heavier spindle nose, etc. There is also a better arrangement for overcoming the centrifugal force of the friction fingers, which has a tendency to open the friction at high speed and cause it to drag in its cup.

ROCKFORD FOUR-HEAD PLANER WITH SPECIAL HOUSING

In the September number of MACHINERY, we illustrated a special planer built by the Rockford Machine Tool Co., Rockford, Ill. This machine has an auxiliary housing and is especially designed for machining gas engine bed-plates. The accompanying illustration shows another planer built by this company for machining the baseplates of drill presses. This planer also has a special housing, although the construction differs considerably from the machine formerly described.

By referring to the illustration, it will be seen that there is a special housing carrying two tool-holders which are mounted on a ram of square construction. This ram is supported by the housing and has a lateral feeding movement, whereas the tool-slides are adjustable vertically. The power feed for the ram is obtained from a friction at the rear of the machine, which is mounted on the intermediate shaft of the planer. This friction transmits the motion to the horizontal shaft seen at the top of the housing, which connects through gearing with the horizontal feed-screw of the ram. The feeds are controlled and reversed by a trigger gear located in front of the head within easy reach of the operator. The machine is equipped with this company's standard four-speed drive giving four cutting speeds with a constant return. It is arranged for a belt drive direct from the lineshaft, eliminating the usual countershaft.

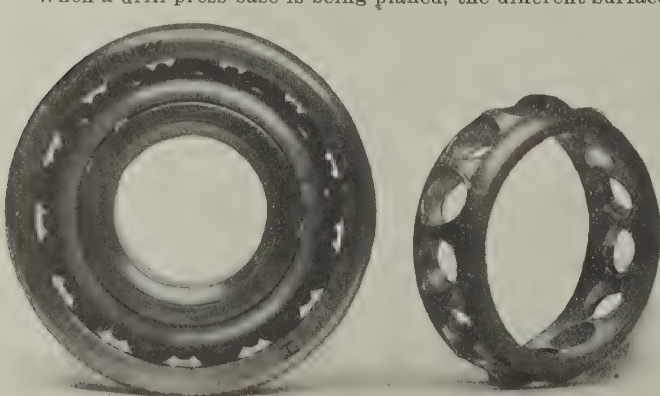


Special Planer for Machining Upright Drill-press Bases

When a drill press base is being planed, the different surfaces are machined as follows: The flat T-slotted base is planed by the two heads on the regular cross-rail. While this is being done, the rear head of the special attachment planes the top surface of the hub for supporting the drill press column, while the front head planes the pad for the outer bracket at the rear end of the base. By the use of this special attachment, three separate surfaces which vary in height are planed simultaneously. This machine is said to handle this work very satisfactorily and the castings are planed in one-half the time previously required on a similar machine without the special attachment. Of course, when an ordinary planer is used, it is necessary to plane the work at three different settings, inasmuch as the surfaces are on different planes.

GURNEY ANNULAR BALL BEARING

The Gurney Ball Bearing Co., Jamestown, N. Y., has recently placed upon the market the form of annular ball bearing herewith illustrated. The balls of this bearing are carried in a solid cast separator, which is shown beside the assembled bearing. In mounting these bearings, the inner races should have a light driving fit on the shaft, while the outer races are made a free fit in the housing. No filling slots are used and the method by which the balls are held between the races is such that the bearing is capable of carrying light thrust loads. The inner races are stamped with a number and the outer races with the corresponding number, and also the name "Gurney." The bearings are assembled in such a way that the markings on the inner and outer races are on opposite sides, and when a thrust load is to be carried the arrangement should be such that the thrust on either race comes against the stamped sides.



Gurney Ball Bearing and Alloy Retainer

NEW MACHINERY AND TOOLS NOTES

Ink Wash: W. G. Bond, P. O. Box 229, Wilmington, Del. This wash is applied by dampening the surface to be erased with a moist cloth. The ink is softened in one or two minutes and can then be wiped off. The wash is put up in one-ounce and four-ounce bottles.

Rotary Chucks: Pratt & Whitney Co., Hartford, Conn. Double and quadruple rotary chucks for the vertical spindle surface grinder built by this company. The double chuck enables two pieces to be ground simultaneously and the quadruple chuck, four pieces. The double chuck is adapted to concave grinding.

Stand for Portable Drills: Chicago Pneumatic Tool Co., Chicago, Ill. Drilling stand built to hold the Duntley portable electric drilling machines. The drill can be attached or detached very quickly and the stand will take either of the standard portable machines having capacities for drilling 3/16 or 1/4-inch holes in steel.

Radial Drilling Machine: Fosdick Machine Tool Co., Cincinnati, Ohio. New design of radial drilling machines built

in sizes having 2½- and 3-foot arms. These machines have a geared feed of the drive-key type, instead of the belt feed formerly used. The reverse and rapid traverse frictions have been made more powerful and the round table has been replaced by a box table.

Bench Filing Machine: Edge & Edwards, 34 N. 11th St., Newark, N. J. Bench filing machine, the table of which can be adjusted to any desired angle by means of two thumb-screws. The reciprocating file-holder slides in two bearings placed five inches apart. The upper bearing is bronze-bushed and can be adjusted for wear. The file-holder carries with it a cap which entirely covers the upper bearing.

Cutting-off Machine: The W. P. Davis Machine Co., Rochester, N. Y. Six-inch cutting-off machine having a geared scroll chuck on the rear end of the spindle, which is operated by a handwheel instead of a pin, as formerly. This handwheel enables the operator to make adjustments quickly. A splash guard has also been placed over the front chuck to prevent the cutting compound from flying about.

Aloxite Cloth Rolls: The Carborundum Co., Niagara Falls, N. Y. Aloxite rolls of abrasive cloth having widths varying from one-half to two and one-half inches. The cloth is tightly rolled on metal spools, each containing fifty yards. These rolls can be kept on a rack or in any convenient place in the shop. They prevent waste of material and loss of time. The Aloxite cloth is clean and sharp and cuts fast. It is made with various grades of grit.

Telpherage System: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Telphers for handling miscellaneous packages in freight terminals, transfer stations, etc. The telpher train runs on an elevated, single-rail track and consists of a motor-driven tractor with one, two or three trailers. Each trailer is equipped with a motor-operated hoist. The tractor motor and trailer-hoist motors are controlled by an operator stationed in the cab of the tractor.

Convertible Open-side Planer: Detrick & Harvey Machine Co., Baltimore, Md. This planer is primarily a double-housing type, but by removing the outer housing or post, the machine can be converted into an open-side planer, thus greatly increasing its range and adaptability. The note published in the September number relating to this machine, was incorrect in that it referred to the planer as an openside type which could be converted into a double-housing machine.

Belt Shifter: The W. P. Davis Machine Co., Rochester, N. Y. Belt shifter applied to this company's lathe countershafts for shifting the belt from one step of the pulley to another. The device is located on the shifting rod and it leads the belt from one step to another without injuring it. In shops where the ceilings are high, it is difficult, with the usual arrangement, to change the speed of a belt-driven lathe without the use of a pole. This belt shifter is now a part of the company's standard equipment.

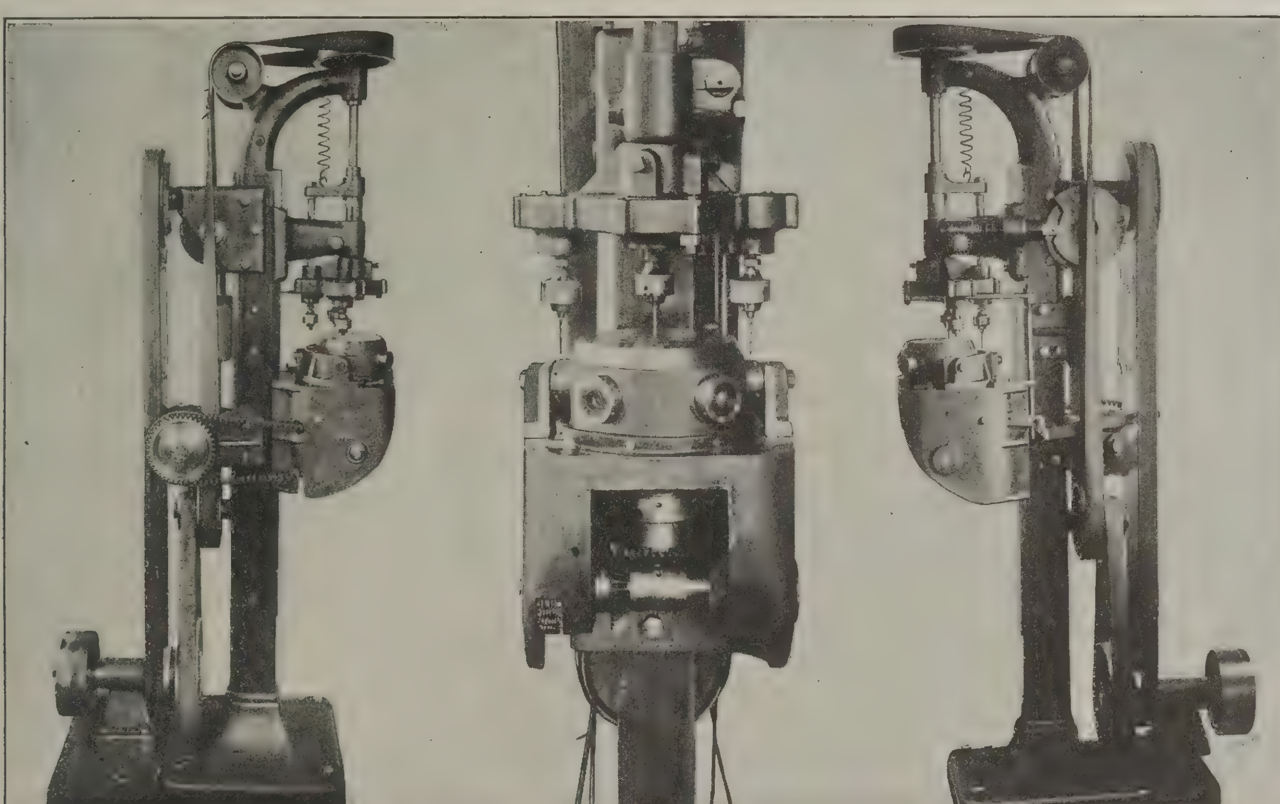
Portable Slotting Machine: Newton Machine Tool Works Inc., Philadelphia, Pa. Portable slotting machine driven by a ten horsepower Westinghouse reversing motor. The saddle has a power cross-feed of 48 inches, and if a greater traverse is required, the upright or vertical column can be adjusted by hand on the base. The length of the stroke is controlled by a master switch operated by adjustable trips or by hand. This tool has a cutting speed on the downward stroke ranging from 20 to 37½ feet per minute and a quick return varying from 42½ to 75 feet per minute. The complete weight of the machine is 23,000 pounds.

Thread-rolling Machine: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. Automatic machine for rolling threads on round shells having flanges or steps. It is also possible to handle straight, cylindrical pieces. The shells to be threaded are placed in a chute and are released by an automatic trip. The chute is made in two sections and the lower half swivels and carries the shells in line with the lower chuck. An automatic pusher forces the shell into the chuck where it is held by a retainer, while the upper chuck moves in and rolls the thread. At the completion of the thread-rolling operation the finished shell is automatically ejected. This machine has a capacity of 30,000 shells in ten hours, and will roll diameters varying from ½ to 3 inches.

* * *

FRANKLIN AUTOMATIC CAP-SCREW DRILLING MACHINE

An automatic cap-screw drilling machine, which reduces the work of four men to one, is the latest product of the tool-construction department of the H. H. Franklin Manufacturing Co., 203 So. Geddes St., Syracuse, N. Y. This automatic cap-screw drilling machine, three views of which are shown herewith, has the capacity of drilling holes in two thousand cap-screws a day. It is a continuously operating drill which drills three cap-screws at a time. Formerly the cap-screw holes were drilled on four separate machines. Each machine drilled one hole at a time, and two minutes was required to drill the holes in one cap-screw. This new machine not only drills three cap-screws at a time but, after the cap-screw is completely drilled, it is automatically forced from the machine and all the operator has to do is to insert another cap-screw. This one machine will take care of the drilling of all the cap-screws needed in the manufacture of Franklin automobiles.



Automatic Machine that will drill Holes in 2000 Cap-screws a Day—built by the H. H. Franklin Mfg. Co.

The turret in which the cap-screws are inserted, holds five at a time. There are three drills operating simultaneously and each one drills a hole through one cap-screw. After the holes have been drilled and the drills back out, the turret revolves and, at the same time, each cap-screw is turned over

so that when it arrives at the next drill, a hole is drilled through another side. In this way each cap-screw has a hole drilled through it by each one of the three drills. After the third drill has finished its work and the turret revolves again, the screw is ejected from the machine automatically.

The turret revolves through an arc of 72 degrees for each indexing and the screws are revolved through an arc of 120 degrees. The turret is worked about by a cam. As the turret revolves, an automatic spring-plunger ejects the cap-screw which has been completely drilled. The drilling head is also fed by a cam which is shown in the view to the right. This cam engages a horizontal spring-plunger having a rack cut on the front end which meshes with a pinion connecting with the spindle quill. At the back of the turret there is a guide which holds the three cap-screws being drilled, firmly in their places. The machine uses 3/32-inch drills and will drill cap-screws from 5/16 inch to 1/2 inch in diameter.

These cap-screws are used in all parts of the Franklin motor and car. The object in drilling holes through the heads of the cap-screws is for locking them. When the engine has been assembled, a wire is drawn through the holes in the cap-screws, completely locking them and preventing their working out, thus providing a perfect safety device.

* * *

F. A. GEIER TWENTY-FIVE YEARS WITH CINCINNATI MILLING MACHINE CO.

Frederick A. Geier, president of the Cincinnati Milling Machine Co., gave a dinner on Friday evening, September 13, in Cincinnati to some of his friends and business associates to celebrate the twenty-fifth anniversary of his connection with the business. The growth of the Cincinnati Milling Machine Co., which operates one of the two or three largest and best equipped machine tool works in the world, has been coincident with the advance of the machine tool industry in this country, and illustrates in a striking manner what can be accomplished by energy, perseverance and business ability. For the steady and continued development of this great enterprise from small beginnings, Mr. Geier is responsible, although he has had the help of able mechanics from the outset; and it is fitting that his twenty-fifth anniversary should be celebrated in company with several of the men who helped him to achieve success, as well as others well known in the machine tool industry and in Cincinnati business circles. Those present at the dinner were: H. T. Atkins, Albert Bettinger, George H. Bohrer, E. M. Chace, George D. Crabbs, A. L. DeLeeuw, E. F. DuBrul, Lewis N. Gatch, Frederick V. Geier, Dr. Otto P. Geier, P. O. Geier, C. S. Gingrich, Louis J. Hauck, Prof. F. C. Hicks, J. C. Hobart, Robert Hochstetter, Fred Holz, Sr., F. W. Jaeger (New York), George H. Kattenhorn, Ernst Krause (Vienna), Louis S. Levi, William Lodge, P. G. March, Alfred Marshall, George E. Merryweather, James P. Orr, George Puchta, B. B. Quillen, H. M. Ramp, Sherman Schauer, Prof. Herman Schneider, Murray Shipley, Nelson W. Strobridge, Dr. C. W. Tangeman, A. H. Tuechter, C. Wood Walter, Dr. J. M. Withrow.

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JOINT MEETING OF A. S. M. E. AND V. D. I.

The council of the American Society of Mechanical Engineers has accepted an invitation from the council of the Verein Deutscher Ingenieure to hold a joint meeting with them in Leipzig, June 23-25, 1913. The meeting will be followed by an official tour of the industrial centers of Germany and will include a trip on the Rhine and special opportunities for a comprehensive study of the Great Museum of the Technical Arts and Industries at Munich. Many establishments will be thrown open that could not be visited under other auspices, and extraordinary and unique opportunities will be afforded the members of the party to familiarize themselves with the latest developments in every industry. Invitations to visit firms throughout Germany have been received.

It is desired that the party be large enough to warrant chartering an entire steamer. This would afford a minimum expense with a maximum of pleasure and personal comfort. Past President E. D. Meier is chairman of the committee on arrangements.

DIE CASTING AUTOMOBILE MOTOR BEARINGS

The manufacture of die castings is one of the numerous lines of manufacture which has advanced rapidly with the growth of the automobile industry. The production of die castings originated with the H. H. Franklin Mfg. Co., Syracuse, N. Y., about nineteen years ago. As is generally known, die castings are produced in steel dies instead of sand molds. By the substitution of steel dies for the sand molds and the use of pressure for conveying the metal from the pot into the die, a degree of smoothness and accuracy is secured which equals, and often surpasses, that obtained by the usual machining operations. The result is that the castings are practically ready for assembling without additional machine work.

At first the die-casting process was confined to the manufacture of electrical instruments, phonographs, computing machines, etc., for producing small, accurate parts which were expensive to finish by the common methods of machining. When the Franklin Co. entered the automobile field, experiments were made with die casting in order to determine to what extent it could be used in automobile construction.

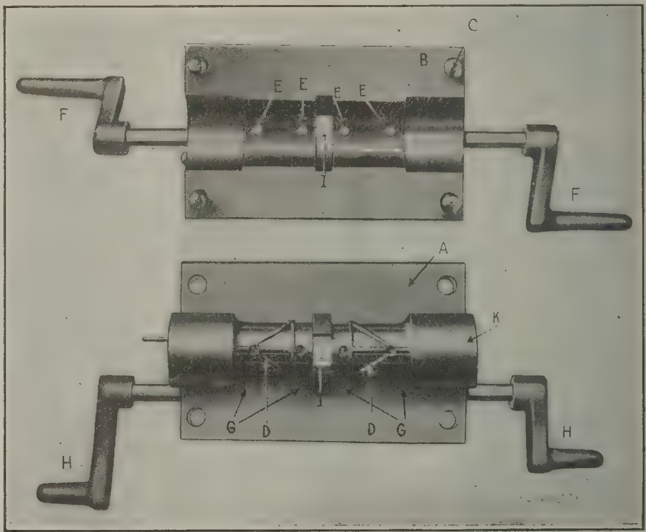
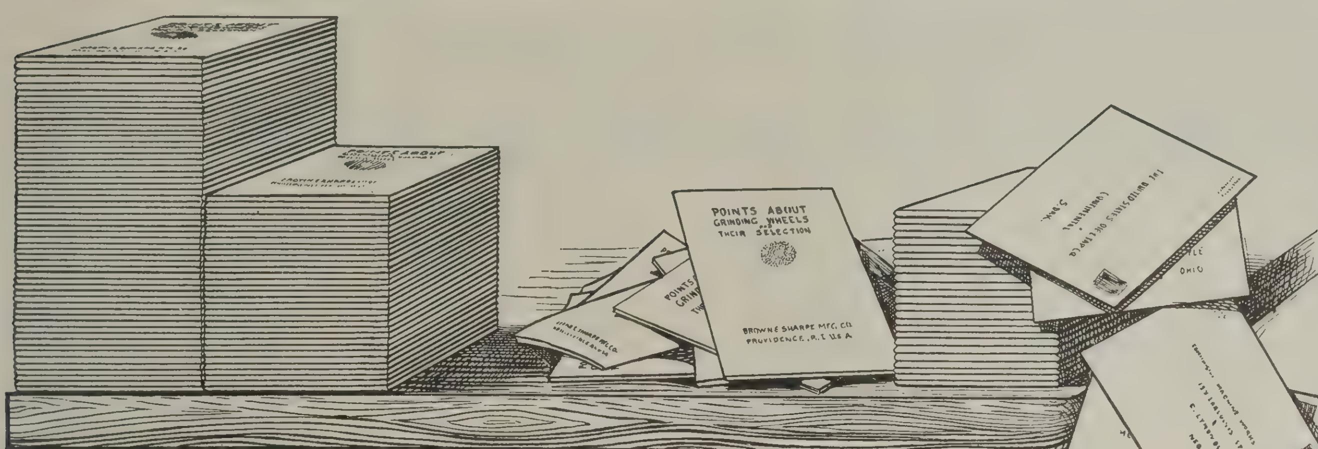


Fig. 1. Die used by H. H. Franklin Mfg. Co. for Producing Bearings by the Die-casting Process

For most automobile parts, either because of their size or intended use, the process was not practicable, but for the production of bearings it was found ideal. The accuracy of the die-cast bearings makes additional machining operations unnecessary and only such scraping and reaming as is customary in the assembling of machined bearings, is required. The high pressure of the die-casting process, combined with the chilling received from the die, gives a hard, close-grained bearing surface, which is of considerable value.

The first die-cast bearings used in automobile construction were for the connecting-rods of the Franklin 1904 motors. These bearings were made of hard babbitt and replaced machined phosphor-bronze. Their success was so marked that babbitt has almost entirely replaced phosphor-bronze as a bearing material in the Franklin motor. It is probably true that one grade of babbitt will not meet all conditions, yet the range of babbitt metals would seem to be sufficiently wide to insure satisfactory results. For instance, in an engine where the heat generated is purely frictional, the addition of a small percentage of lead is probably an advantage, although in engines where the bearings are subject to external heat, a tin, antimony and copper babbitt, devoid of lead, is imperative.

The construction of one of the Franklin dies is illustrated in Fig. 1. The die consists of upper and lower plates which are held rigid by dowels *C*. On the lower half is located the main core *K* and in this are the cores *D* for the oil grooves. These oil-groove cores are either formed by cutting down the main core so as to leave the oil-groove cores raised in relief, or by slotting the main core and "letting in" small cores, which are then located securely. The lower half also contains a set of ejector pins *G* operated by levers *H*. The upper half is more simple. The depression conforms to the outside



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This **forty page**, attractively and serviceably bound book treats of the subject in a concise manner, and contains information that it would be difficult to gain short of an extensive study.

Do you know what wheels to select for facing shoulders, for disc grinding, or for internal grinding? Have you at hand any ready means of determining how to order wheels?

These and many other points are taken up thoroughly in the book; in fact it is a regular treatise on grinding wheels. **It contains useful information for everyone from owners to operators of machines.**

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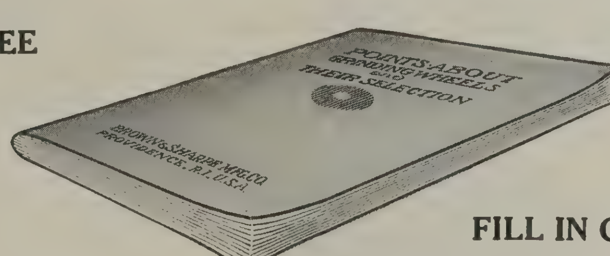

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Brown & Sharpe Mfg. Company

PROVIDENCE, R. I., U. S. A.

BROWN & SHARPE MFG. CO., Providence, R. I.

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of the bearing, and contains the cores *E* for the dowel holes. These cores are operated by levers *F*, and also act as ejectors in case the bearings stick in the upper half of the die.

Both halves contain corresponding gate holes *I* in which the gate operates. When in operation, the closed die is fastened between the upper and lower halves of the die vise, which is placed directly over the casting machine. The cores for the dowel-pin holes are thrust forward and the ejector pins are drawn back even with the face of the die plate, after which the gate is turned back to allow the metal to enter. The metal is then forced in, and when the die is full the gate is sheared off and only a slight mark (which is sometimes imperceptible) is left instead of the usual heavy sprue common in sand castings. The die remains closed only long enough for the casting to set. When it is opened and the ejector pins are thrust forward by means of levers *H*, the casting is loosened from the main core where it usually sticks

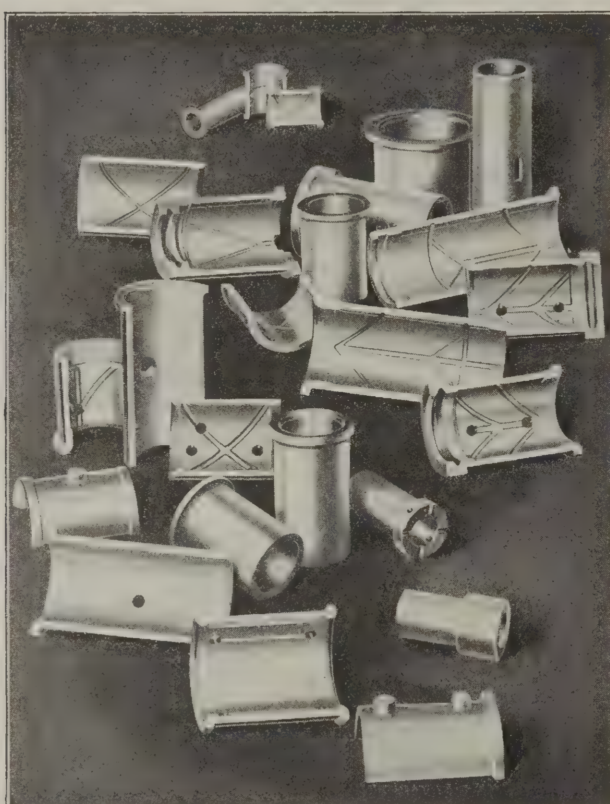


Fig. 2. Group of Die-cast Bearings

somewhat. Fig. 2 shows a number of bearings produced by the die casting process.

The construction and working of the various dies differ, of course, in accordance with the parts to be produced. On account of the effect of high temperature on the dies, the metals available are limited. At present, lead, and tin and zinc base alloys are chiefly employed.

The accessory manufacturers have found die castings, especially of the harder alloys, well adapted to such parts as timer bodies, and the framework of magneto and lighting systems. In addition to the bearings, the automobile manufacturers are using die castings extensively for such parts as oil and water pumps. As the process is constantly being developed, both in regard to materials used and the size of the castings made, it is probable that die castings will in the future, have an even greater place in automobile construction than at present.

* * *

MACHINERY's tenth annual outing will be held on October 19, following the National Machine Tool Builders Association convention. It will be of a similar character to the previous outings, comprising a steamer trip in the waters around New York.

* * *

In selecting the number of teeth in a gear, care should be taken to select such numbers as can be obtained by ordinary indexing methods, without the use of special gears.

PERSONALS

Lucius I. Wightman, a well-known publicity man, recently joined with Joseph A. Richards & Staff, Tribune Bldg., New York, forming the firm of Wightman & Richards.

George W. Burley, instructor of machine shop practice in Sheffield University, England, and a well-known contributor to the British and American mechanical journals, sailed for home September 5, having spent a month in the United States.

F. G. Kretschmer of F. G. Kretschmer & Co., Frankfort-on-Main, representative in Germany of many well-known American machine tool builders, will visit the United States early in October. His address during his stay will be Hotel Astor, New York.

Louis L. Burghoff, lately connected with the New England Watch Co., Waterbury, Conn., as assistant superintendent, has taken a position with the Remington Arms–Union Metallic Cartridge Co., as assistant equipment engineer of the gun works at Ilion, N. Y.

Dr. Conrad Matschoss, lecturer at the Royal Technical Institute (dozent der Konigliche Technische Hochschule) Charlottenburg, Berlin, Germany, and a writer on industrial science, is making a tour of American manufacturing centers as representative of the Verein Deutscher Ingenieure (Society of German Engineers). Dr. Matschoss is keenly interested in the comparative average intelligence and educational qualifications of German and American workmen.

Prof. George B. Thomas of Colorado College, Colorado Springs, Colo., was selected by the Westinghouse Electric & Mfg. Co., to take charge of twenty-eight representatives of the engineering faculties of twenty-four colleges in the United States who were on the payroll of the company at the works during the past summer. These instructors were studying the practical side of engineering so as to be better fitted to instruct their students. They were engaged as regular employes and were assigned check numbers the same as other workmen. The work made them familiar with the requirements of engineering work and the advances that are being made in the design of electrical apparatus.

* * *

OBITUARIES

Milton G. Puffer, inventor of the machine for making envelopes, died recently at Willimantic, Conn., aged ninety-three years.

John Hope, inventor of the pantograph engraving machine and other devices used in engraving, died at his home in Providence, R. I., September 8, aged ninety-two years.

William S. Lamson, inventor of the Lamson carrier system for store service, and treasurer of the Lamson Consolidated Store Service Co., died at his home in Lowell, Mass., August 16, aged sixty-six years.

Charles F. Putnam, president of the Putnam Machine Co., Fitchburg, Mass., and one of Fitchburg's best known business men, died August 29 at Massapequa, L. I., aged sixty-seven years. Mr. Putnam had been in poor health for a year and a half but attended to his daily duties with the Putnam Machine Co., up to the time of going to Brooklyn, N. Y., in May, where his daughter lived. His entire business life was devoted to the Putnam Machine Co., with which he was connected in various capacities during his earlier life. Shortly after the death of his father, Salmon W. Putnam, in 1872, the company was reorganized, at which time the deceased was elected president, his brother Salmon W. Putnam, Jr., vice-president, and the late Henry O. Putnam, treasurer. Mr. Putnam was married in 1872 to Miss Coralie J. Lawrence of Pepperell. A daughter, Mrs. Edith Ormsbee of Brooklyn, a brother and four sisters survive him.

WILLIAM J. FLATHER

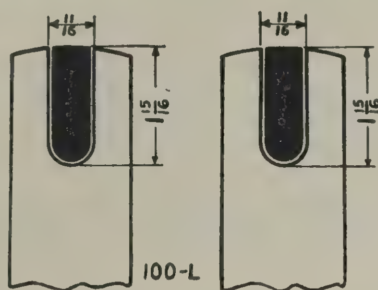
William J. Flather, one of the founders of the Flather machine tool companies of Nashua, N. H., died at his home in Nashua, September 10, 1912, of heart failure, following a short illness caused by arterial sclerosis.

Mr. Flather was born in Norwich, England, in 1841. The family moved to Bradford in 1849, where, after receiving a common school education, he entered the employ of his uncles, William and Henry Hodgson, manufacturers of worsted machinery. His father being in poor health was advised to come to America, which he did, sailing for Philadelphia in 1856. The following year William followed with other members of the family, soon after settling on a farm near Rainsboro, Highland County, Ohio. During the next few years he was employed as a machinist at Harpers Ferry, Va.; Lowell Machine Shop, Lowell, Mass.; Chase & Co., Nashua; and the Grover & Baker Co., Boston. After the Civil War broke out he enlisted in a Pennsylvania company, but on account of his mechanical ability was transferred to the Frankfort Arsenal at Bridesburg, Philadelphia, where he remained throughout the war.

In 1866 Mr. Flather with his brothers moved to Parkersburg, W. Va., and established a shop for the manufacture and

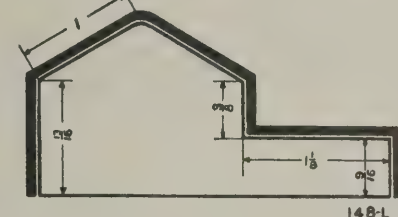
Some Examples of Work done on the

No. 2 Plain Cone Driven Cincinnati Miller



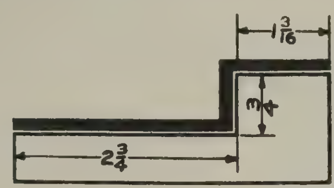
100-L

Material, 40 Carbon Steel.
Size of cut, 11-16" wide, 1" deep, 1 15-16" long.
Cutters, 6" in diameter.
Two Pieces are milled at one time.
The work is held horizontally and fed directly into the Cutter at a travel of 1" per minute.



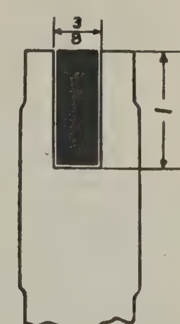
148-L

Material, Cast Steel.
Total width of cut, 5".
Depth of cut, 1-16" to 3-32".
Thickness of piece, ⅞".
Largest Cutters, 5½" diameter, 53 revolutions.
Feed, 2.9" per minute.
Four Pieces are held in a jig at one time.
Total time per piece, 1¼ minutes.



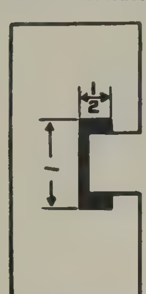
190-L.

Material, Cast Iron.
Total width of cut, 4 11-16"; depth of cut, ⅛"; length of cut on each piece, 1⅛".
Cutters, 4½" and 3" diameter.
Twenty-four Pieces are held in a string jig at one time.
Feed, 1⅞" per minute.
Finished surfaces are accurate within .001."



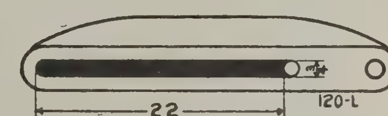
169-L

Material, Steel Forgings.
Cut consists of a slot 1" deep, ⅜" wide at a table travel of 4" per minute.
Cutter, 3½" in diameter, ⅜" face, 53 revolutions.
The pieces are of irregular form and 5 of them are held in a string jig at one time. The length of cut in each piece is approximately 1".



168-L.

Material, Cast Iron.
Cut consists of undercutting T slots, with a Cutter 1" diameter, ½" face, running 286 revolutions. Our average rate of feed on this work is 15¾" per minute.



120-L

Material, Cast Iron Bars. 1" thick.
A slot ¾" wide is cut through the solid at one cut, starting from a drilled hole with a ¾" diameter, 3 fluted end mill at 3⅝" table travel per minute.
Metal removed per minute is equivalent to a bar 1" x ¾" x 3⅝" long. Actual cutting time for slots 22" long, 6 minutes.

For the usual Tool Room work; for repair work; for manufacturing small machine parts—in fact, for all work on which the cutting is light, a modern Cone Driven Miller will bring you bigger returns for your investment than a Single Pulley Drive Machine.

We have redesigned ours, brought them up to date, made them handier than ever before, and we are offering a full line for all that work for which they are especially adapted. we also make a full line of single pulley High Power Millers for the heavier classes of milling.

The Cincinnati Milling Machine Company

CINCINNATI, O., U. S. A.

repair of oil-well tools. As this venture did not prove remunerative he returned to Nashua, and with his brothers entered a partnership with the late J. K. Priest who at the time manufactured sewing machines but who later established himself under the title of The American Shearer Co., as a manufacturer of clippers of all kinds. It was the intention of Mr. Priest and the Flather brothers to build lathes also, but the lines were so dissimilar that the partnership was soon dissolved, the Flathers taking over the manufacture of lathes under the firm name of Flather Brothers. Later the name was changed to Flather & Co., the concern consisting of Mr. Flather and his brother Joseph, as active members, and Edward Flather as a silent partner. The high quality of their hollow spindle engine lathes, then somewhat of a novelty, secured them such agents as Hill, Clarke & Co., of Boston, and a certain amount of success. In September 1876 their factory was destroyed by fire, being practically a total loss. With the small amount of insurance received, it was with difficulty that they rebuilt. They had, however, exhibited their lathes at the Centennial Exposition in Philadelphia, which attracted favorable notice from several European manufacturers, resulting in their initial foreign business. After the panic years of the late 70's, their success was firmly established and the business steadily grew in size to its present capacity.

Mr. Flather was also one of the founders of the Mark Flather Planer Co., Flather Foundry Co., and the E. J. Flather Mfg. Co., withdrawing in 1901 from Flather & Co., and the Mark Flather Planer Co. At the time of his death he was president of the Flather Foundry Co., and was actively identified with the E. J. Flather Mfg. Co. He had marked mechanical ability, sound judgment and a faculty of quietly impressing his convictions on his business and other associates. Although a man of retiring disposition, he had an extensive acquaintance in this country and Europe. He was much interested in civic and state affairs, having served as a member of the city government, board of education, state legislature and constitutional convention. He was also a thirty-second degree Mason and prominent in financial circles, being a director of the Indian Head National Bank for twenty-five years. Mr. Flather was actively interested in religious work, being an officer and trustee in several Methodist Episcopal church societies and institutions, including Tilton Seminary. In May of this year he was chosen one of the two lay delegates from New Hampshire to the Methodist Episcopal General Conference at Minneapolis, at which he took an active part. While his early education was interrupted by the migrations of his father's family he was a student all his life, attending evening schools when employed at Philadelphia and devoting much of his leisure time to study and travel, both in this country and Europe. He is survived by his widow; a daughter, and two sons, Ernest J. and Harry E. Flather.

* * *

COMING EVENTS

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

October 16-18.—Annual convention of the National Machine Tool Builders' Association in New York; headquarters, Hotel Astor. James H. Herron, general manager, Cleveland, Ohio.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Pratt Institute, Brooklyn, N. Y. Circular describing the evening technical courses conducted by the School of Science and Technology at Pratt Institute. These courses offer unusual opportunities to young men who would devote their evenings to studying mechanical drawing and machine design.

Michigan College of Mines, Houghton, Mich. Year book 1911-1912 and announcement of courses for 1912-1913. The year book contains the usual information relating to admission to the college, courses and departments of instruction. It also contains a map of the Portage Lake mining district showing the location of the college in the midst of an active mining territory. Another map shows the mineral district of the upper Michigan peninsula, with the various iron and copper ranges accessible from the college.

NEW BOOKS AND PAMPHLETS

Natural Gas: Its Properties, Its Domestic Use, and Its Measurement by Meters. By P. F. Walker. 38 pages, 6 by 9 inches. 10 illustrations. Published by the University of Kansas, Lawrence, Kans.

This engineering bulletin No. 2, published by the Engineering Experiment Station of the University, contains a report on the subject of natural gas prepared for the Public Utilities Commission of the State of Kansas. The most interesting part of the bulletin is that which relates to the meters for gas, showing the effect of different rates of flow and pressure differences on different makes of meters.

High Explosives. By W. R. Quinan. 210 pages, 6 by 8½ inches. Published by Critchley Parker, Melbourne, Australia. Price, 21 shillings, net.

This book is a treatise on high explosives, mainly from a scientific point of view. The contents of the book are as follows: Historical; Velocity of Detonation; Industrial Explosives; Australian Conditions; Theory of Explosive Energy; Available Energy or Maximum Work; Useful Work; Strength of Explosives; Theories of Explosion; Dissociation; Detonation of Gaseous Mixtures; Dissociation of Explosives—Specific Heats—Boyle's Law at High Densities.

Strength of Materials. By Mansfield Merriman. Sixth Edition. 169 pages, 5 by 7½ inches. Published by John Wiley & Sons, New York. Price $1.

This is one of the standard references on this subject which has become generally known to the profession in its previous edition. In the sixth edition a new chapter on combined stresses has been added. Numerous changes have also been made throughout the text and ninety new review problems added to illustrate the principles treated in each chapter of the book. The number of illustrations has also been increased from forty-eight to fifty-four and the number of articles from seventy-two to ninety-one. It is hoped that the book in its new form may be even more valuable in furthering the progress of technical education than it has been in the past.

Materials and Construction. By James A. Pratt. 196 pages, 5 by 7 inches. Published by P. Blakiston's Son & Co., Philadelphia, Pa. Price 90 cents.

The material in this book has been published with the view of presenting an elementary text for students in technical schools; also as a reference on the more simple problems of construction. Each chapter of the book concludes with problems of a practical nature which not only explain the preceding principles but give the student practice in applying them on the class of problems which he is likely to meet with in engineering practice. One of the notable features of the presentation of material in this book is the method of illustrating. In many cases rough sketches are used, the idea being to familiarize the student with this practice which is followed in many factories, rather than to let him rely entirely upon accurate working drawings.

Manual for Engineers. By Charles E. Ferris. 248 pages, 3 by 5¾ inches. Published by the University of Tennessee, Knoxville. Price 50 cents.

This useful pocketbook which has passed into the seventeenth edition was compiled with the view of interesting the controlling men of the South in technical education as a means of developing the undeveloped resources of their section. Following the pages devoted to the courses of study offered by the University of Tennessee and its equipments and facilities, the book is devoted to the presentation of useful technical data. This section includes mathematical tables, the properties of engineering materials and data pertaining to the transmission and generation of power, to electric wiring, to hydraulics, and to the effect of heat on various materials. Especial attention is called to the excellent presswork and binding which make it attractive to the user.

American Machinist's Grinding Book. By Fred H. Colvin and Frank A. Stanley. 383 pages, 6¼ by 9¼ inches. Published by McGraw-Hill Book Co., New York City. Price $3 net.

The wide application of grinding machines of suitable forms to adapt them for a variety of operations in the manufacture of machinery and of finished metal parts in general, suggested the desirability of presenting material on the subject of grinding in the form of a reference book. The idea in so doing was to present reliable data on the machines, wheels and methods, that is likely to be of interest and service to those engaged in the grinding department. In presenting their subject the authors have dealt separately with the different types of machines in regard to their application in different classes of manufacture. The methods of mounting the wheels and of dressing them are then taken up, and later a number of particular classes of work are dealt with in detail. The authors have drawn upon the columns of different technical papers and also acknowledge assistance received from the manufacturers of grinding machines in securing the data which they have presented.

Shop Arithmetic. By Earle B. Norris and Kenneth G. Smith. 187 pages, 6¼ by 9¼ inches. Published by McGraw-Hill Book Co., New York. Price $1.50.

Many a good mechanic is held back by a lack of mathematical knowledge which makes it necessary for him to "ask the boss," whenever there is any figuring to be done. Such men find it difficult to acquire knowledge that is of much value to them from an ordinary textbook on arithmetic. This is largely due to trouble in applying arithmetical methods to practical problems. In the present book, the mechanic should be saved from this difficulty by the practical problems which follow the discussion in each chapter. Thus the treatment of addition of fractions is followed by exercises in finding the overall dimensions of drawings scaled off in the usual way. A discussion of the micrometer caliper follows the chapter dealing with decimals. Similarly the treatment of methods to find the areas and volumes of different shaped figures is followed by practical problems. The latter section of the book deals with problems occurring in the simpler branches of mechanics. Treated in this way, the mechanic should be able to acquire the knowledge of arithmetic he requires in his work without the aid of an instructor.

Practical Descriptive Geometry. By William Griswold Smith. 208 pages, 6 by 9 inches. 132 illustrations. Published by McGraw-Hill Book Co., New York. Price, $2.

The author of this book, who is assistant professor of descriptive geometry at the Armour Institute of Technology, has endeavored to emphasize the relation which exists between descriptive geometry and drafting. In preparing the book, his aim has been to present the subject in such a manner as to arouse the interest of the student. A large number of exercises are provided, the author believing that a thorough knowledge of the subject is achieved not through much study of the text, but through working exercises. The book is divided into four specific parts, the first dealing with definitions, notations, preliminary theories and exercises; the second, with problems relating to points, lines and planes; the third, with curved lines and surfaces; and the fourth, with perspective and isometric projection. The extent to which the idea of presenting a great number of exercises has been carried can be best understood by noting that there are 860 different problems presented, of which about one-quarter are of such a nature as may be met in actual practical drafting. Most of the exercises are dimensioned so as to require the student to make his drawing according to some predetermined scale.

Machine Design; Hoists, Derricks, Cranes. By Henry D. Hess. 368 pages, 6½ by 9⅜ inches. Published by J. B. Lippincott Co., Philadelphia, Pa. Price $5.

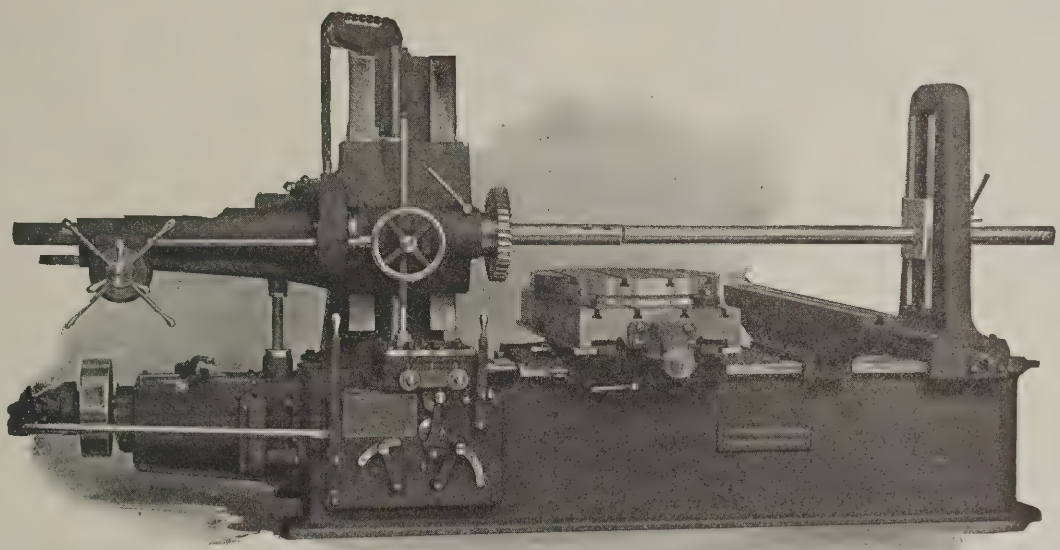
The details comprising the structure of a crane include a large variety of the simpler forms of mechanism met with in many classes of machinery. The stresses which occur in both the frames and machinery are also such that they are readily determined by analytical methods. These conditions have made the presentation of methods used in crane design valuable in two directions: The general reader can acquire accurate data on the design of the common forms of mechanism met with in most classes of machinery. Those seeking specific information on the subject of crane design will also welcome the book as a reliable source of information. The first four chapters are devoted to a discussion of the properties of various materials used in machine construction and to the design of the types of mechanism and structural members applied in cranes of the different forms that are treated. The eight succeeding chapters cover the standard practice followed by the designing departments of leading American crane builders. The book is expected to meet the requirements of the field of machine design covered in technical colleges. Drafting-rooms work-

Some Expert has said: "Don't Advertise the Obvious"
but we wish to break this rule enough
to say that the

"PRECISION"

Boring, Drilling and Milling Machine

was ALWAYS the BEST, and is now
BETTER THAN EVER



It has *feeds* in every direction and a *constant speed quick return* for every feed; *one* handle starts whichever feed is wanted, and the *reverse* motion of the *same* handle starts the quick return always in the opposite direction from the feed.

The constant speed Quick Power Movement is accomplished by separate mechanism and does not operate through the feed change gears.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

CONTENTS FOR OCTOBER

The first column of page numbers applies to the Engineering and Railway Editions: the second to the Shop Edition.

ing upon general classes of machine design should also find it of value, and the careful attention to detail which has been observed in the preparation of this book should make it favorably received in a variety of designing establishments.

NEW CATALOGUES AND CIRCULARS

Geuder Paeschke & Frey Co., Milwaukee, Wis. Circular of "Cream City" electric butt and spot welding machines.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin No. 1026 entitled "The Youngstown Safety Limit Stop for Direct-current Motors."

R. D. Nuttall Co., Pittsburg, Pa. Supplement to catalogue No. 10 on forged steel motor gears and pinions, containing twenty-nine pages of gear lists.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue E of "Brownhoist" buckets and tubs for handling ore, coal, gravel, sand, earth and other materials.

Vulcan Engineering Sales Co., 2014 Fisher Bldg., Chicago, Ill. Circular of the "Mumford" jolt ramming machines for foundries, enumerating their advantages.

Electro-Dynamic Co., Bayonne, N. J. Data sheets Nos. 3, 4 and 5 on wiring diagrams of interpole motors with Cutler-Hammer compound non-reversible and reversible drum controllers.

Gurney Ball Bearing Co., Jamestown, N. Y. Catalogue of annular ball bearings having full complement of balls, unbroken raceways, and full depth of raceways; also ball thrust bearings of the plain and grooved types.

Foote Bros. Gear & Machine Co., 210-220 N. Carpenter St., Chicago, Ill. Catalogue and price-list No. R on "IXL" speed reducers which are made of the spur gear and worm gear types in a large number of sizes.

C. W. Hunt Co., West New Brighton, N. Y. Catalogue No. 12-8 on manila rope for transmission and hoisting, being a brief treatise for engineers on the manufacture and characteristics of ropes, with formulas, tables and data useful in mill engineering.

Walter B. Snow, 170 Summer St., Boston, Mass. Booklet entitled "Publicity Engineering," outlining the scope of Mr. Snow's activities in engineering publicity work and showing in what radical respects they differ from those of the typical advertising agencies.

General Electric Co., Schenectady, N. Y. Bulletin No. 4995 on direct current switchboards, double polarity, 125, 250 and 600 volts; No. 4996 on alternating current switchboards with oil switches, three-phase, three-wire 240, 480 and 600 volts, 25 to 60 cycles.

Racine Tool & Machine Co., Racine Junction, Wis. Circular illustrating No. 7 high-duty metal cutting machine of the hacksaw type, having capacity from 0 to 12 inches and using blades 17 to 24 inches long. The machine is especially adapted for structural work, being arranged for cutting I-beams, angles, channels, etc.

D. & W. Fuse Co., Providence, R. I. Leaflet describing D. & W. fused switch boxes, being an improved combined switch and fuse box particularly adapted for mill service, etc., inasmuch as it may be locked after the fuses are installed, thereby preventing tampering with the connections and increasing the capacity of the fuses.

National Tube Co., Pittsburg, Pa. Pamphlet entitled "Modern Welded Pipe" illustrating and describing the processes from the mining of the ore through the reduction of the ore to steel, rolling the skelp, lap welding, butt welding, testing, threading, etc. The illustrations are effectively printed in colors, thus showing the metal being worked in the hot state.

Davis-Bournonville Co., 97 West St., New York. Folders Nos. 6 and 7 illustrating examples of locomotive repair work and Davis-Bournonville style C oxy-acetylene welding and cutting torches. The examples of locomotive repair work comprise welding broken frames, firebox cutting and welding, welding firebox cracks, building up thin spots, welding broken driving wheel spokes, etc.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 2480 giving directions for ordering motors for driving machine tools. In addition to giving the characteristics of voltage of direct-current circuits and voltage, phase and frequency of alternating-current circuits, it is necessary also to specify the horsepower and speed. The Westinghouse engineers will advise regarding the power and speed of motors for any type of machine tool.

Standard Mfg. Co., Bridgeport, Conn. Catalogue of gear cutting, milling and slitting machines, consisting of twenty-four pages, 6 by 9 inches, with embossed cover. The catalogue illustrates and describes "Standard" machines Nos. 1, 2, 3 and 5, showing examples of typical commercial work performed; also machines with special attachments adapting them to cutting worms, racks, slitting dials, cylinders, etc. The special work to which these machines can be adapted makes them of unusual interest to manufacturers generally.

Charles H. Besly & Co., 118-124 N. Clinton St., Chicago, Ill. "Besly's Modern Disk Grinding Practice," a treatise on the art of disk grinding, with special reference to reducing cost of flat surfacing in machinery construction, illustrating and describing the extensive line of grinding apparatus made by the company. The growth of the disk grinding art in the past few years and its present importance can be somewhat appreciated by referring to this comprehensive and interesting publication. The first edition containing 40 pages and 23 illustrations was issued two years ago. The present edition contains 111 pages and 103 illustrations.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 3516 listing machine tool motor applications and giving horsepower ratings and classes of motors used. This leaflet covers applications to bolt and nut machinery, boring and turning mills, bulldozers, buffing lathes, drilling and boring machines, cylinder boring machines, pipe threading and cutting-off machines, planing machines, rotary planing machines, hydrostatic wheel presses, punching and shearing machines, punches, shears, shaping machines, bending rolls, cold saws, horizontal boring, drilling and milling machines, multiple spindle drilling machines, emery grinders, grinding machines, gear cutting machines, engine lathes, milling machines, etc.

Hill, Clarke & Co., 125 N. Canal St., Chicago, Ill. "Machinery Bluebook of Modern Machine Tools," describing the line of boring machines, broaching machines, chucks, die heads, drilling machines, grinding machines, gear hobbing machines, key-seating machines, lathes, metal sawing machines, milling machines, patternmaking machines, pipe machines, planing machines, power hammers, presses, shaping machines, screw machines and turret lathes sold by the company. The descriptive matter is unusually complete for a comprehensive catalogue like this, being illustrated with halftones and drawings showing details to which references are made in the text. The book is too costly for general distribution, and will be sent chiefly to manufacturers, or their official representatives, using machine tools.

TRADE NOTES

Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes, are building a large addition to their plant and expect to have it completed January 1, 1913.

Charles H. Sawyer, 7 Lake St., Worcester, Mass., has been appointed New England representative for Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes.

Greenfield Tap & Die Co., Greenfield, Mass., has placed the contract for the erection of four reinforced concrete machine shops with the Aberthaw Construction Co., Boston.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York, furnished about 400,000 square feet of "J-M" asbestos roofing to the Memphis Union Stock Yards, Memphis, Tenn.

Gardner Machine Co., Beloit, Wis., has been made the exclusive distributor and selling agent for the entire output of abrasive disks manufactured by Hermann Behr & Co., Inc., New York.

Pratt & Whitney Co., Hartford, Conn., has opened an office and salesroom for small tools and gages at 336 W. 4th St., Cincinnati, Ohio. The office will be in charge of Mr. C. M. Pond.

Van Dorn & Dutton Co., Cleveland, Ohio, has appointed William E. Reau district sales manager for its portable tool department with headquarters in the Plymouth Bldg., Minneapolis, Minn.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., makers of drop forgings, have opened an office and warehouse at 40 S. Clinton St., Chicago, Ill., where a large stock of drop-forged specialties will be carried.

Kerr Turbine Co., Wellsville, N. Y., has opened an office in Pittsburg to take care of its increasing business in that district. The office will be located at 2137 Oliver Bldg., and will be in charge of Mr. R. M. Rush, formerly with the Drave-Doyle Co.

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

NOVEMBER, 1912

SOUTHERN PACIFIC ELECTRIC LOCOMOTIVES

THE first of the fifteen sixty-ton Baldwin-Westinghouse electric locomotives under construction for the Southern Pacific Co. has been completed, and is shown in Figs. 1 and 2. Twelve of these are so equipped that they can be operated on 600 or 1200 volts direct current, and three are for 600–1500 volts. They will all be used by the Southern Pacific Co. on its Pacific Coast properties in freight haulage and switching service. The mechanical parts for the engines were built by the Baldwin Locomotive Works, at their Philadelphia shops, while the electrical equipment was constructed and installed by the Westinghouse Electric & Mfg. Co. in its works at East Pittsburg.

While designed primarily for freight service, these locomotives may be used for passenger train service if necessary. The trucks, one of which is shown in Fig. 4, are of the equalized pedestal type, with rectangular frames which are forged in one piece. The bolsters are steel castings, rigidly secured to the frame with tapered bolts, and the pedestals are protected by shoes, which can easily be replaced when worn. The wheels have cast-steel centers with the tires held in place by bolted fastenings. Westinghouse EL straight and automatic air brake equipment is used, and a hand brake is also provided for holding the engine when it is out of service and standing in the yards or on sidings.

The cab underframing consists of four longitudinal sills, each thirty feet in length. The frame bolsters, to which the center pins are secured, consist of plates 15 inches wide and 1½ inch thick. The longitudinal sills are strongly braced above these plates by flanged plates, which are riveted to the channels transversely. Further bracing is effected by the coverplates, which are ½ inch thick. The cab floor consists of diamond plating ¼ inch thick, which is laid on the coverplates. The end sills are of cast iron.

One of the 600–1200-volt locomotives has a step at each end, while all of the others are fitted with iron pilots. The couplers are of the M.C.B. type, fitted in pocket castings mounted on the end sills, with their centers 33½ inches above the rail. The cab is of steel, and measures 18 feet long by 9 feet, 6 inches wide. It is centrally located and is arranged for double end operation. A hood is placed at each end of the cab. There are side steps at each end of the locomotive, and the cab is entered through end doors; the hood is placed out of center, which, of course, gives room for a wide running board on one side.

These locomotives are equipped, mechanically, in accordance with trunk-line railway practice, Southern Pacific standards being followed where possible. The furnishings include an air whistle, a standard locomotive bell equipped with an automatic bell ringer, and sand boxes located in the hoods at each end with pneumatic sanders.

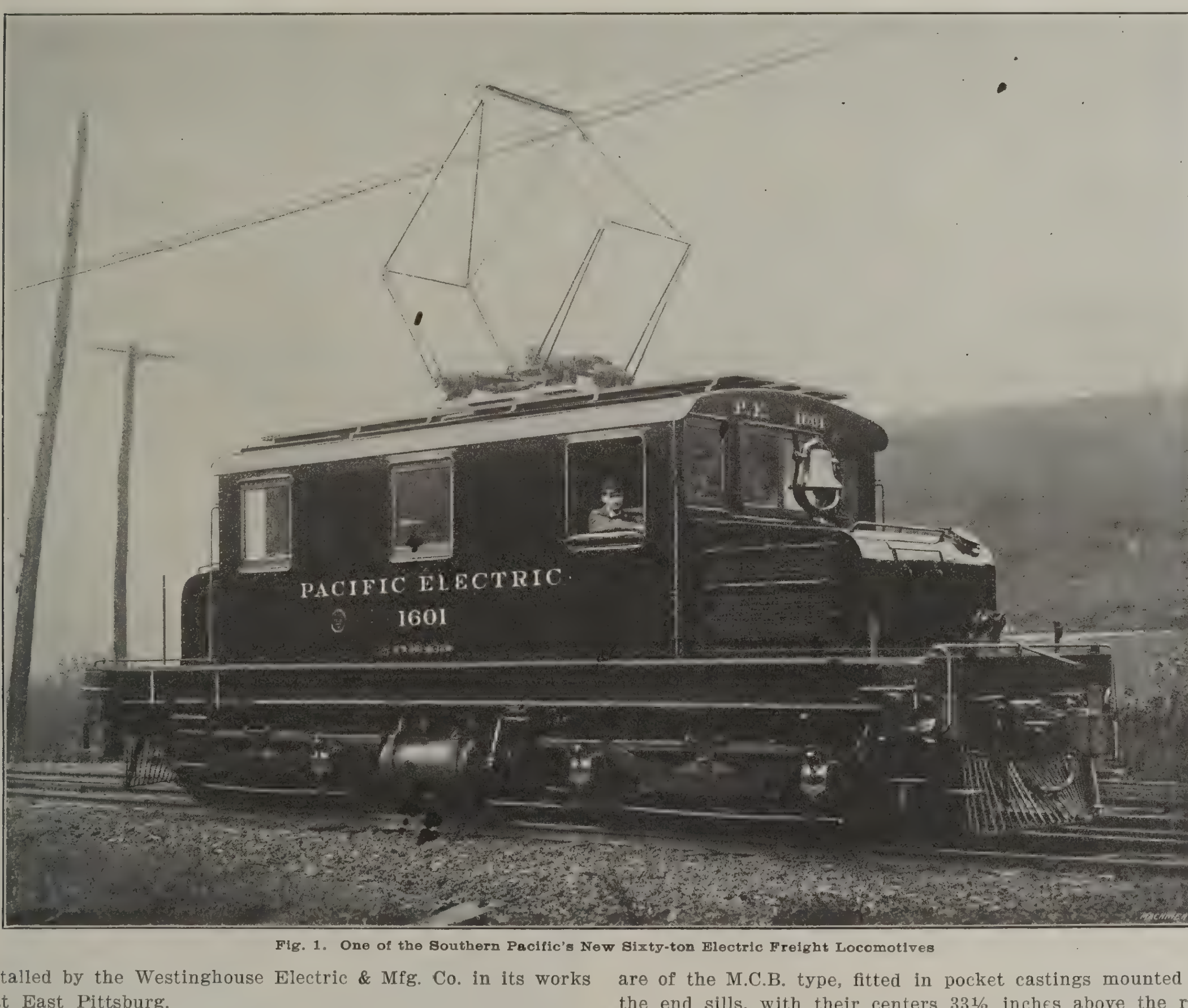


Fig. 1. One of the Southern Pacific's New Sixty-ton Electric Freight Locomotives

The principal dimensions are as follows:

Track gage, 4 feet, 8½ inches.
Wheel-base, rigid, 7 feet, 4 inches: total 25 feet.
Driving wheels, diameter outside, 36½ inches.
Journals, 5½ by 10 inches.
Distance between truck centers, 17 feet, 8 inches.
Width, 10 feet over-all.
Height to top of cab, 11 feet, 5½ inches.
Length between coupler knuckles, 35 feet.
Weight, 120,000 pounds.

Four Westinghouse No. 308-D-3 motors drive each of the engines. Each axle is equipped with an independent geared motor, the motor weight being partially carried by two axle bearings, and the remainder being supported by the nose resting directly on the truck bolster. The No. 308-D-3 motor has the same general characteristics as the Westinghouse standard 308B 600-volt motor, but is insulated for 1500 volts. Its normal rating with natural ventilation is 225 H. P. at 600 volts. The motors are provided with commutating poles and the other exclusive features of Westinghouse motors that minimize maintenance costs.

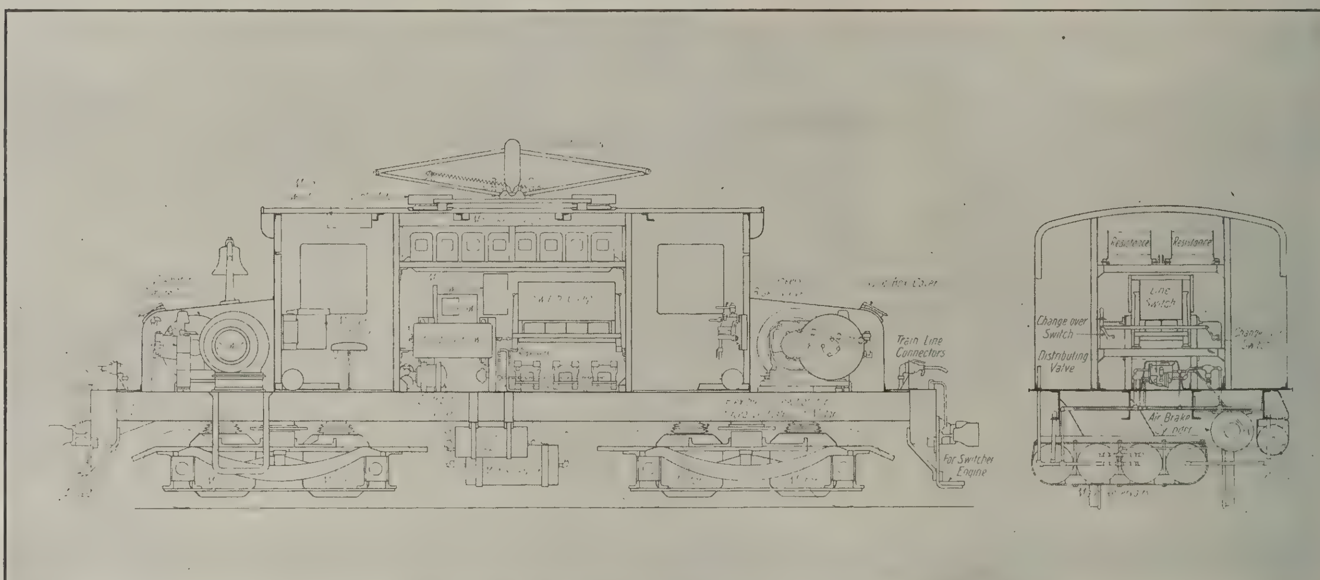


Fig. 2. Longitudinal and End Sectional Views showing Arrangement of Equipment

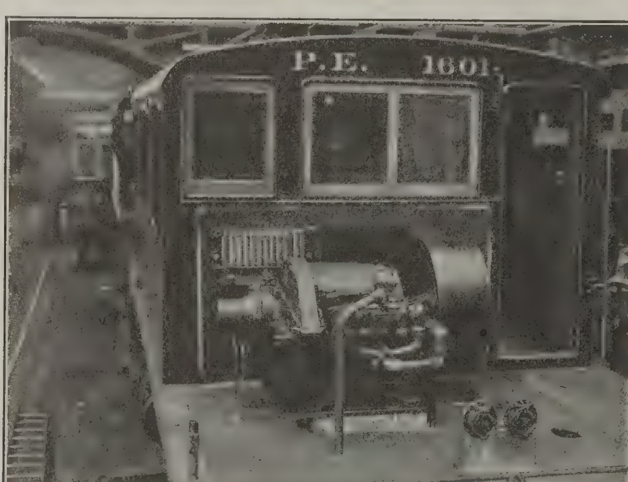


Fig. 3. Entrance to Cab with Hood removed from Dynamotor-Compressor

Westinghouse unit switch type HL control is used. Three running positions are provided for 600 volts, and two for 1200 and 1500 volts. To give the three running positions, a pneumatically operated series-parallel switch has been installed. This switch can be operated by a control switch from either end of the cab, and is so connected that the two motors comprising each pair may be arranged in series or parallel with each other, at the will of the operator. An interlocking arrangement has been provided, rendering it impossible to operate the series-parallel switch except when the circuit on the main motor is opened. There are eleven notches on the master controller with the motors in full series, nine notches with the motors in series-parallel, and nine notches with the motors in full parallel. On 1200 volts, the motors are operated only in full series and in series-parallel.

Two hand-operated drum type switches, whereby a change over from 600 to 1200 volts can be effected, have been installed in the cab. Each of these change-over switches simultaneously readjusts the divisions in the main resistance, connects the two "dynamotors" for 1200-volt operation, and locks the series-parallel switch in the series position. The same number of notches is available on the master controller for 1200-volt operation as for 600-volt operation, for full series or series-parallel positions. The control and line switches, the reverser, and the master controller are of the standard Westinghouse HL types that have been used on a great many Baldwin-Westinghouse locomotives. Each locomotive is equipped with train line receptacles and jumpers so that any number of engines can be controlled in tandem by one operator.

In addition to the standard HL control apparatus, a relay has been provided which will open all of the circuits on the motors whenever the trolley passes a specially arranged aerial brush contactor; one of these contactors is mounted on each side of every trolley wire section insulator. This device insures that there can be no current through the motors when the trolley passes the section insulator. To set the relay, and thereby remake the control circuit, it is necessary to first bring the master controller to the "off" position. A Westinghouse over-speed relay is provided, which opens the main motor circuit when the armature speed exceeds the safe limit.

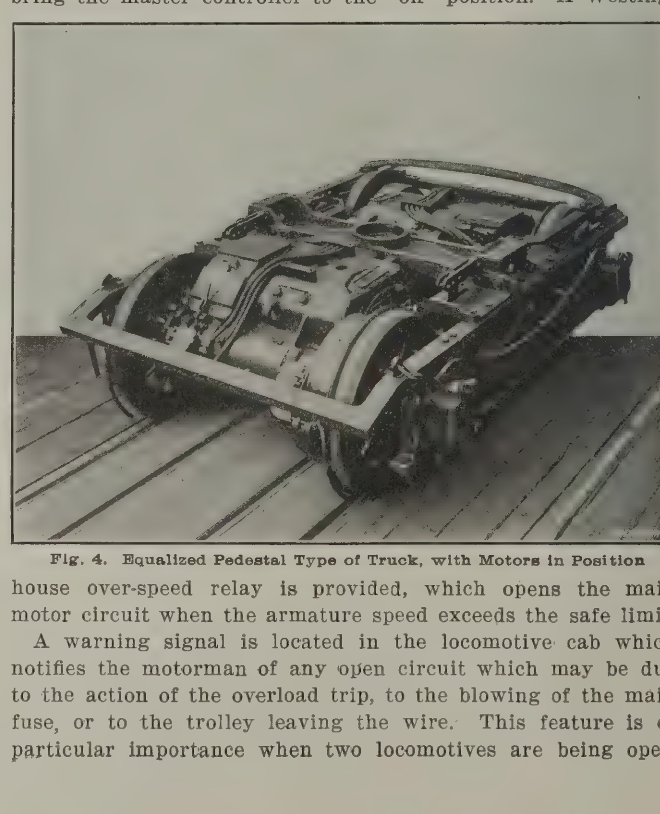


Fig. 4. Equalized Pedestal Type of Truck, with Motors in Position

A warning signal is located in the locomotive cab which notifies the motorman of any open circuit which may be due to the action of the overload trip, to the blowing of the main fuse, or to the trolley leaving the wire. This feature is of particular importance when two locomotives are being oper-

ated in tandem, as it makes sure that the operator will be notified, should the main circuit on the rear locomotive be opened accidentally.

The air brake equipment includes two D-4-K Westinghouse dynamotor driven compressors. Each of the D-4-K compressors has a displacement capacity of approximately 50 cubic feet of free air per minute. The dynamotors for operating the air compressors were supplied by the Westinghouse Electric & Mfg. Co. The dynamotor runs constantly, while the friction clutch, pneumatically operated and controlled by the main reservoir pressure, will cut in the compressor whenever necessary to maintain a predetermined pressure in the main reservoir. Each dynamotor consists of two sets of armature and field windings, which are mounted respectively in the same slots and upon the same poles. When the locomotive is operated on 1200 volts, the two windings are connected in series, and current for the lights and controller apparatus is tapped midway between the two, providing a voltage of 600 to ground. When operating on 600 volts, one set of the armature and field coils will be cut out and the remaining set will operate as in a series motor.

Two fans for supplying forced ventilation to the main motors are mounted on the extended shafts of the two dynamotors; in addition to their function of supplying cooling air, they serve as a light load to limit the speed of the dynamotors when the compressors are not in service. With natural ventilation, the motors and auxiliary apparatus on each locomotive have sufficient capacity to enable it to exert a tractive effort of 5600 pounds continuously. With blowers in operation, the locomotive will exert a continuous tractive effort of 11,520 pounds, and for a period of one hour, a tractive effort of 21,600 pounds at a speed of 17.6 miles per hour with 600 volts at the motors. With clean dry rails, the locomotive can exert a momentary tractive effort of 30,000 pounds.

* * *

HEAT TRANSMISSION THROUGH BUILDING WALLS

In considering the rate of transmission of heat through building materials, considerable uncertainty exists in regard to the accuracy of the results obtained, on account of varying conditions of wind and weather, leakage, exposure, and a number of other causes. The problem becomes especially puzzling when the engineer is called upon to deal with materials with which his profession has not had experience.

The modern tendency to construct shops and manufacturing establishments with large window areas—where the concrete or steel frame frequently forms little more than a grid—has directed considerable attention to the calculation of the heating requirements of such buildings. The Green Fuel Economizer Co., Matteawan, N. Y., has recently installed hot-blast heating equipments in a number of concrete and glass buildings, and also in buildings covered with sheet metal. This installation recently afforded an opportunity to ascertain the transmission of heat through one of the sheet-metal buildings last referred to. This shop has a continuous window space on one side 15 feet high and on the opposite side 19 feet high. The walls of the building consist of corrugated iron of single thickness and without lining. The crevices at the eaves are filled with asbestos, the corrugated iron is cemented in at the bottom, and other precautions have been taken to make the building as nearly air-tight as possible. The exposure of the windows is east and west, the smaller windows being on the east side.

The coefficients given by different authorities for the rate of heat transmission through single windows vary somewhat. Prof. Homer Woodbridge gives this coefficient for single windows with a southern exposure as 1 B. T. U. per square foot per hour, per degree difference between the inside and outside temperatures. This figure is increased 35 per cent for northern exposures, 25 per cent for western exposures, and 15 per cent for eastern exposures. The only available figure for corrugated iron without sheathing is the one determined by Rietschel, which is 2.132, but no statement is given as to whether it refers to superficial wall area or to the actual surface of the iron.

In the case of the building under discussion, the total surface is made up of approximately 7538 square feet of window space which includes the sash, 8247 square feet of wall space, and 11,925 square feet of roof. The surfaces of both walls and roof are given in superficial area, and in order to account for the corrugation in the iron, this value must be multiplied by a factor of 1.35. This gives the total area of the walls and roof as $20,172 \times 1.35 = 27,232$ square feet.

The building is heated by a Green hot-blast heater with the assistance of an engine-driven centrifugal fan drawing through a "Positiv-flo" heater made up of six sections of four rows of piping. The sections measure 7 by 8 feet. The heater is ordinarily drained of condensate and air by a Dexter vacuum system. There are altogether 6816 lineal feet of one-inch pipe in the heater, which is equal to 2272 square feet of heating surface. The air is distributed throughout the shop by circular sheet-iron conduits with their outlets directed down into the zone occupied by the workmen.

The temperature of the building was maintained constant during the test which covered a period of three hours. The fan was run at 258 R. P. M., and received 22,416 cubic feet of air per minute, figured at a temperature of 50 degrees F; this air was actually received by the heater at a temperature of 73 degrees F., and delivered from the fan at 156 degrees F. The temperature of the steam in the heater was 212 degrees F, and the temperature of the air delivered from the furthest outlet was 141.5 degrees F. Under these conditions the temperature of the building, measured at a distance of three feet from the floor, was found to be 66 degrees F., and measured in the gallery, it was 70 degrees F.; the temperature outside the building at the time of the test was 15 degrees F.

Two methods were employed for the determination of the total heat supplied. The first method consisted in calculating the heat from the rise in temperature of the air passed through the heater. By the second method, the heat was calculated from the condensation taking place in the heater. For the latter purpose the steam pipe from which the steam was introduced to the heater was carefully drained and the condensate from the heater was weighed. Figured by the air method, the consumption of heat was 2,084,000 B. T. U. per hour, and by the condensate method 2,029,730 B. T. U. per hour. Using these figures, it appears that the average rate of heat transmission through the superficial area of the building was 1.42 B. T. U. per square foot, per hour, per degree difference in temperature, and using the value obtained by the steam method, the coefficient is 1.38 B. T. U. per square foot, per hour, per degree difference in temperature.

Taking Prof. Woodbridge's figures for the rate of heat transmission through the windows, we would get 1 B. T. U. per square foot, per hour, per degree difference in temperature as the coefficient for a southern exposure. This value must be increased by 15 per cent for an eastern exposure, and 25 per cent for a western exposure, or an average value of approximately 20 per cent for the present case; this gives the value of 1.2 as the coefficient for the window surface. The value of the coefficient for the corrugated iron, merely figuring the superficial area, is 1.5. Figuring the entire surface of the iron gives the value of the coefficient as 1.13, which is less than an equivalent amount of glass surface. This result seems hardly correct, although it may be so, the explanation being that the corrugations in the iron protect the surface to a certain extent, thus making the heat transmitted from a square foot of corrugated iron less than it would be from an equal surface of flat metal.

Allowing for many indeterminate conditions, it would probably be safe in calculating the heat supply for buildings of this kind to provide for a coefficient of transmission of 2 B. T. U., per square foot, per hour, per degree difference in temperature for the whole wall and roof area.

* * *

In an article in *Gluckauf*, Mr. S. Schulte states that the erosion of the blades of a steam turbine produces changes which have a serious effect upon the efficiency of the turbine. The lateral wear of the bearings has also a detrimental effect on the efficiency, and the duration of the blade decreases with increasing steam velocity. It is pointed out that temperatures of over 480 degrees F. may totally destroy bronze blades

in from two to four years. Nickel steel with 25 per cent nickel has been found almost useless for turbine blades. The best metal for blades is nickel steel with 5 per cent of nickel. As a specific example of the decreasing efficiency of a steam turbine after use, it may be mentioned that in one case a turbine of 500 K. W. capacity running at 3000 revolutions per minute showed an increase in steam consumption of 27 per cent after it had been running for 29,700 hours. Hence, it appears that in order to maintain the initial efficiency of a steam turbine, it may require occasional re-blading.

MAKING NEW DEPARTURE BALL-BEARINGS*

MACHINING AND GAGING METHODS EMPLOYED IN PRODUCING THE "TWO-IN-ONE" BEARING

BY CHESTER L. LUCAS†

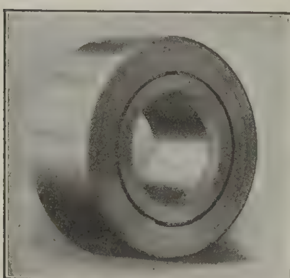


Fig. 1. The New Departure Two-in-one Bearing

THE factory of the New Departure Mfg. Co., Bristol, Conn., is now being operated to its full capacity in the manufacture of ball bearings. This healthy state of business is largely due to the increasing number of uses to which ball bearings are now being put and the realization of the economy effected by their use. But a few years ago, the principal use to which ball bearings were put was in the main bearings of the bicycle. From this, however, the field for the use of the ball bearing has broadened until it now is an important factor in the mechanism of automobiles, and is making rapid strides in the machine tool field. The future bids fair to see ball bearings in general use in machine tools. In order to give the readers of MACHINERY a general insight into the ball bearing industry,

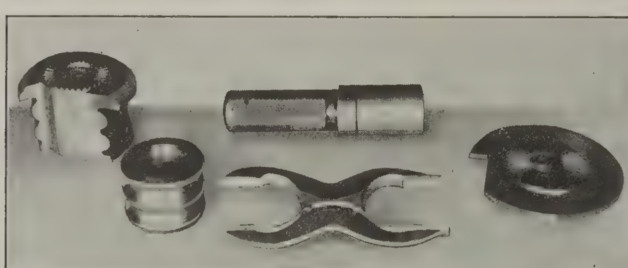


Fig. 2. Special Tools used in Machining the Cone

this article will describe briefly the machining operations connected with making the parts of a typical bearing.

The New Departure Mfg. Co. makes three distinct types of ball bearings, namely: the single-row, the double-row, and the radax. These, of course, are made in numerous sizes, and as it would be obviously impractical for us to take up the description of the manufacture of more than one, the double-row ball bearing has been selected on account of its general utility

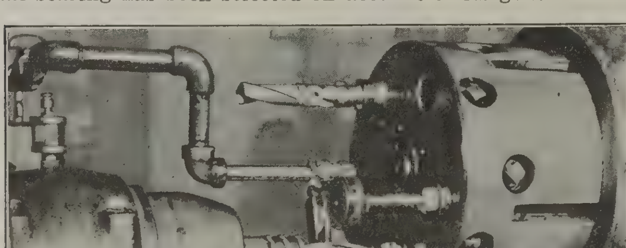


Fig. 3. Machining the Cone

as well as on account of the interesting machining operations connected with its manufacture.

The double-row ball bearing is illustrated in Fig. 1, and in Fig. 6 it has been shown in side elevation and in section in order to make the construction and relation between the several parts as clear as possible. It will be seen by a glance at the latter illustration that the bearing has been designed particularly to resist both radial and thrust stresses. Moreover, on account of the two rows of balls, its capacity for load-carrying exceeds that of any other type of bearing, and it is more efficient than two single-row bearings would be

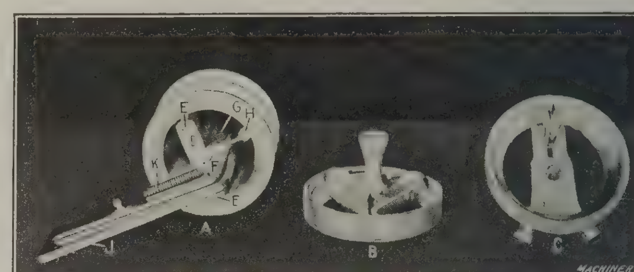


Fig. 4. Gages used on Bearing Parts

placed side by side. In the double-row bearing it is assured that each row of balls will carry a proportional part of the load, a condition mechanically impossible in two separate bearings. The parts of this bearing are, the cone or inner member, the two cups or outer members, the two bronze ball separators, the steel shell which holds the bearing parts together, and, of course, the steel balls themselves.

Turning the Cone

In taking up the machining of the parts of the New Departure bearing itself, the cone naturally comes first in order.

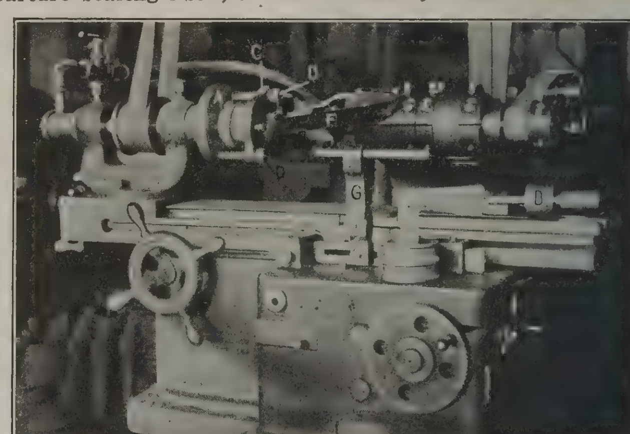


Fig. 5. Grinding the Cone Bore

This part is shown in detail in Fig. 8. By referring to the illustration Fig. 3 it will be noticed that the production of this cone is a simple screw machine job and is handled effectively on a Cleveland automatic. The working tools may be plainly seen in this illustration, and it will be noticed that circular forming tools are used. Attention is called to the fact that these forming tools are made from low carbon steel and carbonized. The cone is first formed, the forming tool being so shaped as to finish the end of the bar and partly sever the piece, as well as to turn the races for the balls. The piece is then drilled, reamed and cut off. Fig. 2 is shown to illustrate the forming tool, cut-off tool, plug gage and limit gage for the race section. It will be noticed that the sides of the cut-off and forming tool are radially serrated to facilitate holding in the forming tool fixture.

Grinding the Cone

The cone and the cups which will be subsequently described are, of course, hardened. The first operation in grinding the cone after hardening is shown in Fig. 5, in which is illustrated a special grinding machine for grinding the bore

* For additional information on this subject previously published in MACHINERY, see "Ball and Roller Thrust Bearings," August, 1912, engineering edition, and articles there referred to.
† Associate Editor of MACHINERY.

of the cone. For this purpose, the cone is held on the faceplate *A* of the machine illustrated, and it is located thereon by means of plug *B* shown on the end of the table. As will be noticed, this locating plug has a pilot which fits into a corresponding hole in the body of the faceplate. By means

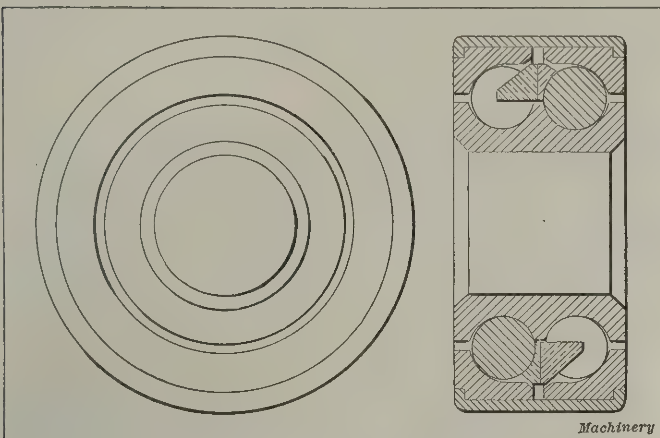


Fig. 6. Details of Bearing

of the larger section of the locating plug, which is a close fit for the bore of the unground cone, the work is located centrally under the clamping plate *C*. This clamping plate is held against the work by two retaining screws *D*. When released, the clamping plate is held back against the heads of the screws by means of spiral springs. A test indicator *F*, mounted on the bracket *G*, may be swung into position to prove the alignment of the work before grinding. For this

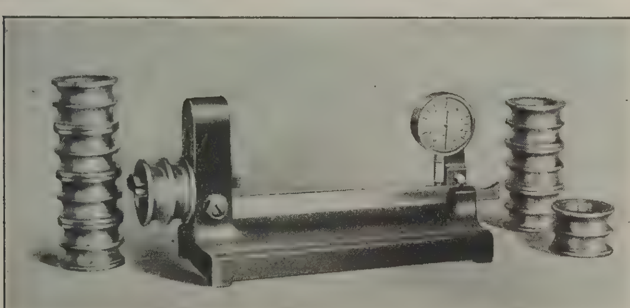


Fig. 7. Gaging Fixture for Cone Bores

and succeeding grinding operations on this class of work which will be described, the speeds used are 300 R. P. M. for the work spindle, and for the grinding wheel a peripheral speed of 5000 feet per minute is employed.

The accuracy of the grinding of the bores of these cones is held to 0.0005 inch, and this accuracy is tested from time to time by means of the special gaging device which may be seen within the bore of the cone in front of the machine. This

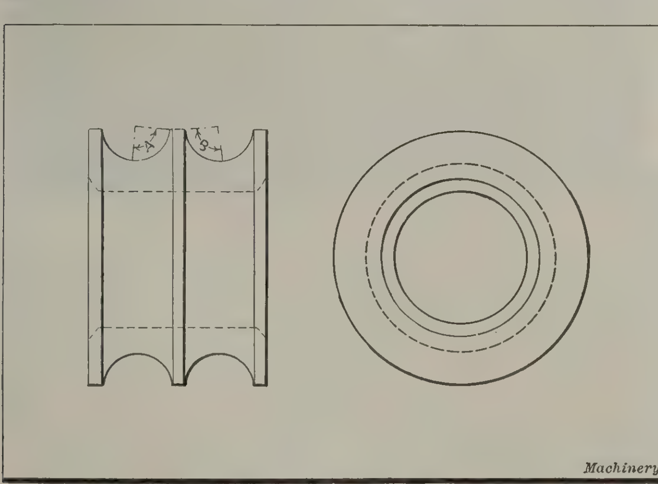


Fig. 8. Details of Cone

gage is shown in another position at *A* in Fig. 4. In this illustration it will be seen that the gage consists of a body *D*, supporting at its outer ends two hardened steel bearing pins *E*, and hinged at a central location is gaging arm *F*, fulcrumed on stud *G*. The short end of this bent lever terminates in a ball *H*, while the long arm ends in a needle point which indicates the size of the bore upon the graduated surface *J*. By means of spiral spring *K*, the gaging lever remains normally at its outermost position. Thus, by merely inserting the gage in the bore of the cone, the exact size is at once indicated upon the graduated section. By gaging from a three-point bearing, maximum accuracy is secured.

The grinding of the races in the cone is illustrated in Fig. 10, in which the cone *A* may be seen upon the arbor *B*. The grinding wheel *C* has a formed face and is used for finishing the races. By referring back to Fig. 8, it will be noticed that the balls bear only upon the two inner sides of the races along the section indicated by *A* and *B*. This, of course, facilitates meeting the requirements demanded in grinding the races, and the operation resolves itself into grinding these two sections of the cone races at correct radii whose centers are located at proper distances from each other. Referring again to Fig. 10, indicating gage *D* is used to locate the cone at the proper position upon the arbor *B*, after which one of the races is ground. Then by moving the wheel the proper distance to

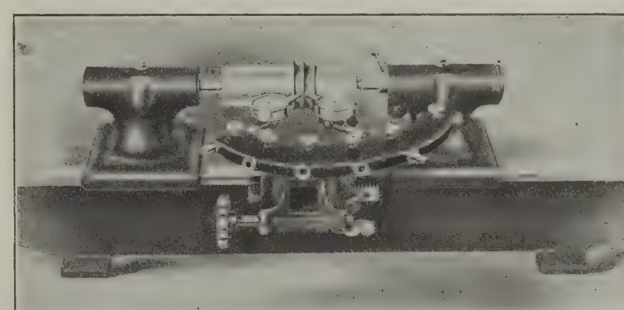


Fig. 9. Gaging Fixture for Cone Races

the left, the other radius is ground, which completes this part of the work.

Gaging Fixtures for Finished Cones

The grinding of the cones is held within close limits of accuracy. To assist in maintaining proper standards, the two gaging fixtures shown in Figs. 7 and 9 are made use of. In Fig. 7 is shown the method of gaging the cone bores. This fixture is similar to the one shown at *A* in Fig. 4, but it is far

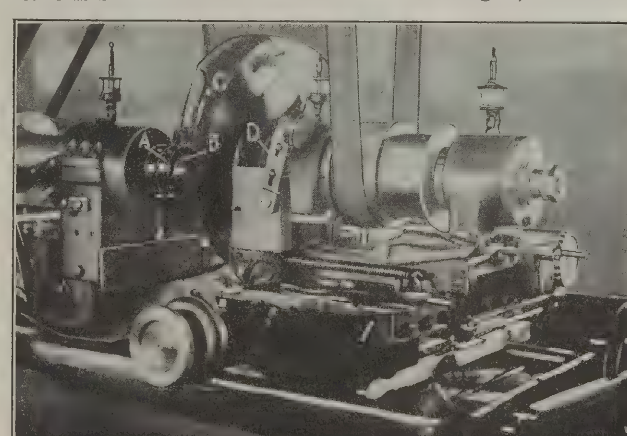


Fig. 10. Grinding the Cone Races

more accurate. The cones are slipped over the stud which may be seen at the left-hand end of the fixture. This stud is fitted with a two-point bearing, and the gaging arm forms the third point. A multiplying lever extends to the other end of the fixture and the end of this lever bears against the plunger of the dial gage shown. Any variation in the size of the bore is thus multiplied ten times and an error of 0.0001 inch is thus indicated as 0.001 inch on the dial.

The machine shown in Fig. 9 is used for determining the accuracy of the ball race grinding. This machine is fitted with two indicators connected with the dial gages shown, each of which acts upon one of the ball races. The cone is held upon an arbor centering it, and the machine indicates errors of 0.0001 inch in either parallelism or concentricity of the races.

Machining the Cups

The cups of New Departure ball bearings are made from drop forgings, and the general lines of the finished cup are

shown in Fig. 11. The first operation in the machining is shown in Fig. 12, being done on a Fay automatic lathe. In this illustration, the work *A* is shown gripped in a universal chuck, the jaws *B* holding the work firmly from the outside. Mounted on carriage *C*, is the forming tool, which is fed into

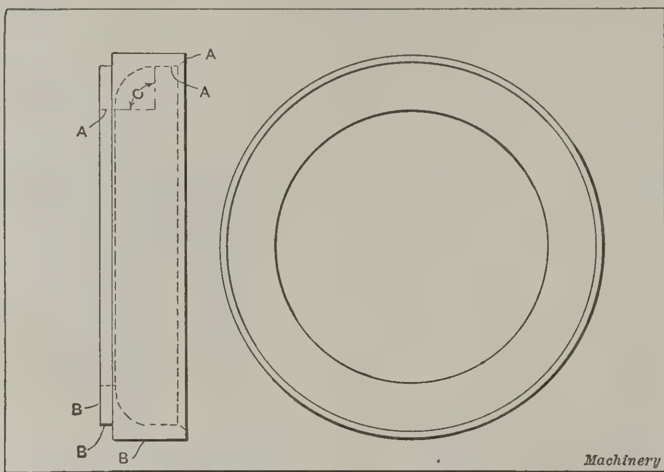


Fig. 11. Details of Cup

the work, producing the shape required for the ball race. At the same time, facing tool *D* is at work finishing the edge of the cup. Referring to Fig. 11, the surfaces indicated at *A* are finished in this operation. Two of the gages used in checking the turning operation of the inside of the cups are

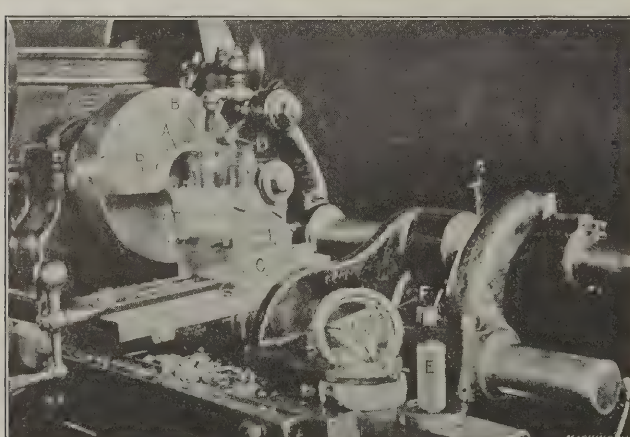


Fig. 12. Machining the Inside of the Cup

shown at *E* and *F*, *E* being the plug gage for testing the interior diameter, while *F* is the radius gage for checking the internal diameter and radius of the turning of the race.

The semi-machined cups next go to another Fay automatic lathe, where the outside parts of the work are machined.

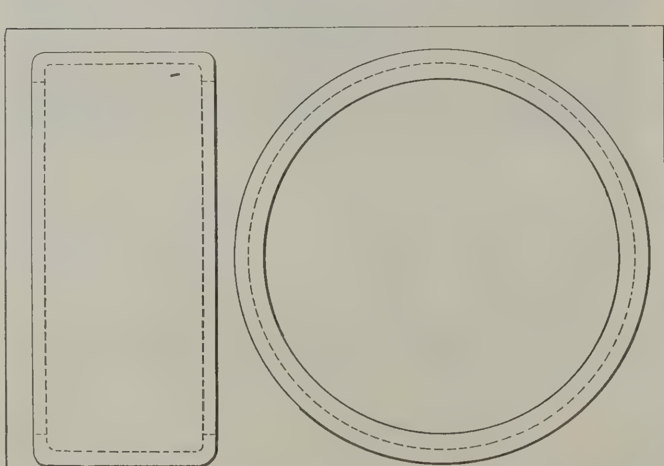


Fig. 13. Details of Shell

This operation is clearly shown in Fig. 14. The work is held in a special chuck *A*, the principal parts of which are the expanding jaws *B* which grip the work by the inside edge and are expanded when the operator turns in the central tapered screw *C*. The work being thus securely held, the outside face is turned by a combination of turning tools on the carriage *D*. These tools are located at a fixed distance apart on carriage *D* and operate simultaneously upon the work. While the edge of the cup is being turned, facing tool *E* is at work finishing the face of the cup. The accuracy of these turning operations is checked by three gages, of which the one shown in part at *F* gages the outside diameter, the one shown at *G* checks the turning of the face and edge, while that shown at *H* controls the thickness of the cup.

Grinding the Cups

The Norton automatic grinding machine shown in Fig. 19 is used for grinding the outside edges of the cups. The operation of the machine is extremely interesting, and is essentially as follows: The cups are fed into the chute *A*, dropping down against a pin whose movement is controlled by slide *B* automatically operated through link *C*. This slide is withdrawn, allowing one cup to drop between the spring

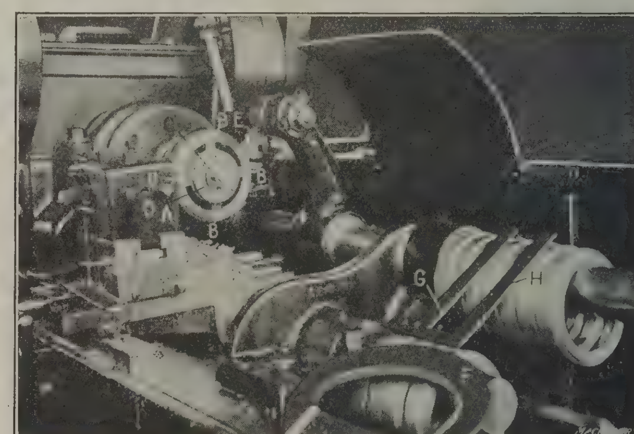


Fig. 14. Machining the Outside of the Cup

plungers of the grinding machine. These plungers correspond to centers, and their purpose is to locate and drive the work. After being chucked, the grinding wheel is passed across the face of the work, the number of times having been previously determined in accordance with the finished size desired. After the cup has been ground, the plungers automatically

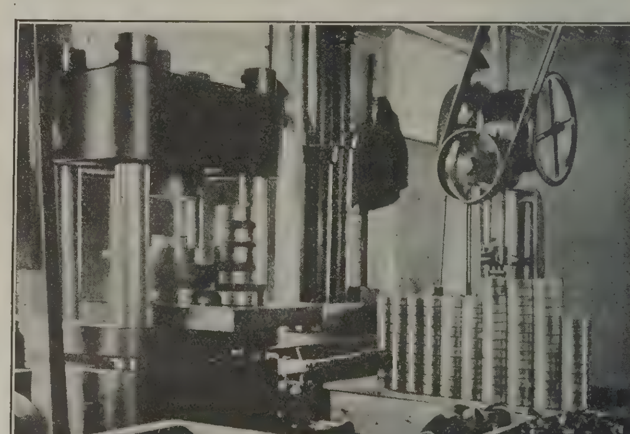


Fig. 15. Presses for Assembling Bearing Parts

open, allowing the ring to drop upon an endless belt while a new piece is being received by the plungers. The ejected piece is carried by the endless belt to the box containing the completed work, which may be seen at the left of the machine.

From time to time, the grinding of this automatic machine is checked on the Ames gage, shown on the standard at the left of the machine. The cups are slipped under the gaging arm until they reach the stop at the left. Errors of 0.0001 inch are magnified on the dial and thus easily perceptible.

Grinding the Cone Races

From the automatic grinding machine, the cups go to the oscillating machines which grind the races. Working parts of one of these machines are shown in Fig. 18. The cup is held by a magnetic chuck *A*, being located centrally thereon by means of fingers *B*. The current is supplied to this magnetic

chuck by means of feed wires C which run to a contact constantly bearing on a similar contact flange on the rear side of the chuck spindle. The wheel spindle D carries a grinding wheel whose edge has been shaped to a radius slightly smaller than that of the race to be ground. The oscillating head of the machine, which carries the chuck and work, is located so that the path traversed by the work coincides with the radius of the race. This location is reached by moving the head to or from the oscillating center upon the slide. The

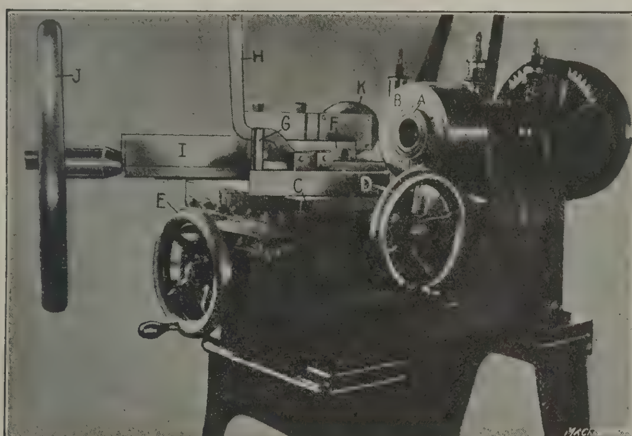


Fig. 16. Spinning the Edge of the Shell over the Assembled Bearing

oscillating mechanism consists of a crank and arm at the rear side of the machine (not shown) which causes the head to traverse a path extending over 120 degrees of a circle. Two gages are used continuously upon this work, these being shown at E and F. These two gages are shown on a larger scale in the illustration Fig. 4, where they are indicated as B and C. Gage B is for testing the accuracy of the diameter and radius of the ground race, and consists of a central triangular body from which three hardened and ground steel disks are supported. These disks are ground with knife-edges, and are of proper diameter to coincide with the curve of the race. The gage shown at C in Fig. 4 is used more especially as a check on the size of the radius and consists principally

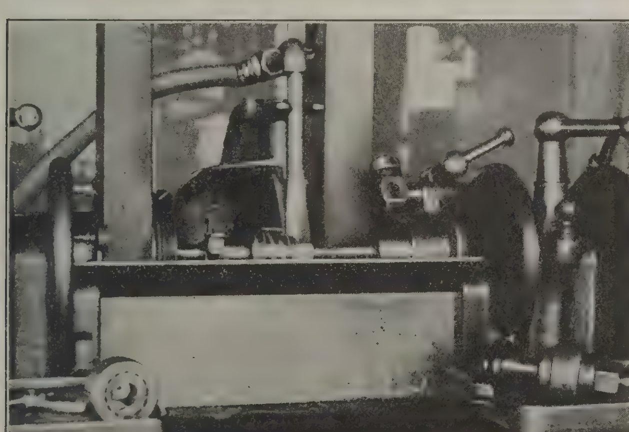


Fig. 17. Finish-grinding the Outside of the Bearing

of a base with two locating lugs and a hardened steel disk similar to those before described, but in this case the disk is mounted on the end of a lever fulcrumed in the body of the gage. Referring again to the gage as shown at F in Fig. 18, which illustrates the other view of the gage, a spring may be seen which tends to keep this disk as far as possible from the locating lugs at the other end. In Fig. 4, the gage is shown in use, and by this means it is possible to see if the race is being ground to the correct radius.

Assembling the Bearing

The parts of the bearing are kept in the proper relation to each other by means of an enclosing shell. This shell, shown in Fig. 13, is of soft sheet steel, and made by a series of ordinary press operations, consisting of cutting and drawing in combination press tools. As it leaves the press, the cup has a bottom at one end and the edges are, of course, straight and more or less irregular. The bottom is therefore punched out, leaving a flange of the proper width to complete this end of the shell. The reverse end is trimmed for a distance that will permit of its being rolled in to form the second flange.

In assembling the bearing, forcing presses are used of the two types shown in Fig. 15. The press in the foreground is a hydraulic press, and the one in the background is operated by a friction drive. A cup is first forced into the shell, after which the cone, a set of balls and a separator are dropped in; then comes the second separator, the second set of balls and the second cup. As the cups fit tightly within the shell, they are forced into their respective places by means of the presses, the second cup being inserted to a point where it just touches the second row of balls.

Rolling the Flange

The rolling-in operation now follows, being done in the machine shown in Fig. 16. The rolling-in operation, or as it is

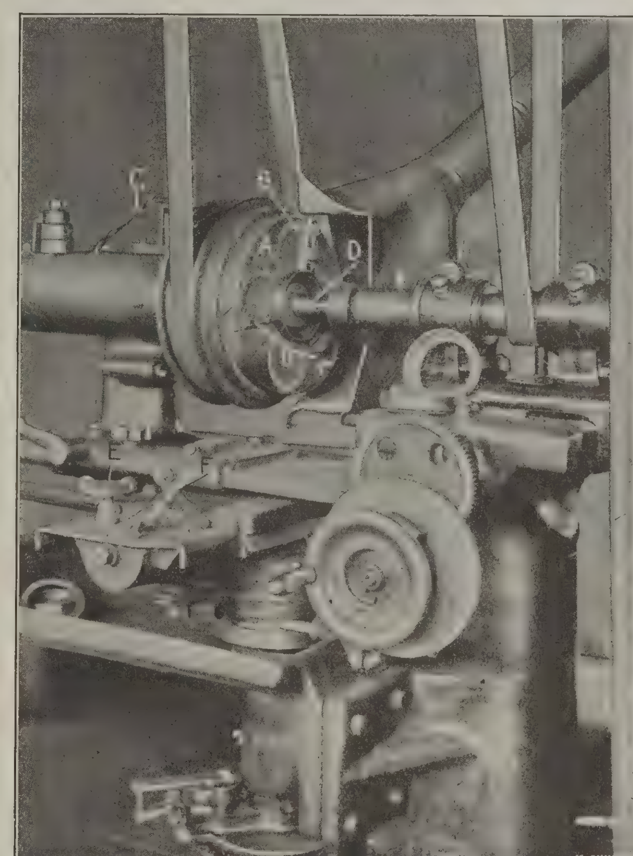


Fig. 18. "Oscillator" Grinding Machine for Cup Races

called, the spinning-over of the shell, is accomplished in three operations, all of which are performed on this machine. Referring to Fig. 16 in connection with the line engraving Fig

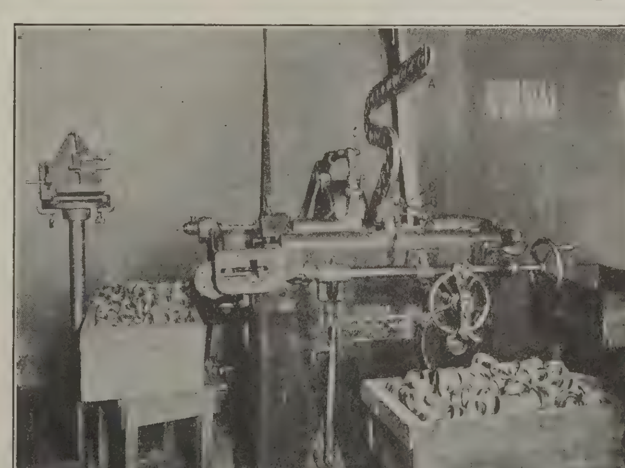


Fig. 19. Norton Automatic Cup-grinding Machine

21, the work done in these three operations may be followed. The bearing A is held within the collet chuck B, which is mounted on the spindle of the machine. The carriage C of

the machine is operated in a lateral direction by handwheel D, and in a longitudinal direction by handwheel E. Mounted upon this carriage is the rolling fixture F which may be swiveled to any one of three positions, being held in any of these positions by means of the index pin G, which is lifted by handle H. Corresponding index-pin holes are, of course, located in the body of the carriage. A slide I operates on this carriage by means of the large handwheel J. On the forward end of this slide the roll K is mounted. This roll is of hardened steel and has a face approximately 1½ inch wide.

In operation, the carriage is indexed to a position sixty degrees from the center line of the bearing, as shown at A

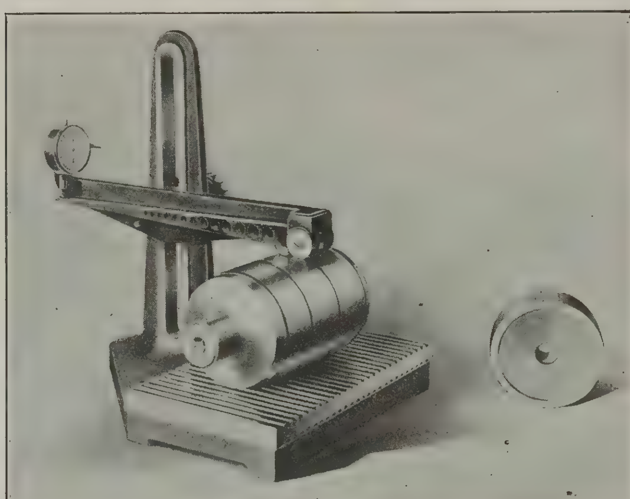


Fig. 20. Testing the Diameter of the Finished Bearing

in Fig. 21, at which position the roll is brought up to the flange, causing it to turn inward to an amount corresponding with this angle. In the meantime, the bearing is being rotated against the roll. The result of this operation is shown at B in the line engraving Fig. 21. This being done, the ratchet is indexed to the second position. In this second

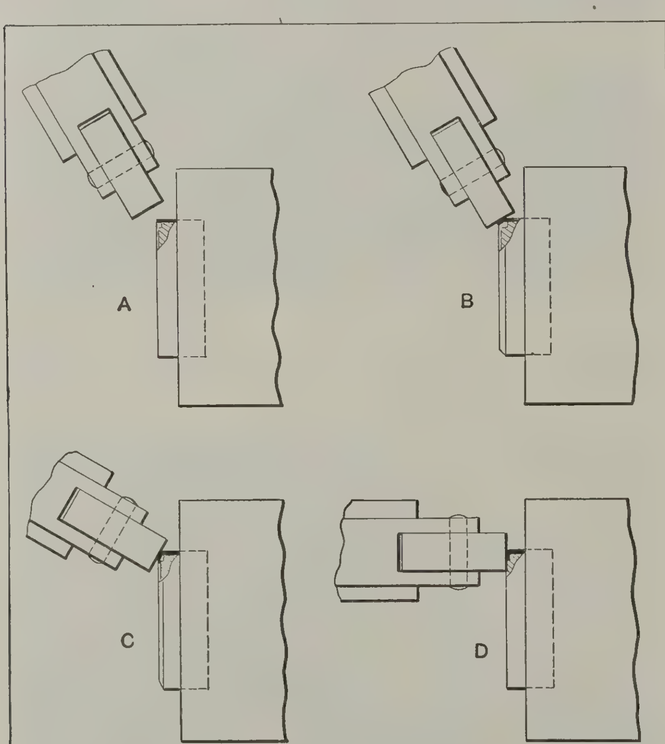


Fig. 21. Steps in Spinning over the Edge of the Shell

position, the slide on the carriage stands at a position of thirty degrees to the center line of the bearing, and, consequently, when the roll is brought into conjunction with the work by means of the large handwheel J, the flange of the shell is turned inward a corresponding amount, leaving the bearing and shell in the condition shown at C in Fig. 21. As soon as this part of the work is done, the roll is again withdrawn and the carriage swiveled to a position in line with the center line of the bearing, after which the edge of the shell is rolled down into the recess in the outer cup of the bearing, leaving it finished as shown at D in Fig. 21. During the three rolling operations, the roll is fed from the outside of the shell inward, by means of lateral feed-screw handle D.

Finish-grinding

In order to give the bearing a finished appearance, as well as a truly concentric exterior, it is ground all over after it has been assembled. These grinding operations, which face off the ends and periphery of the bearing, are comparatively simple, the first being performed in ring grinding machines, and the second upon plain grinding machines, as shown in Fig. 17. For this latter grinding operation, the bearing is held upon an arbor having a fixed collar against which the bearing is clamped by means of a washer and nut.

Finish-inspection and Test of the Bearings

Fig. 20 illustrates a gaging fixture used by the inspectors who pass upon the finished bearings. The gage consists of a multiplying lever whose outer end acts upon an Ames gage. A master testing disk is shown at the right, by means of which the reading of the gage is checked from time to time. In the illustration, three bearings are shown under test.

The master measuring machine shown in Fig. 22 is used for miscellaneous inspecting, but more particularly for the checking of the master plugs, disks and ring gages which are examined every day to insure that they are accurate. This

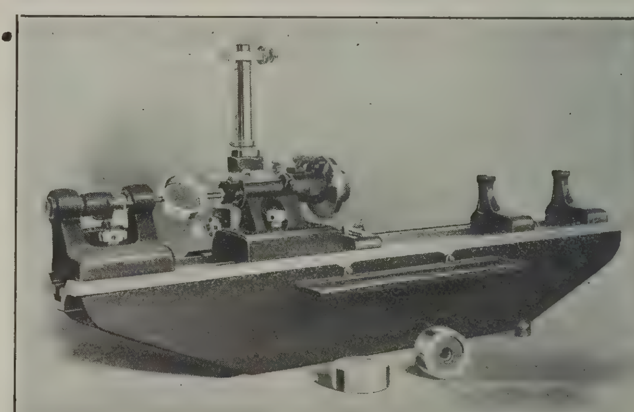


Fig. 22. Master Measuring Machine

machine is fitted with a microscope to facilitate the proper setting of the vernier. In this illustration it is shown with one of the cups between its measuring points.

* * *

LUBRICATION OF MACHINE TOOLS

In an article on machine tool lubrication abstracted from *L'Industria* in the foreign review of the *Journal of the American Society of Mechanical Engineers*, attention is called to the fact that inefficient lubrication in machine tools is the principal cause of the rapid deterioration of this class of machines. It is the minor or secondary working parts, it is stated, which most easily get out of order. The main parts are provided with sufficient and continuous lubrication, while the secondary parts are left to be lubricated by the workman squirting oil through an oil hole from time to time. These oil holes, however, often become clogged with dirt; besides, the lubrication of the minor working mechanisms of the machine is often neglected. This was of little consequence as long as the speeds of machine tools, in general, were low and the power small, but it has become a very important factor under present-day conditions. Some American manufacturers, says the writer, are beginning to design machine tools with automatic lubrication throughout, but this practice is not yet as general as it ought to be.

* * *

RESTORING OVER-EXPOSED BLUEPRINTS

C. J. Kranz of Chicago, Ill., writes that over-exposed blueprints can be restored if immersed in hot water. He has used hot water successfully for restoring blueprints when the white lines were blue and the portions that should normally be blue were steel gray.

A BETTER MAGAZINE—A PLEA FOR COOPERATION

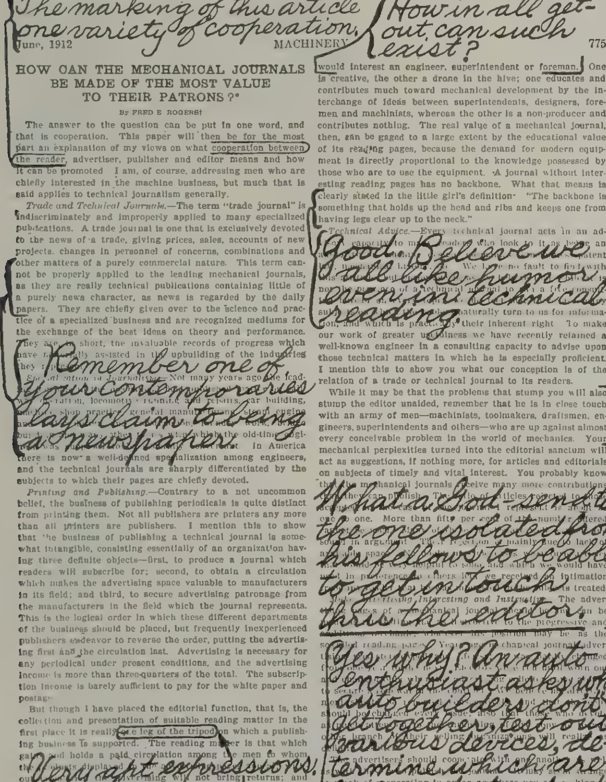
BY JOHN S. MYERS*

Am I an editor? No. Then why an editorial from my pen? Because I am a reader who understands that the reader is to a magazine what the common people are to a popular government—he's IT, or should be. Why is the reader IT? Because he is the person for whom the magazine is published. If the magazine appeals to a reader he is likely to interest his friends. This boosts the circulation, and enlarged circulation means more advertisers, hence more income for the magazine to spend on good articles.

Every triangle has three angles and three sides. In an equilateral triangle the three sides, and consequently the three angles, are equal. The conscientious publisher tries to make his enterprise an equilateral triangle, but he can do it only with cooperation. The three sides are the publishers, the readers and the advertisers; the three angles are the viewpoints of these three sides.

Now how can you obtain a better magazine? By cooperating, by making intelligent comments on the articles published, by contributing articles, by joining the staff of educators. Remember that if the magazine is not what you would have it, you are partly to blame.

One way of aiding the contributors to MACHINERY is to write your comments on the margin of the article and send them to the editor or the author. This shows at least that you have read the subject matter and were interested. Your suggestions may bring forth fruit. For example, see the accompanying reproductions of the pages of an article with comments.



The marking of this article one variety of cooperation.

How in all get-out can such exist?

June, 1912 MACHINERY 775

HOW CAN THE MECHANICAL JOURNALS BE MADE OF THE MOST VALUE TO THEIR PATRONS?*

By FRED E. ROGERS†

The answer to the question can be put in one word, and that is cooperation. This paper will then be for the most part an explanation of my views on what cooperation between the reader, advertiser, publisher and editor means and how it can be promoted. I am, of course, addressing men who are chiefly interested in the machine business, but much that is said applies to technical journalism generally.

Trade and Technical Journals.—The term "trade journal" is indiscriminately and improperly applied to many specialized publications. A trade journal is one that is exclusively devoted to the news of a trade, giving prices, sales, accounts of new projects, changes in personnel of concerns, combinations and other matters of a purely commercial nature. This term cannot be properly applied to the leading mechanical journals, as they are really technical publications containing little of a purely news character, as news is regarded by the daily papers. They are chiefly given over to the science and practice of a specialized business and are recognized mediums for the exchange of the best ideas on theory and performance. ...

Remember one of your contemporaries lays claim to being a newspaper.

... In America there is now a well-defined specialization among engineers, and the technical journals are sharply differentiated by the subjects to which their pages are chiefly devoted.

Printing and Publishing.—Contrary to a not uncommon belief, the business of publishing periodicals is quite distinct from printing them. Not all publishers are printers any more than all printers are publishers. I mention this to show that the business of publishing a technical journal is somewhat intangible, consisting essentially of an organization having three definite objects—first, to produce a journal which readers will subscribe for; second, to obtain a circulation which makes the advertising space valuable to manufacturers in its field; and third, to secure advertising patronage from the manufacturers in the field which the journal represents. This is the logical order in which these different departments of the business should be placed, but frequently inexperienced publishers endeavor to reverse the order, putting the advertising first and the circulation last. Advertising is necessary for any periodical under present conditions, and the advertising income is more than three-quarters of the total. The subscription income is barely sufficient to pay for the white paper and postage.

But though I have placed the editorial function, that is, the collection and presentation of suitable reading matter in the first place it is really one leg of the tripod on which a publishing business is supported. The reading matter is that which gains and holds a paid circulation among the men to whom the ... not bring returns; and without advertising patronage the modern trade journal can not be maintained.

Very apt expressions.

Value of the Reading Pages.—For the sake of emphasis we will expand a little in following around the circle of relative value. It is the circulation of a paper which gives the advertising pages their value, and it is the reading pages which maintain that circulation, although we are not unmindful of the fact that a paper may be of little value, or it may contain no matter at all, and still have a circulation. There is a vast difference, however, between a paper containing high-grade technical matter and one having little or no material that would interest an engineer, superintendent or foreman. One is creative, the other a drone in the hive; one educates and contributes much toward mechanical development by the interchange of ideas between superintendents, designers, foremen and machinists, whereas the other is a non-producer and contributes nothing. The real value of a mechanical journal, then, can be gaged to a large extent by the educational value of its reading pages, because the demand for modern equipment is directly proportional to the knowledge possessed by those who are to use the equipment. A journal without interesting reading pages has no backbone. What that means is clearly stated in the little girl's definition: "The backbone is something that holds up the head and ribs and keeps one from having legs clear up to the neck."

Technical Advice.—Every technical journal acts in an advisory capacity ...

Good. Believe we all like humor even in technical reading.

... our work of greater usefulness we have recently retained a well-known engineer in a consulting capacity to advise upon those technical matters in which he is especially proficient. I mention this to show you what our conception is of the relation of a trade or technical journal to its readers.

While it may be that the problems that stump you will also stump the editor unaided, remember that he is in close touch with an army of men—machinists, toolmakers, draftsmen, engineers, superintendents and others—who are up against almost every conceivable problem in the world of mechanics. Your mechanical perplexities turned into the editorial sanctum will act as suggestions, if nothing more, for articles and editorials on subjects of timely and vital interest. You probably know that the mechanical journals receive many more contributions ...

What a God-send to the one isolated from his fellows to be able to get in touch thru the editor.

Yes why? An auto enthusiast asks why auto builders don't get together, test out various devices, determine which are best and standardize them instead of each advertising his device as best.

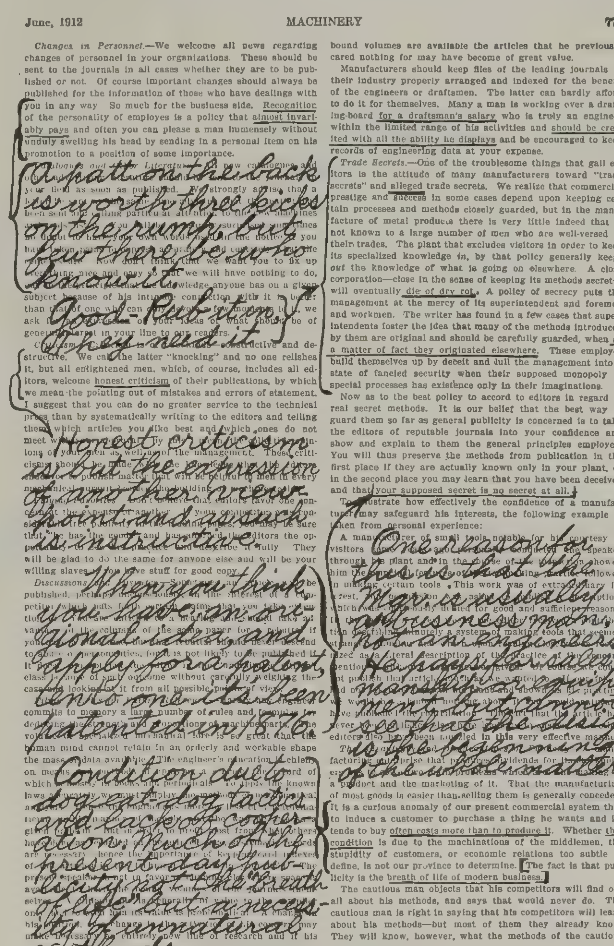
... has planned for that which certain ones of you will furnish. Now why can there not be established an understanding between groups of machine tool builders to the end that they will advertise in harmony, having in mind certain combinations of equipment, which are most often specified? Take, for ex-

* Paper read before the semi-annual convention of the National Machine Tool Builders' Association, Atlantic City, N. J., May 16-17.
† Editor of MACHINERY.

The user of course foots the bill, in the ultimate, for this needless antagonism.

A scythe is whetted by a stone, but man's intellect is best whetted by contact with other intellects similarly trained and interested. You may be marooned on an intellectual oasis, as far as personal contact is concerned, yet you have freedom of expression and response through the technical press ever at your command. The main trouble is that you do not take advantage of your opportunity. You have a right to renew or discontinue your subscription just as the fancy strikes you, but you do not realize that you also have a right to suggest ways and means for making the magazine what you would have it.

It is a joy and stimulus to a writer to know that his articles have been carefully read. Comment and criticism thereon



June, 1912 MACHINERY 777

Changes in Personnel.—We welcome all news regarding changes of personnel in your organizations. These should be sent to the journals in all cases whether they are to be published or not. Of course important changes should always be published for the information of those who have dealings with you in any way. So much for the business side. Recognition of the personality of employes is a policy that almost invariably pays and often you can please a man immensely without unduly swelling his head by sending in a personal item on his promotion to a position of some importance.

A patt on the back is worth three kicks on the rump, but few there be who know it.

Good—Rub it in. They need it.

Criticism.—Criticism is of two kinds—constructive and destructive. We call the latter "knocking" and no one relishes it, but all enlightened men, which, of course, includes all editors, welcome honest criticism of their publications, by which we mean the pointing out of mistakes and errors of statement. I suggest that you can do no greater service to the technical press than by systematically writing to the editors and telling them which articles you like best and which ones do not meet with your approval ...

Honest criticism is but the expression of another viewpoint and as such is instructive.

... They will be glad to do the same for anyone else and will be your willing slaves if you have stuff for good copy.

When you think you have an original idea, and apply for a patent, ten to one it's been patented in 1876.

Condition due to dog-eat-dog tactics and lack of cooperation. Much of the present day publicity not the "breath of life" but a necessity of unnatural methods.

bound volumes are available the articles that he previously cared nothing for may have become of great value.

Manufacturers should keep files of the leading journals in their industry properly arranged and indexed for the benefit of the engineers or draftsmen. The latter can hardly afford to do it for themselves. Many a man is working over a drafting-board for a draftsman's salary who is truly an engineer within the limited range of his activities and should be credited with all the ability he displays and be encouraged to keep records of engineering data at your expense.

Trade Secrets.—One of the troublesome things that gall editors is the attitude of many manufacturers toward "trade secrets" and alleged trade secrets. We realize that commercial prestige and success in some cases depend upon keeping certain processes and methods closely guarded, but in the manufacture of metal products there is very little indeed that is not known to a large number of men who are well-versed in their trades. The plant that excludes visitors in order to keep its specialized knowledge *in*, by that policy generally keeps *out* the knowledge of what is going on elsewhere. A close corporation—close in the sense of keeping its methods secret—will eventually die of dry rot. A policy of secrecy puts the management at the mercy of its superintendent and foremen and workmen. The writer has found in a few cases that superintendents foster the idea that many of the methods introduced by them are original and should be carefully guarded, when as a matter of fact they originated elsewhere. These employes build themselves up by deceit and lull the management into a state of fancied security when their supposed monopoly of special processes has existence only in their imaginations.

Now as to the best policy to accord to editors in regard to real secret methods. It is our belief that the best way to guard them so far as general publicity is concerned is to take the editors of reputable journals into your confidence and show and explain to them the general principles employed. You will thus preserve the methods from publication in the first place if they are actually known only in your plant, or in the second place you may learn that you have been deceived and that your supposed secret is no secret at all.

To illustrate how effectively the confidence of a manufacturer may safeguard his interests, the following example is taken from personal experience:

One reason for this is that the Mgr. is usually a business man, not an engineer. He pays for salesmanship or equipment but cannot see that the design is the beginning of the whole matter.

... a product and the marketing of it. That the manufacturing of most goods is easier than selling them is generally conceded. It is a curious anomaly of our present commercial system that to induce a customer to purchase a thing he wants and intends to buy often costs more than to produce it. Whether this condition is due to the machinations of the middlemen, the stupidity of customers, or economic relations too subtle to define, is not our province to determine. The fact is that publicity is the breath of life of modern business.

The cautious man objects that his competitors will find out all about his methods, and says that would never do. The cautious man is right in saying that his competitors will learn about his methods—but most of them they already know. They will know, however, what the methods of the cautious

spur him to further effort and put him in touch with his readers' viewpoints. If you cannot write a good article yourself, you can offer intelligent comment in the manner indicated, and will find that such mental exercise is good for you—it will teach you to read appreciatively.

* * *

NEW METHOD OF GALVANIZING IRON

A description of a new method recently patented of galvanizing iron is quoted in the United States *Daily Consular and Trade Reports* from a German publication substantially as follows: To protect iron objects from rust it is customary to coat them with zinc, deposited either electrolytically or by plunging them in a bath of melted zinc. The disadvantage of these methods is that real fusion of the two metals is not obtained, and as a result the zinc coating does not properly protect the iron surface underneath. The defect is avoided by the new process which consists in so preparing the iron that the zinc is intimately associated with the surface of the iron, being deposited into its pores. After steeping the parts to be coated in sulphuric acid, they are placed in a solution of mercuric chloride, and then heated, resulting in the decomposition of the mercuric chloride and precipitation of metallic mercury which forms an amalgam on the surface. The iron is then plunged into a zinc bath heated to 500 degrees F., where it remains three minutes. The zinc coating deposited by this method adheres very strongly to the metal. Microscopic investigation shows that the zinc penetrates into the pores of the iron, and in case a portion of the coating is worn or peeled off, the iron does not rust owing to the presence of sufficient zinc in the surface to protect the metal from the action of the atmosphere. In other words, there is a perfect alloy or association of the two metals at the point of juncture.

* Address: 2456 Almond St., Philadelphia, Pa.

SAFEGUARDS FOR POWER PRESSES*

A NUMBER OF EFFECTIVE SAFETY DEVICES ADOPTED BY LEADING MANUFACTURERS

BY EDWARD K. HAMMOND

The problem of providing for the safety of power-press operators presents two possibilities of solution. The first alternative is to use presses equipped with some form of automatic feeding device that makes it unnecessary for the operator to put his fingers under the ram. The second is to adopt some form of safeguard that keeps his hands away from the die during the working stroke of the ram.

The different forms of automatic feeding devices which have been successfully applied in power-press work were fully discussed in articles published in MACHINERY October, 1911, and January, 1912. Owing to the fact that automatic feeding removes the necessity for the operator to put his hands under the ram, presses equipped with such feeding devices are as safe as they can be made for handling the class of work required of them. These devices do not reduce the operator's output, and the only argument against them is that the first cost of presses equipped with automatic feeding devices is higher.

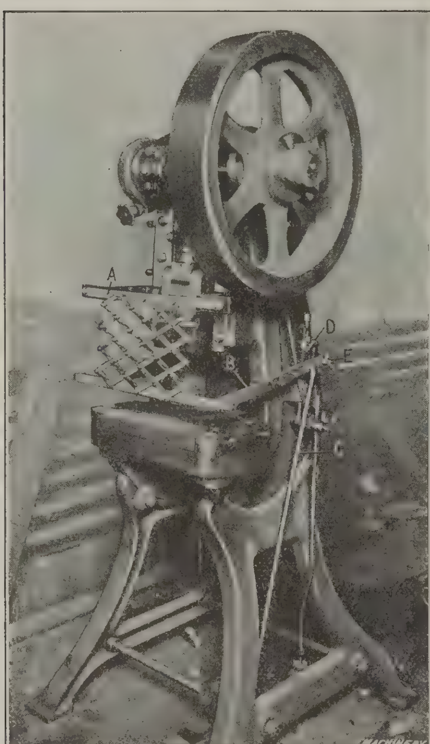


Fig. 1. The Cream City Accident Preventer made by Geuder, Paeschke, & Frey Co.

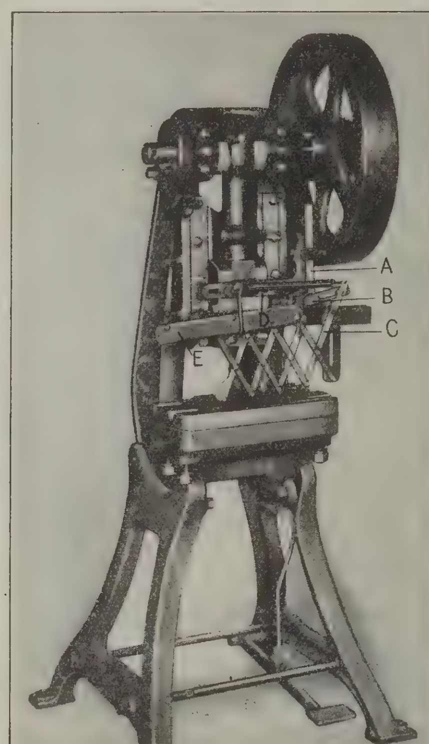


Fig. 2. Safeguard with Pantograph Gate which expands from Side

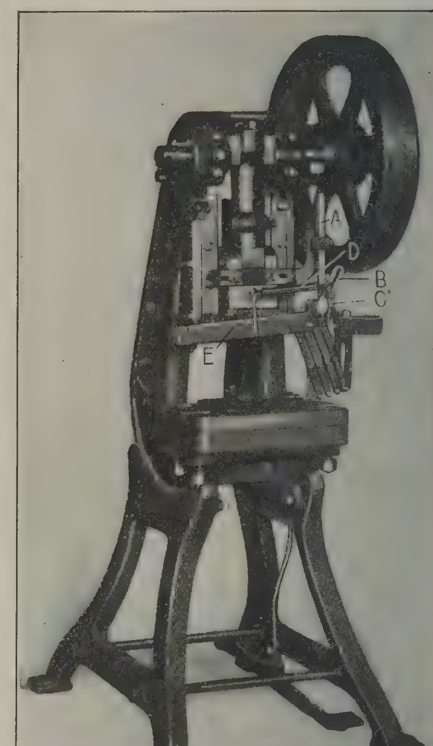


Fig. 3. Same Press as in Fig. 2, with Guard folded to One Side

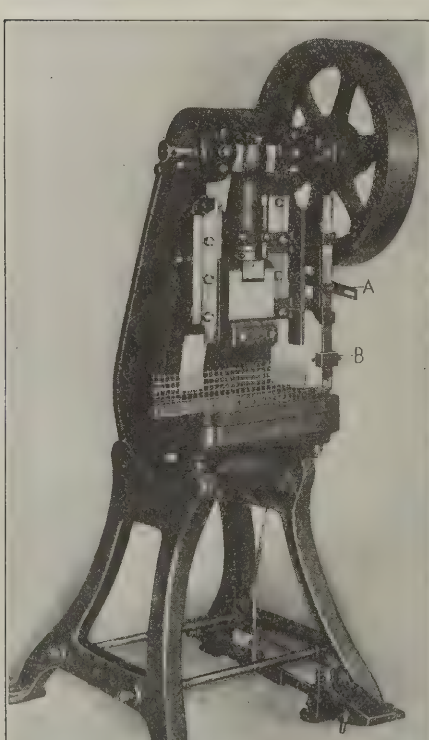


Fig. 4. The Jones Stamping Press Guard; Ram Descending

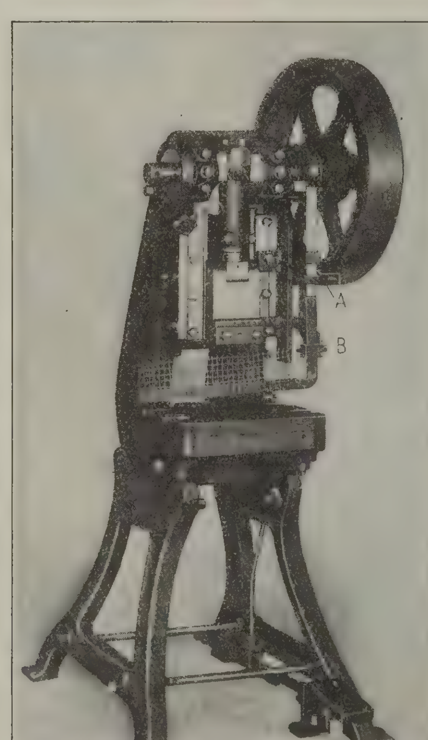


Fig. 5. The Jones Press Guard in Position before Treadle is tripped

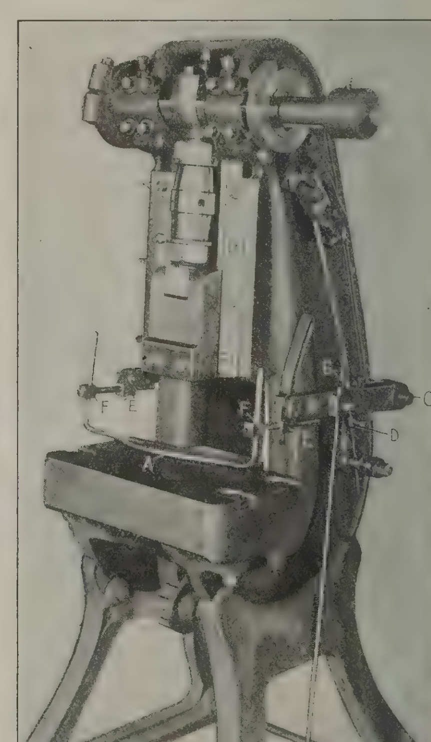


Fig. 6. Safeguard using a Bar instead of Gates

* For further information relating to the safeguarding of machinery and the prevention of accidents in shops and factories, see "Prevention of Industrial Accidents," MACHINERY, engineering edition, April, 1912, and "The Prevention of Industrial Accidents," in the engineering edition, November, 1911. See also the list of previously published matter referred to in connection with the article last mentioned.

In this article, different forms of power-press safeguards which have found successful application in well-known manufacturing plants, will be described. An important advantage in favor of their application lies in the fact that they can be used on the presses which a shop already has in operation, thus providing for the safety of the operator at a relatively small expense. Among the different types, one can almost always be found which will meet the requirements of any one class of power-press work.

The advisability of adopting every precaution to provide for the operator's safety offers little ground for discussion. Aside from humanitarian considerations, which constitute a sufficient reason, safeguards are well worth while when considered from a purely economic standpoint. The premiums charged for accident insurance for operators of power presses average about eight times the rates for operators of other classes of metal working machinery. Well designed safeguards reduce the risk involved and enable a considerable saving to be made in the cost of accident insurance.

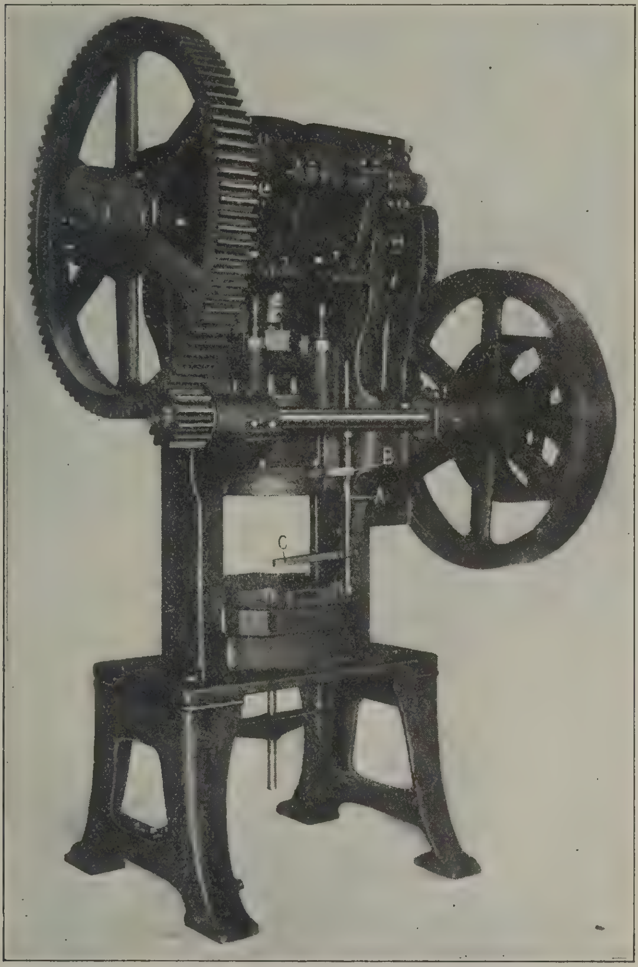


Fig. 7. Guard Bar swung over Die by a Twisted Rod

The Cream City Accident Preventer

The safeguard illustrated in Fig. 1 is manufactured by the Geuder, Paeschke & Frey Co., Milwaukee, Wis. In the manufacture of tinware and sheet steel ware, this company experienced great trouble from the injury of power press operators, and as the result of study given to the subject, the guard shown in Fig. 1 was developed. The original idea was merely to avoid power press accidents in the company's shops, but the guard was found to give such satisfaction that it was decided to place it upon the market. It is known as the "Cream City accident preventer," the first two words corresponding with the names of this company's other products.

The guard consists of an expanding gate, of the pantograph type, which opens before each down-stroke of the ram, thus blocking the approach to the die. It is attached to the press by means of two brackets A, which are secured to the press by means of the regular gib screws. The method of operation is entirely automatic. A lever B is fulcrumed to the side of the press where the driving clutch is located, and is connected with the treadle by means of rod C. When the treadle is tripped, this rod pulls down the lever, which, in its turn, expands the gate in advance of the descent of the ram. The guard is arranged in such a manner that the gate must be all the way down before the clutch can be engaged. This makes it necessary for the operator to remove his hands from the work before the press can be tripped, and should he attempt to adjust the position of a blank at the last moment—which has been one of the most frequent causes of accidents on unguarded presses—the descent of the gate is checked, thus preventing the engagement of the clutch and the downstroke of the ram. When the treadle is released, the tension of spring D causes the gate to return instantly to the folded position, so that it is out of the way for the next operation.

At the place where lever B is pivoted to the frame of the press, a screw E is provided, which enables the point to which the gate must descend before the clutch is engaged to be adjusted. For most classes of work, this screw is set to bring the gate to within at least 1/8 inch of the table before the clutch is engaged. Such a setting, however, would interfere with sheets that extend out in front of the press, and for such classes of work the gate is set to descend to a point just above the level of the die before the engagement of the clutch can be effected. In such cases, the bottom of the gate is practically in contact with the face of the work; consequently, the same degree of protection for the operator is secured.

The application of this guard does not require the construction of the press to be altered in any way, the only work necessary being that of drilling and tapping holes for the bolts which secure the operating lever B to the frame of the machine. The openings in the guard gate enable the operator to have his work in plain view at all times.

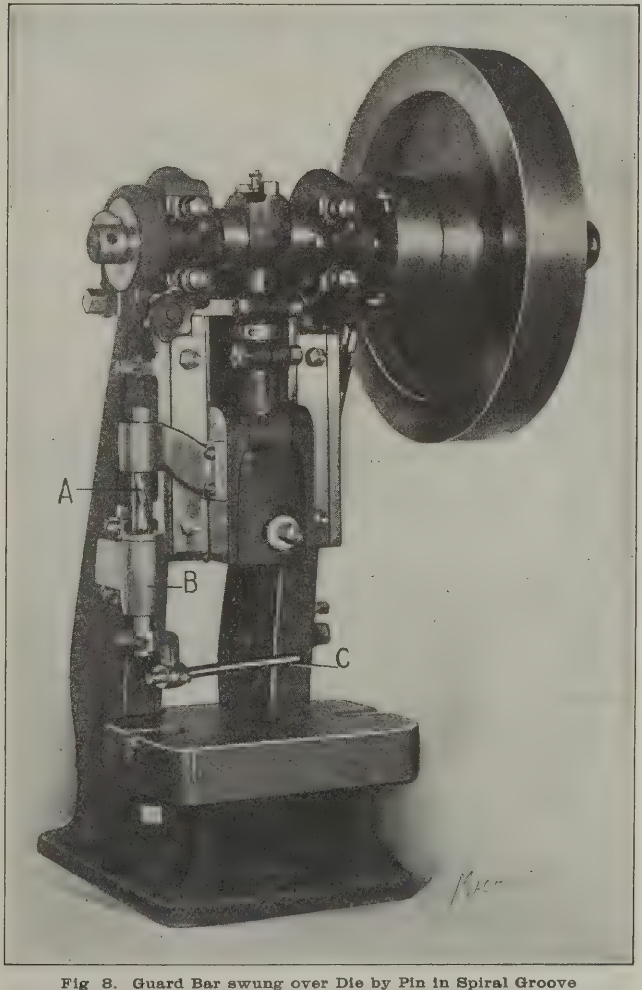


Fig 8. Guard Bar swung over Die by Pin in Spiral Groove

A somewhat similar, although less efficient guard than the one just described, is shown in Figs. 2 and 3. In this case the pantograph gate expands from the side, its movement being controlled by the bar A. As the slide descends, this bar, which is attached to it, engages a cam carried by the pivot

on which lever *B* is mounted. This swings lever *B* down into a nearly horizontal position, as shown in Fig. 2, and expands the pantograph gate across the front of the die, through the leverage exerted by the extended arm *C* of the gate. The action of the mechanism is so timed that the gate shuts off

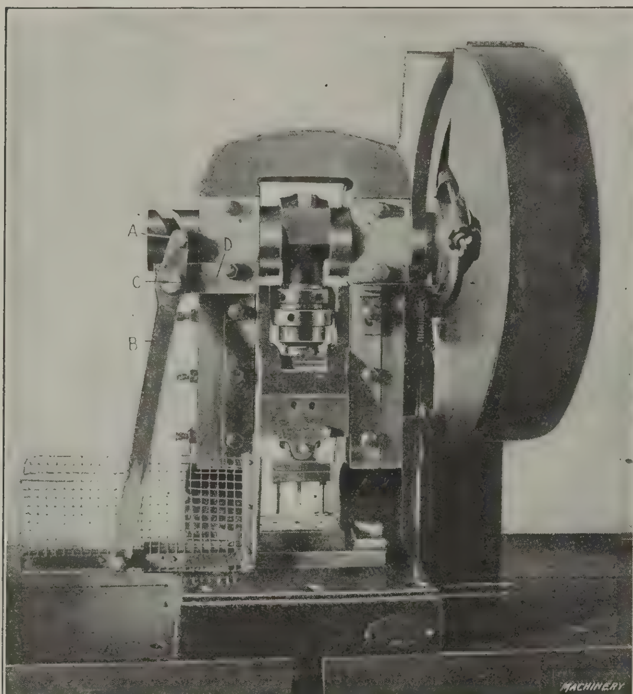


Fig. 9. Safeguard with Gate which swings from the Side

access to the die before the punch has descended upon it. When the ram rises, bar *A* is carried up with it. This releases the mechanism, and the gate is closed by the tension of spring *D*; *E* is simply a guide in which the gate travels.

The Jones Stamping Press Guard

The press illustrated in Figs. 4 and 5 is equipped with a safety device known as the Jones stamping press guard,

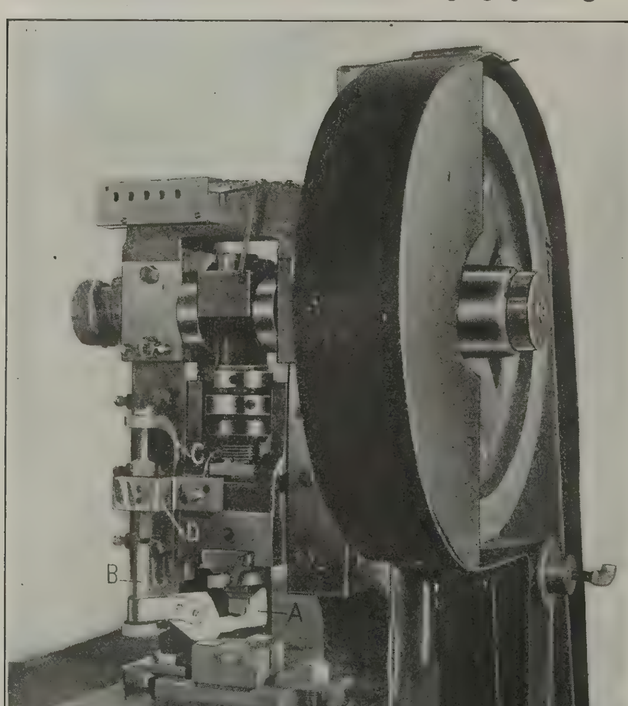


Fig. 11. Guard which sweeps over Die before Ram descends

which is manufactured by the Jones Safety Device Co., Chicago, Ill. When in operation, the wire-mesh gate drops somewhat ahead of the down-stroke of the ram, thus barring the operator's access to the die during the working stroke. The design is such that the gate must reach the bottom of its stroke, which brings it into contact with the table, before the clutch can be engaged.

The operation of the guard is controlled by lever *A*, which is pivoted to the frame of the press. Connection is made

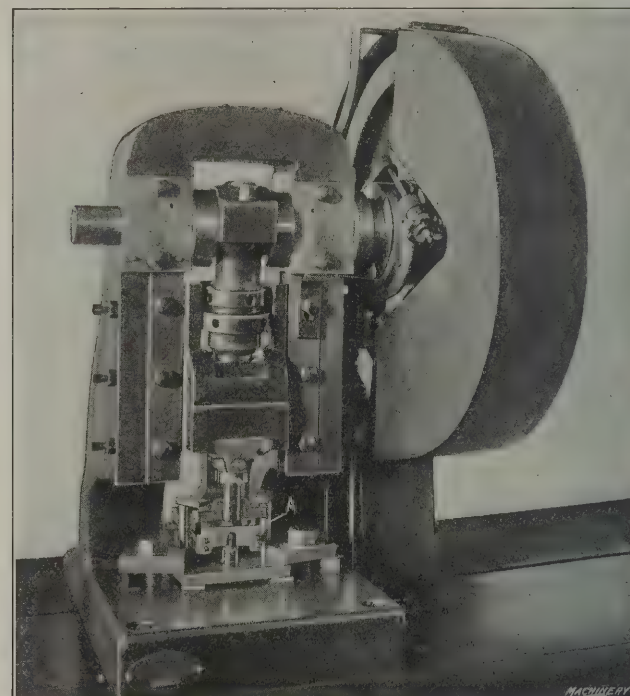


Fig. 10. Guard with a Plate operated by Cam attached to the Ram

between the treadle and the clutch by means of two rods which are secured to this lever by adjustable clips. When the guard is to be applied to an inclinable press, the treadle rod is in two sections, which are threaded at their ends to carry an adjusting clip, so that the length of the rod can be varied as required.

When the treadle is pushed down to trip the press, lever *A*

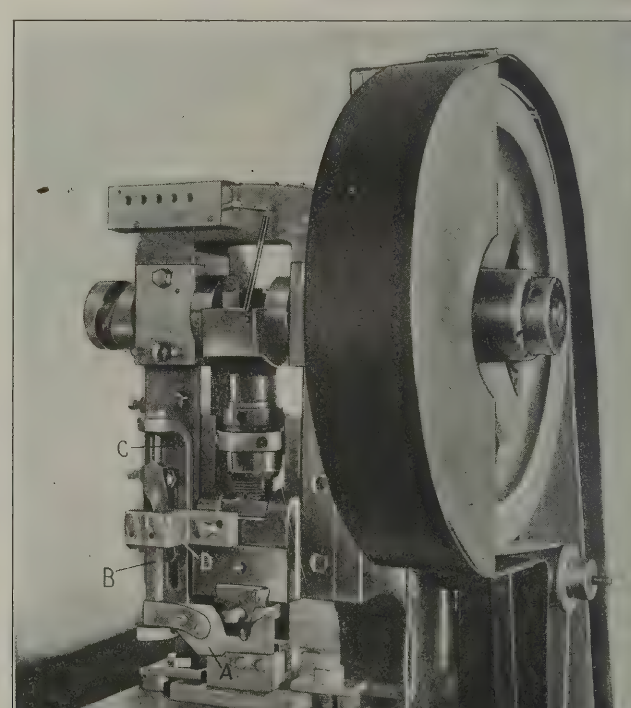


Fig. 12. Same Guard as in Fig. 11, in Position in Front of Die

carries the gate down to the table. If the operator fails to remove his hand from the die, the descent of the gate is blocked and this prevents the press from operating, because the clutch cannot be engaged until the gate has reached the

bottom of its stroke. After the ram has completed its working stroke and started to rise, the gate is immediately lifted by the action of a spring which connects the rear end of lever *A* and the frame of the press. If it is more convenient, this spring can be attached between the treadle and the frame of the machine. The instantaneous action of this spring prevents the output from being reduced, as the guard is out of the way as soon as the ram has risen sufficiently to enable the operator to begin preparing for another operation.

Clip *B*, which secures the gate bar to lever *A*, enables the position of the guard to be adjusted to meet the requirements of different classes of work and dies. The gate should always be set to a point where it touches the table before the clutch can be engaged. This guard is easily attached to the press on which it is to be used. The only work entailed consists of drilling and tapping holes in the frame to secure the operating mechanism in place. In some cases, the wire mesh gate has been replaced by a flat rod, covered with leather, somewhat similar in shape to the one upon which the wire netting is mounted. The object of this modification is to allow the operator an unobstructed view of his work during the entire working period of the press.

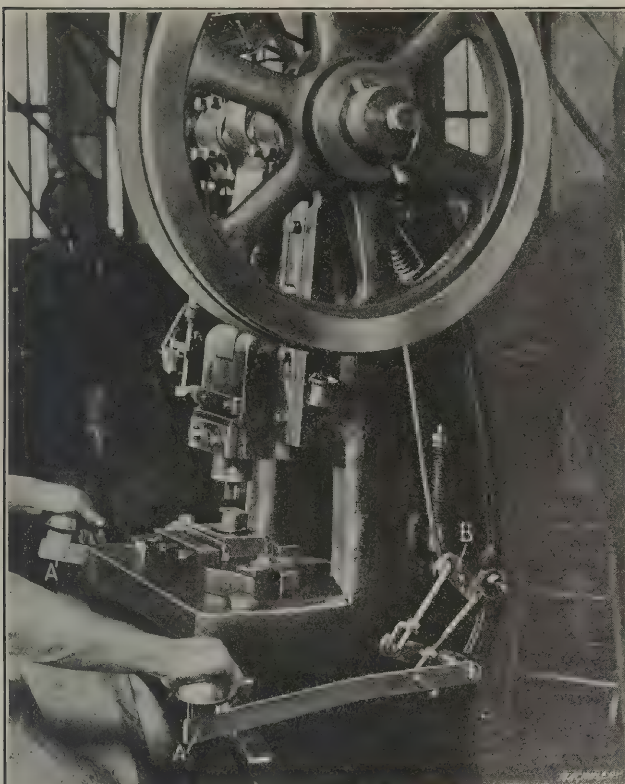


Fig. 13. Arrangement of the Benjamin Stamping Press Guard

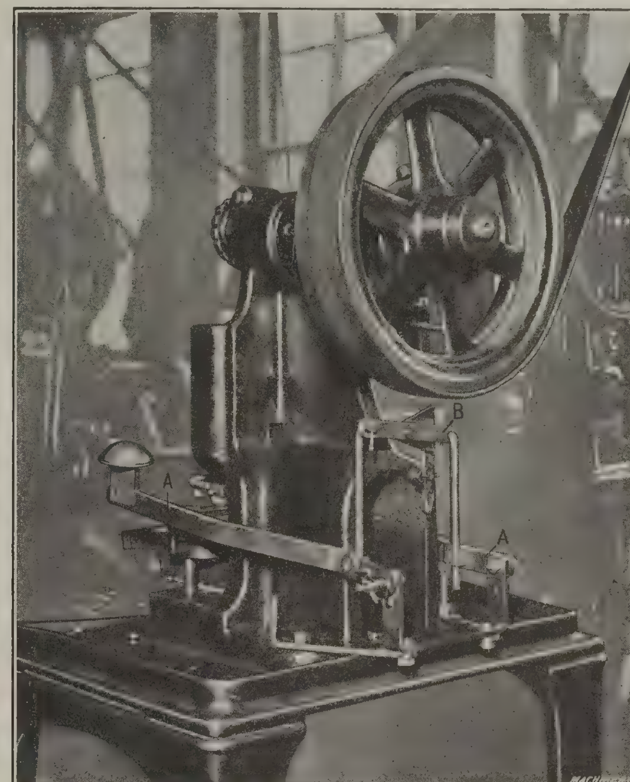


Fig. 14. Another Arrangement of the Benjamin Guard

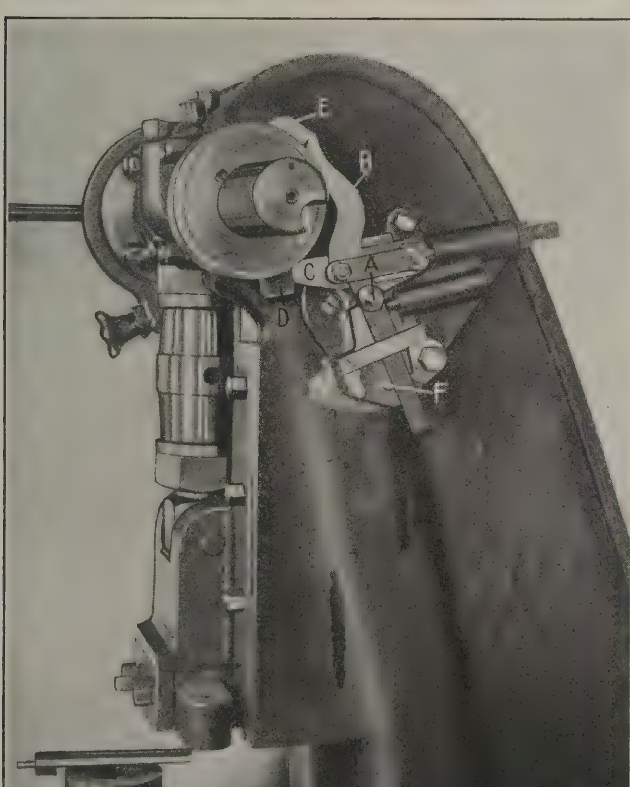


Fig. 15. Mechanism of the Bliss Automatic Safety Clutch

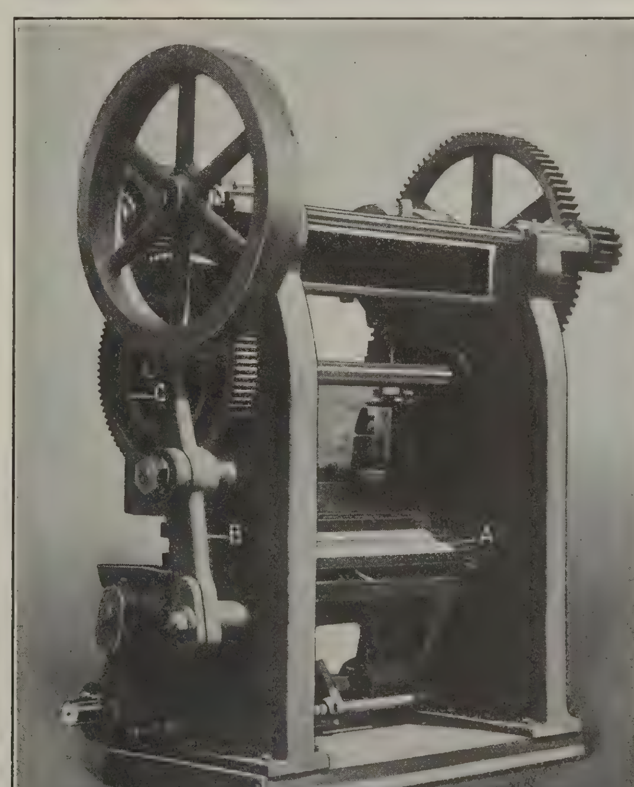


Fig. 16. The Improved Queen City Safety Press

In Fig. 6 a power press guard is illustrated which works on much the same principle that governs the operation of the ones shown in Figs. 1, 4 and 5. In this case, the guard bar *A* has been adopted in place of the gates used in the two other

devices referred to. When an operator is working at a press equipped with one of these guards, his hands are beneath the bar *A* and this bar must drop to the die bed before the clutch can be engaged. This makes it impossible for the operator to trip the press and forget to remove his hands from the die, because, under these conditions, bar *A* cannot fall far enough to allow the clutch to be engaged.

The operation of this guard is controlled by lever *B* which is pivoted to the frame of the press at *C*. When the treadle is depressed, this lever carries the guard bar down with it. After the guard has practically reached the die bed, lever *B* engages the stop *D* on the clutch rod and pushes it down sufficiently to throw the clutch into action.

It will be seen from the illustration that the position of the guard rod can be adjusted horizontally at *E* and vertically at *F*, and that the stop *D* on the clutch rod may be adjusted to correspond with different settings at *F*. This enables the guard to be adapted to different classes of work. The stop *D* should, in all cases, be set so that the clutch cannot be engaged until the guard rod is almost in contact with the die bed.

After the press has been tripped, spring *G* throws the guard up as soon as the ram has begun its return stroke, so that the operator is not delayed in any way. This type of guard can be applied to any type of press without altering its construction, by simply drilling and tapping the holes in the frame of the machine necessary for securing the guard in place.

The two guards shown in Figs. 7 and 8 work on essentially the same principle. When the ram of the machine shown in Fig. 7 begins its down-stroke, the vertical rod *A* is rotated by means of the twisted section which runs through a bearing in *B*. This causes bar *C* to swing over the die, and in case the operator has neglected to remove his hands, they are struck by this bar, thus warning him of his danger. Bar *C* moves considerably before the ram has reached the bottom of its stroke, so that the operator is given plenty of time to get his hands out of danger if he has neglected to do so at the time of tripping the press.

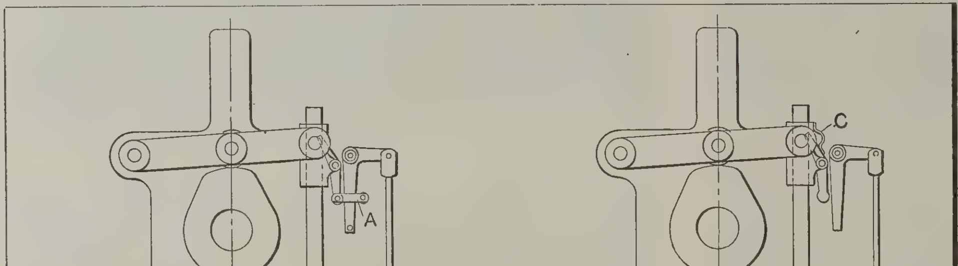


Fig. 17. A Modification of Design, replacing Springs by a Link and Weight

The action of the guard shown in Fig. 8 is similar to that of the one just described, but in this case the round rod *A*, with a spiral groove cut in it, has been substituted for the twisted square rod shown in the preceding illustration. The groove in this rod is engaged by a pin in bearing *B*, thus swinging the guard bar *C* as previously described.

Guards used in the General Electric Co.'s Shops

The guard illustrated in Fig. 9 was developed by the General Electric Co., for use in its power-press shops. When the operator sets the press in motion, the pin which runs in slot *A* swings lever *B* about pivot *C*. The shape of slot *A* is such that lever *B* carries the gate to the right a little ahead of the down-stroke of the ram. This shuts off access to the die during the working stroke of the press; should the operator fail to remove his hands from the work at the time of tripping the slide, he is warned of his danger by the movement of the guard. The gate runs on a guide on the die bed. The guard is secured to the press by bracket *D*, which carries the pivot *C*. This bracket is secured by one of the gib screws and a couple of small pins which prevent it from rotating.

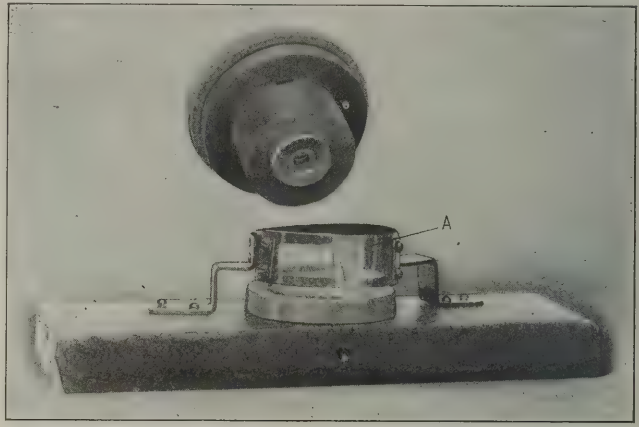


Fig. 18. Guard used for Operations on Thin Stock

Fig. 10 illustrates another form of power press guard which has been used in the shops of the General Electric Co. In this case, the guard plate *A* comes forward, ahead of the down-stroke of the ram, and pushes the operator's hands away from the die. The movement of the guard plate is controlled by a cam attached to the rear of the slide. When the working stroke has been completed and the slide commences its upward travel, this cam releases the guard and allows it to be returned to the rear of the die by the tension of a spring.

The guard illustrated in Figs. 11 and 12 has been adopted by the General Electric Co. to supersede the equipment shown in the preceding illustration. In this case, guard plate *A* swings on rod *B*, passing over the die far enough ahead of the ram to give the operator ample time to get his hands out of danger if he has neglected to do so at the proper time. The guard is attached to the press by means of bracket *C*, which is held in place by means of the regular gib screws. Rod *B* is a loose fit in this bracket, so that it is easily rotated by the action of *D* upon the twisted section of the rod.

When a press is engaged in stamping out parts from thin sheets, a guard of the type shown in Fig. 18 can be used to good advantage. In using a press equipped in this way, the

operator slips the stock under guard *A*. The space between the bottom of this guard and the die is just sufficient to admit the stock, but will not permit the operator's fingers to get within reach of danger. The General Electric Co. uses guards of this type on presses for stamping mica insulations; they would prove equally serviceable on other classes of work where thin stock is being handled.

The Benjamin Stamping Press Guard

The stamping presses illustrated in Figs. 13 and 14 are equipped with a safeguard which has been designed and placed upon the market by the Benjamin Electric Mfg. Co., Chicago, Ill. This device was first developed to meet the requirements of the Benjamin shops, but proved to be so satisfactory that it has recently been placed upon the market. It is not intended for presses used for blanking from strips or ribbon stock, and when presses are used alternately for such operations and for stamping, the guard may be easily disconnected, and the regular treadle used. This change does not involve any particular risk, as blanking operations on ribbon stock do not require the operator to work with his fingers under the ram.

As shown in the illustration, the guard consists of two hand levers *A*, one at each side of the press. These levers connect with the equalizer *B* which is mounted on the clutch rod. This equalizer swings about a pivot at its center, so that pushing down only one of the hand levers does not have any effect upon the clutch. Both levers must be pushed down to trip the press, and as both hands are required for this purpose, the operator cannot get his fingers caught. The release of either lever allows the latch to return to its normal position, thus making it impossible for the press to repeat unless both levers are kept down until the second stroke has been started. In this case, the operator would not have time to get his hand under the ram before its downward travel was completed. Different arrangements of this guard have been worked out to adapt it for use on all standard forms of presses, two such arrangements being shown in the illustrations.

Experience has shown that it is poor policy to depend upon the tension of a spring to control the operation of any mechanism, the failure of which may inflict a serious injury upon the operator. The tension of a spring weakens with age, and may become inadequate for the service which is required of it.

Fig. 17 illustrates a power press that was originally equipped with the springs *C* and *D*, as shown at the right-hand side of the engraving. The danger of relying upon these springs to control the clutch was realized, and the design of the press was modified, as shown at the left-hand side of the illustration. Here link *A* and counterweight *B* have replaced the springs, so that there is no possibility of failure due to an inadequate tension, as the clutch is now controlled by the constant force of gravity.

The Bliss Safety Clutch

A large majority of power-press accidents are caused by the failure of the operator to remove his foot from the treadle after completing an operation. In such cases, the wheel is kept locked to the shaft and causes the ram to descend a second time when the operator is not expecting it. To avoid such accidents, the E. W. Bliss Co., Brooklyn, N. Y., and several other well-known builders of power presses, have designed clutches which require the treadle to first be released and then pushed down again in order to cause the ram to descend for the next operation.

Fig. 15 shows the Bliss safety clutch, which operates in accordance with this principle. When the treadle is pushed down, latch *C* is lowered by means of trip-hook *B*, thus allowing the end of the clutch-key *D* to spring out and throw the clutch proper into position to engage with the flywheel. The shaft now revolves, bringing trip-dog *E* against trip-hook *B*, disengaging it and breaking the connection between latch *C* and the treadle rod that connects at *A*. This allows the latch to spring up and throw the clutch out of action.

When the foot is removed from the treadle, trip-hook *B* re-engages with latch *C*, and the mechanism is ready to be tripped for the next operation. The press may be run continuously by sliding the trip-hook *B* ahead of the spring-pin *F*. In this position, the trip-dog does not strike against the hook, and no break is made between the treadle and the clutch. Consequently, the slide continues to operate as long as the treadle is kept down. The E. W. Bliss Co. is now putting these clutches on all of its presses.

The Improved Queen City Safety Press

The press illustrated in Fig. 16 is built by the Queen City Punch & Shear Co., Cincinnati, O., and has been designed along lines which provide for the operators' safety. The oscillating table *A* swings out from under the ram to permit the removal of finished work and the substitution of new blanks. Hence the operator does not need to put his hands under the ram. The oscillation of the table is controlled by means of rocker arm *B* and cam *C*. The machine shown in the illustration is equipped with a double set of dies and requires two men to operate it, one standing at the front and the other at the rear. After the working stroke, the die bed in which the work has been formed or pressed remains stationary until the ram is partly raised. It then moves forward to the operator and remains at rest long enough to give him ample time to remove the finished work from the dies and replace it with new blanks. During this time, the other die bed is under the ram, a working stroke of the press being made. The die beds thus receive alternate strokes of the press, allowing plenty of time for the operators to perform their work, while the dies are swung out away from the danger zone beneath the ram. Machines of this type are also built with a single die bed and only require one operator to run them.

* * *

LAPPING CRANK-CASES

In the best types of automobile engines, all the vital parts, such as the transmission gears, etc., are enclosed in cases to protect them from dust and dirt. Another point which is just as important as protection from dirt is proper lubrication. In some engines this is accomplished by filling the cases with lubricating oil, which, of course, necessitates that they be oil-tight.

Instead of using packing between the surfaces of the crank- and transmission-cases that come in contact, the White Co.,

Lapping the Contact Surfaces of Crank-cases to make them Oil-tight

Cleveland, Ohio laps all the contact surfaces. This operation is accomplished as shown in the accompanying illustration. A large surface plate is coated with oil and emery, and the cases, after having their contact surfaces milled, are moved back and forth on this plate until a true surface is obtained. This method makes an oil-tight fit which is superior to shims or packing. D. T. H.

* * *

Switzerland, the area of which equals about one-third of that of Pennsylvania, has about 2800 miles of railway, of which 103 miles or about 3.7 per cent of the total is in tunnels. No less than nine of these are more than five miles long, the total number of tunnels being 415.

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DEVELOPING MACHINE TOOLS TO MEET MANUFACTURING CONDITIONS

A well-known machine tool builder, whose product is of a specialized nature, has consistently followed a practice during the past five or six years that undoubtedly has helped greatly in perfecting his machines and selling methods. He took contracts for machining certain difficult pieces in large numbers, submitting prices in competition with other concerns doing contract work. The contracts obtained necessitated equipping a section of his plant on a manufacturing basis to handle this special work. His own machines were installed and fitted with appliances to facilitate the operations as far as possible, after a thorough analysis and time study had been made, and in filling the contracts, workmen were trained to handle peculiar machining propositions with facility and speed never before equalled.

The result was that the limitations as well as the capabilities of his line of tools became apparent as they never had before. Where weaknesses were discovered, the design of the machine was changed to eliminate them, but the most important result was in finding out just how the machine could be used in manufacturing work to the best advantage. This manufacturer now has a corps of salesmen who know exactly what they are talking about and can prove what they claim. They can go into a plant and size up the possibilities of machining almost any given part by their specialized practice, making estimates based on the data acquired in the home plant, and when the machines are installed, operators can be sent to instruct workmen in handling the parts to the best advantage. Consequently guarantees of production can be made and fulfilled that competing makers would not dare to offer.

* * *

THE VALUE OF A PROPER FINISH

A prospective purchaser forms his first impression of a machine largely from its appearance. Sometimes good points in the design are evident at a glance—although this is seldom the case—but whether these points of more intrinsic value show up or not, the care which has been taken in finishing the different parts of the machine contributes much to its appearance and the impression made.

In deciding upon the finish for each part, two points should be considered—the durability of a given finish under the conditions to which it will be exposed in service, and its effect on the general appearance of the machine. The argument is sometimes advanced that an outlay for unnecessary finish adds to the price which the customer must pay for his machines, without giving him any additional value. This is hardly accurate. Shop environment exerts a strong influence upon the ideals of a conscientious mechanic, and he will naturally strive for higher attainments in the quality of his work when it is produced on machines which are well finished.

From the builder's standpoint a good finish is obviously desirable, in that it constitutes an outward manifestation of the quality of the materials and workmanship put into the machine. For instance, where parts are poorly finished because the mechanical operation of the machine does not require them to be accurate, the conclusion naturally follows that the entire machine has been produced with a corresponding lack of care. In this connection, a clearly defined line must be drawn between the substitution of finish for quality in the materials used. The former cannot be regarded in any other light than a deliberate attempt at deception, but a finish that truly represents the quality of the machine, is one of the best means at the builder's command for expressing the care that has been taken in the selection of materials and in the process of manufacture.

* * *

MEASURING SCREW THREADS

Although much has been written on the characteristics of screw threads, screws and taps, and the methods by which they should be measured, it appears that there are many mechanics who are not as well informed on these subjects as they should be. Tap manufacturers constantly receive complaints that their taps are not up to size, when the whole trouble lies in the fact that the users do not know how to measure tap threads properly. Few people realize, it appears, that the outside diameter is of little practical importance, provided it is not under size. A tap is not defective if the outside diameter is considerably over size, provided the pitch or angle diameter is not above the prescribed limit. A tap should always be measured in the angle of the thread, the well-known Brown & Sharpe thread micrometer being the tool most used for this purpose. When using this micrometer, certain precautions must be taken, however, which those unfamiliar with its use are likely to overlook.

A tap manufacturer received several complaints from one of his best customers, that the taps supplied were under size. Now, as a matter of fact, while certain limits are necessary in tap manufacturing, as well as in other fields, no reputable tap maker would ever let a tap go out of his shop that was under size. Taps should always be a certain amount over size, in order to compensate for errors in lead and to provide for a reasonable amount of wear. Some tap manufacturers even instruct their inspection departments to reject taps that are exactly to size, because such a tap, having no provision for compensating for errors in the lead, is practically to be regarded as being under the standard size. Hence the manufacturer of the taps that were said to be under size, doubted the accuracy of the statement, and as the customer who had made the complaint was one well worth taking care of, he went to the latter's plant, several hundred miles distant, to personally investigate the methods and measuring tools used for testing the taps he had supplied. He found that the man who did the testing—apparently a good, all-around mechanic—measured the angle diameter of the threads with a Brown & Sharpe micrometer by holding the tap steadily in one position while he screwed down the micrometer point onto it. When measured in this way the point and anvil are likely to bear upon the surface of the thread at points below or above the actual diameter of the tap thread, so that the true dimension is not obtained, and most of the taps will appear to be below standard size. The angle diameter should be measured by passing the tap back and forth between the point and the anvil of the thread micrometer, so as to make sure that the largest dimension or the actual diameter is being measured. When the taps in question were measured in this way, they were all found to be a certain amount over the standard size, meeting all requirements.

A mistake sometimes is made in measuring threads in the angle with the B. & S. thread micrometer, by using the wrong anvil. The anvil is limited in its capacity to certain sizes of thread, and should agree with the number of threads per inch to be measured. The reason for this is that if made large enough to measure a four-threads-per-inch thread, it would be too wide at the top to measure, say, a twenty-threads-per-inch thread. If, again, it were designed to measure a twenty-threads-per-inch thread it would be so small that a four-threads-per-inch thread would not have a proper bearing in the anvil. Hence each screw thread micrometer is limited to the range of threads per inch that can be measured with the anvil furnished with the tool, and care should be used to employ these micrometers only with anvils designed for the particular numbers of threads per inch to be measured. Otherwise the readings obtained cannot be depended upon.

* * *

WIRE AND SHEET-METAL STANDARD GAGES

The confusion incident to the use of many gages is commonly experienced by all who have to specify wire and sheet metals. We have in common use the American or Brown & Sharpe gage, Birmingham or Stubs iron wire, Stubs steel wire gage, Roebling and Washburn & Moen gage, British Imperial wire gage, U. S. standard gage for sheet and plate iron and steel, Edison or circular wire gage, steel music wire gage, twist drill and steel wire gage and letter drill gage. These gages can be combined so as to give an ascending series differing approximately by thousandths or half thousandths inch, but any one of the standard gages taken by itself will be found to give a large number of sizes varying by small increments at certain stations. Between these stations there are wide gaps that the gage does not provide sizes for. If it is necessary to use sizes between those specified by a commonly used gage, other gages must be resorted to, in order to specify the desired dimensions.

The following extract from a letter received from a representative of one of the large machinery manufacturing concerns describes the situation clearly:

I am chief draftsman at one plant of a company which operates four drafting departments. Each department specifies different gages for the same material. I find coil springs specified under four gages, and the same confusing conditions prevail with sheet metal, copper and brass. Sheet copper is specified by ounces and by the Stubs wire gage. Inasmuch as the various existing plants of our company exchange details and specifications, you can understand how confusing our drawing files are because of these conditions.

The need for a commonly accepted standard of wire and sheet-metal gages becomes more and more imperative as the manufacturing industries of the United States grow in importance and diversity. The American Society of Mechanical Engineers has appointed a committee to investigate the present systems of gages with the view of securing the adoption of some standard gage embracing the best features of all, which will be known as the standard wire and gage system recommended by the society.

The gage system, that is the system of referring to wire and sheet-metal diameters and thicknesses by numbers, is probably too firmly established to be changed. Nevertheless, it seems that we could profitably abolish the gage system in favor of a decimal system giving in every case the thickness in thousandths of an inch, instead of referring to it by an arbitrary number liable to be confused with the numbers of other gages.

* * *

The use of aluminum is constantly being extended into new fields. One of the latest applications of this metal, says the *Scientific American*, is for making foil to take the place of tin foil in wrapping up food products. Aluminum foil can now be made with a thickness of less than 0.002 inch. Aluminum powder is also coming into common use as the basis for a paint which is especially valuable for exposed metallic surfaces. Aluminum powder is very soft and adhesive, somewhat similar to graphite.

STEELS FOR TAPS, DRILLS AND MILLING CUTTERS

While any good high-carbon or high-speed steel can be used successfully for drills and milling cutters, when the requirement is simply that the steel shall possess good cutting qualities, the conditions met with in tap making make it necessary to select the steel to be used with great care. The best steel for taps must, in the first place, possess the same good qualities, as regards cutting properties and strength, as steel for other cutting tools, but, in addition, it must be so uniform in its composition that it is possible to cut the thread and harden the tap with the assurance that the lead of the thread of the hardened tool will be within certain specified limits. There are certain steels which, as far as strength and cutting qualities are concerned, would be excellent to use for taps, were it not for the fact that it is impossible to control the lead of the thread in the hardening process. Some of these steels will sometimes lengthen and sometimes become shorter in the lead, so as to make it impossible to compensate for the change in hardening by cutting the tap either long or short in the lead before hardening.

The Winter Bros. Co., of Wrentham, Mass., has experimented extensively to determine the best grade of steel to be used for high-class taps—that is, taps that after hardening will be as true to size, both as regards diameter and lead, as possible. During the last two years this firm has tried out twenty-six different kinds of steel and has finally settled upon using a steel made by an English maker, because this steel was found to be more uniform than any steel obtainable elsewhere. The results of the Winter Bros. Co.'s experiments are, in a general way, as follows:

The best steel to use for tapping cast iron and brass is one containing from two to three per cent tungsten, but otherwise having the same composition as an ordinary high-carbon steel, that is, with from about 1.15 to 1.25 per cent of carbon. This steel, if uniform in its composition, will contract or shorten 0.002 inch per inch in hardening, the same as most carbon steels. When hardening, it should be heated to a higher heat than a regular carbon steel, possibly to a temperature of 100 degrees F. higher (or up to about 1525 degrees F.) than that used for a carbon steel. It will also stand a greater variation in its hardening heat, and is, hence, easier to handle than steels that require closer watching in this respect.

The best steel for taps to be used on steel, as far as strength is concerned, is vanadium alloy steel containing from 0.25 up to 1 per cent of vanadium. The greater the vanadium content, the greater is the strength of the steel. The objection to this kind of steel for taps, however, is that it is very uncertain as regards its change in hardening. It is likely either to shorten or lengthen up to 0.002 inch per inch, and, hence, it is practically impossible to secure taps of correct lead when using this steel. The carbon content is the same as in regular carbon steels used for this purpose—from 1.15 to 1.25 per cent. An advantage of the steel is that it is easily hardened as it will stand a variation in the hardening heat of about 100 degrees F. without showing any marked difference in the qualities of the hardened tap.

It should be mentioned, however, that while the vanadium alloy steel experimented with by the Winter Bros. Co., proved very uncertain as regards its change in hardening, it is possible that the vanadium had no influence in this matter. It may be that the mere addition of vanadium to a steel which without vanadium will change uniformly, would not injure it in this respect. This, however, is a matter that has not been decided, and further experiments would prove of value.

Expensive special steels are obtainable in the market that will show practically no change whatever in either the lead or diameter of a tap when hardened, but steels of this character, while excellent in special instances, are not commercially suitable for tap making on account of the increased cost. Hence, in order to meet the requirements of the trade, the tap maker is forced to look around for a steel, the price of which is not prohibitive and which, at the same time, will meet the requirements as regards strength and uniformity.

These conditions are fairly well met in certain English and Swedish steels. These steels are more uniform as regards the change in hardening than are ordinary American tool steels, and they also differ from most of these steels in one particular: they nearly always lengthen, instead of shortening, about 0.002 inch per inch in hardening. The objections to English and Swedish steels are that the bars are not rolled as well as are those of American manufacture; they are rougher, they are not always round, and sometimes they are larger in diameter at one end of the bar than at the other.

High-speed steel is not used to any great extent for taps, one reason being the difficulty of hardening a high-speed steel tap with its fine cutting edges, which cannot be ground after hardening and which are liable to be injured by the extreme heat to which high-speed steel must be subjected in the hardening process. A high-speed steel suitable for taps should contain from 0.60 to 0.75 per cent of carbon and from 15 to 20 per cent of tungsten. This steel will harden at from 2100 to 2200 degrees F. The temper should be drawn at from 500 (in some cases) to 1000 degrees F. High-speed steel taps have been found especially advantageous for automatic screw machine work, particularly when tapping in brass or bronze. When used under these conditions, it has been found that the production per tap has been increased from five to fifteen times by the use of this material for the taps. The price of taps made from high-speed steel is, on an average, from three to four times that of ordinary carbon steel taps. The strength of high-speed steel drill rod, when properly hardened and tempered, is, on an average, slightly greater than that of carbon steel drill rod.

While, as mentioned, high-speed steel is not used to any great extent for taps at the present time, the Winter Bros. Co. states that the demand is increasing to a considerable extent. Although many tap manufacturers have had difficulty in hardening high-speed steel taps, this company has had no trouble in this respect, on account of the methods used for the purpose. A difficulty that has been met with, however, is that of keeping the cutting edges on the tools with which the high-speed tool taps and dies are threaded. The tools wear so fast that it is very difficult to cut smooth threads of correct form.

The superiority of the English and Swedish steel over the American made steel is very difficult to explain, because if a chemical analysis is made, it is often found that the American steel is freer from impurities—phosphorus and sulphur—than are these foreign steels; yet the latter will have greater strength, possess as good cutting qualities, and show greater uniformity after hardening. The cause, no doubt, is to be found in the different composition of the iron ores and the different processes to which American and foreign steels are subjected while being manufactured into tool steel.

While high-speed steel is not used to a great extent for taps, it is being used to a constantly increasing extent for milling cutters and drills. It is always advisable to use high-speed steel for these tools if they are used in regular manufacturing work. A high-speed steel cutter, for example, can be run at a cutting speed of from 100 to 125 feet per minute, while a carbon cutter should not be run at a higher speed than from 50 to 60 feet per minute. The high-speed steel cutter will also last from three to four times as long between grindings as a carbon steel cutter. Hence, it is safe to say that the output of the high-speed steel cutter between grindings will be from six to eight times that of a carbon steel cutter, while the price of high-speed steel milling cutters is only about three times that of carbon steel cutters.

Practically any good brand of carbon steel or high-speed steel is satisfactory for milling cutters or drills. Vanadium increases the strength and is, therefore, of special value in steel used for drills. High-speed steel drills have a capacity of from five to six times (in some cases up to ten times) that of carbon steel drills. For the larger sizes of drills, in manufacturing work, high-speed steel is of a decided advantage, as the price for drills larger than 5/8 inch in diameter is only about three times that of carbon steel drills. On the smaller sizes, however, the price of the high-speed steel drills increases proportionately to that of carbon steel drills, so that for a 1/8-inch drill the price is about seven times greater when using high-speed steel than when using carbon steel. Hence, the advantage in using high-speed steel for small sizes of drills is not as great, and, in some cases, the use of high-speed steel on the smaller sizes may be inadvisable.

While, as a general rule, it is advantageous to use high-speed steel cutters for all manufacturing work, there are some exceptions. Angular cutters, having a sharp corner, cannot be run at the high speed most advantageous for high-speed steels without danger of breaking off the weak points on the teeth, and, hence, in this case, the advantages of the better steel cannot be realized. There is also danger of burning the pointed cutting edges in hardening the high-speed steel cutters. Neither is high-speed steel particularly suited for gear-cutters or cutters used for work where the surface being cut is required to be especially smooth and of good finish. The high-speed steel cutter becomes dull at least as rapidly as does the carbon steel cutter, and in this state it will not produce a better surface than would a dull carbon steel cutter, but it has the advantage that it can continue to cut with its dull cutting edge on roughing work for a much longer time. Where a good finish is required, however, a sharp edge and a moderate speed are necessary, and as the advantages of the high-speed steel are not brought out under these conditions, there is no object in making cutters for this purpose from that material. The makers of milling cutters state that at the present time from 40 to 50 per cent of all milling cutters are made from high-speed steel.

Twist drills are made from high-speed steel to even a greater extent. Most firms making twist drills state that about 50 per cent, or perhaps slightly more, of their drills are made from this steel, while in the case of one firm, 75 per cent of all the drills made are high-speed steel drills. When carbon steel is used for drills, a steel containing as much as 1.30 per cent carbon is found to give the best results. A high-speed steel containing 18 per cent tungsten and 0.25 per cent vanadium is recommended for high-speed steel drills.

To illustrate the advantage of using a high-speed steel containing a high percentage of vanadium, the following example may be cited: A 3/4-inch drill made of a high-speed steel containing 1.25 per cent vanadium and 17 per cent tungsten was run at 600 revolutions per minute and with an 8-inch feed, drilling cast iron. The drill was used almost continuously and required to be ground but once a day. In a general way, it may be stated that high-speed steel drills containing this percentage of vanadium will last twice as long between grindings as ordinary high-speed steel drills. The price of drills of this material should not be more than 10 per cent greater than that of ordinary high-speed steel drills containing no vanadium.

When using high-speed steel for drills, it is necessary to allow a greater amount of stock for grinding after hardening than when using carbon steel. This is on account of the scale that is produced on high-speed steel tools in the hardening process. Ordinarily from 0.010 to 0.015 inch is allowed for grinding on ordinary carbon steel drills, while those made from high-speed steels have an allowance of about 0.025 inch.

In the making of reamers, there is no advantage in the use of high-speed steel, except in the case of chucking reamers. A high-speed steel reamer will not retain its size any longer than a carbon-steel reamer will, and with the slow speed at which hand reamers are used, there would be no other advantage to be gained.

* * *

According to an item in *Engineering*, the Russian Government has decided upon building a railway from Vladikavkas to Tiflis, right through the Caucasus mountains. The distance between these two cities by a straight line is only 125 miles, but, at present, it can be covered by rail only by making a long loop around the Caucasus chain, a journey of 990 miles long. The new project requires, however, the construction of a tunnel nearly 16 miles long, at a height more than 4000 feet above sea level. It is estimated that eight years will be required for the construction. Another interesting tunneling project of considerable magnitude is that being planned at Montreal, Canada, where it is proposed to construct a tunnel under the St. Lawrence River for the use of all Canadian railways.

DYNAMICS OF GAS ENGINE CAMS*—1

AN INVESTIGATION INTO THE RELATIVE MERITS OF DIFFERENT TYPES OF CAMS

BY M. TERRY†

To design a cam of proper shape for a given movement requires, in the majority of cases, only a general knowledge of the elements of mechanism. However, the timing cams of a gas engine—most notably a marine, automobile or aerial engine—where the parts in motion move at a high velocity, constitute an exception. To design this class of cams of the proper shape requires a full working knowledge of mechanics, and it seems that the correct design of these cams is a subject generally neglected by most draftsmen and designers. There is a great temptation to treat the timing cams as mere trips, intended to give a certain lift to their respective valves. When, therefore, a designer recognizes the importance of dynamic analysis of timing cams, he finds himself practically alone in his attempt to solve the problem, as there is no reliable data on this subject available. The discussion that has so far been published has been superficial; a volume would be required to thoroughly cover the subject and do it justice.

It is the object of the writer, in the following, to analyze the different types of cams, and to make a comparison between the designs. While the present article deals primarily with the various timing cams of automobile engines, the author believes that the study of the dynamics connected with them will be of interest to all readers of MACHINERY, whether they are directly engaged in the automobile industry or not. A short introduction on the types of engines used in self-propelled vehicles, and a survey of the present situation, will help the layman to grasp the importance of the problem and acquaint him, in a general way, with the "whys and wherefores" of the various types of valves used on the present-day motor cars.

Need of Valves

There are two general types of gas engines, known as two- and four-stroke cycle engines; but no matter what type of engine is selected for automobile use, the cycle consists of four distinct acts, namely: suction, compression, expansion, and exhaust. In the two-stroke cycle engine these four acts are accomplished in one revolution of the crankshaft or two strokes of the piston, while in the four-stroke cycle engine these four acts are extended over a period of two revolutions of the crankshaft or four strokes of the piston.

In the two-stroke cycle engine, suitable exhaust and inlet ports are provided in the cylinder walls, which the piston in its course of travel covers and uncovers, drawing in or expelling gases, and thus acting as its own valve. (See Fig. 1.) The piston of a four-stroke cycle engine, however, cannot unassisted be its own valve, as it will uncover both ports every other stroke, while the four-cycle action requires the opening of the ports only once in four strokes of the piston. Hence the need of auxiliary valves.

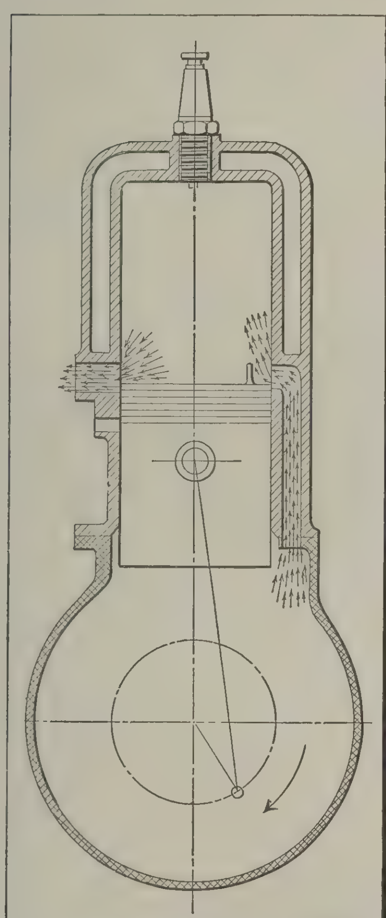

Fig. 1. Section through Three-port, Two-stroke Cycle Engine

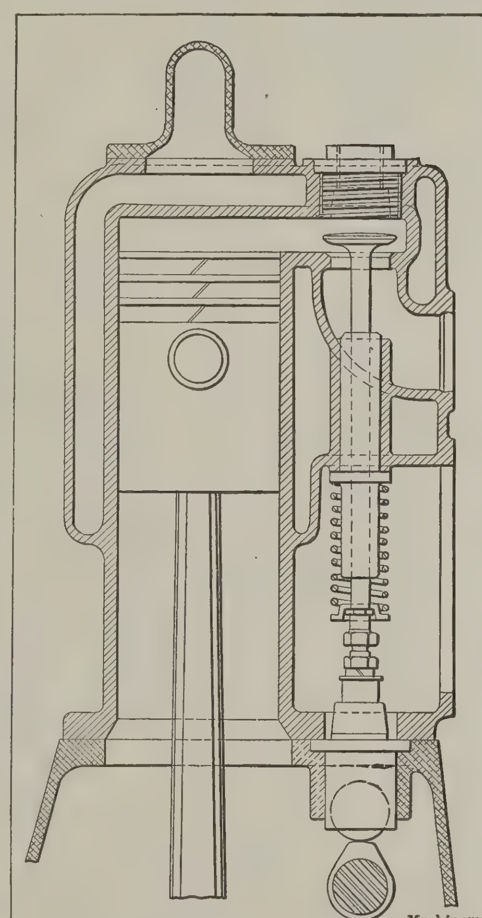

Fig. 2. Section through Poppet Valve Engine of the L-type

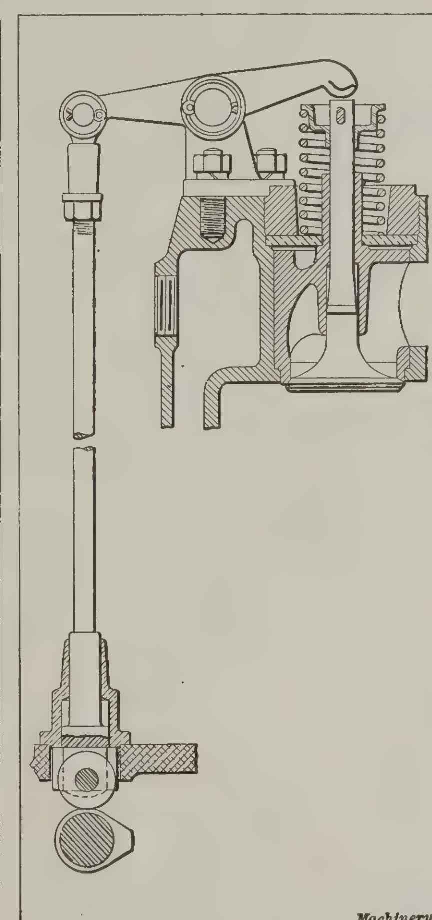

Fig. 3. Section through Valve of a Poppet Valve Engine of the Overhead Type

Types of Valves

The great majority of automobile engines operate on the four-cycle principle. These engines can be classified in various ways—horizontal or vertical, long- or short-stroke, water- or air-cooled, etc.; but, the classification which interests us most at present is that based on the type of valves employed. When studied from this point of view, any engine can be placed in one of the three following groups:

1. Poppet valve engine, shown in Figs. 2 and 3.
2. Sliding piston-valve engine, shown in Fig. 4.
3. Rotary valve engine, shown in Fig. 5.

At present the first group is by far the largest, and the poppet valve engines represent a well tried out, established and conventional form of design. The second group, up to a

* See MACHINERY, engineering edition, February, 1911, "Timing an Offset Automobile Engine," and other articles there referred to.
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short time ago, was in its experimental stage, but with the recent advent of the "Silent-Knight" engine, it is considered by some to be the coming rival of the first group. The rotary valve engines are conceded to be in a purely experimental stage of development.

In the last group the inlet and exhaust valves have a continuous rotary motion, accomplished either by direct gearing with the crankshaft, or by means of an endless silent chain driven by the crankshaft. Thus, on account of the continuous

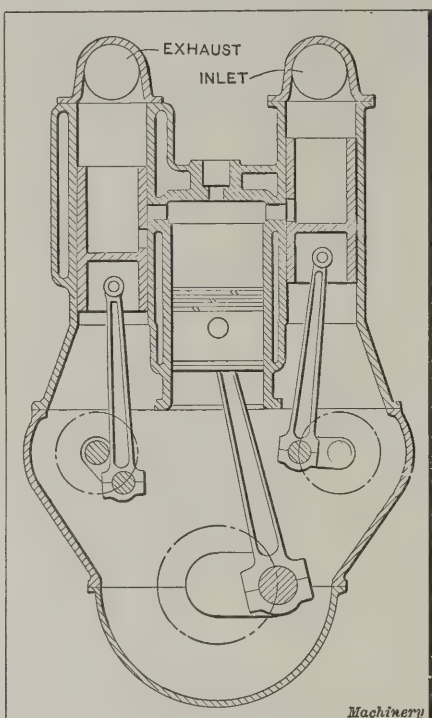


Fig. 4. Sliding Piston-valve Engine

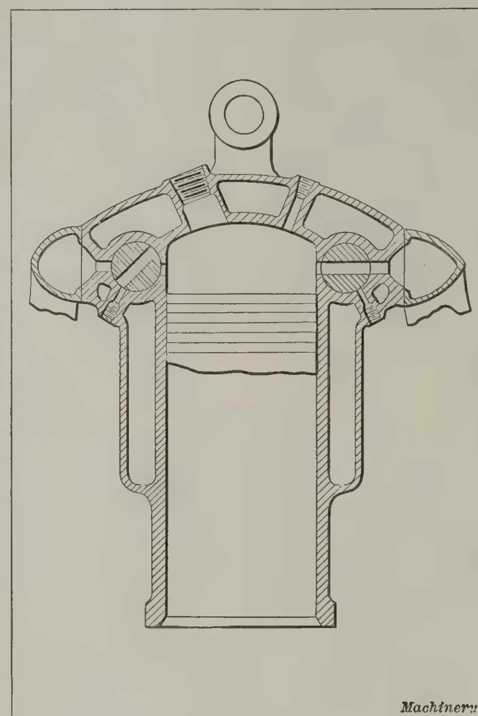


Fig. 5. Arrangement of a Rotary Valve Engine

rotary motion of the valves, the cam problem does not exist in this group.

The first two groups have the feature of reciprocating valve motion in common. The valve mechanism of the sliding sleeve engine is a miniature reproduction of the main working parts of the engine; in other words, it consists of a secondary crankshaft, connecting-rods and pistons (or sleeves as used in the "Silent-Knight" engine). The secondary crankshaft receives its motion from the main crankshaft, either by means of gears or an endless silent chain, and with the assistance of the small connecting-rods it imparts a reciprocating motion to the secondary pistons—valves or sleeve-valves, as the case may be. These valves travel in a smooth bore with no obstacles in their paths. The highest and the lowest points of their travel are determined by the throw of the secondary crankshaft. In other words, the entire linkage of the sliding piston or sleeve-valve is rigid.

As mentioned before, the poppet valves also have a reciprocating motion, but, in order to insure gas-tightness in the working cylinder, the valves must be brought tightly against their seats (flat or conical) which are formed either in the main casting or in inserted cages at right angles to the path of the valves. (See Figs. 2 and 3.) In a properly working gas engine these seats determine, then, one of the extreme points in the line of valve travel, and with this arrangement, the use of rigid linkage for poppet valve gears is out of the question. Even if it were possible by accurate machining or careful adjustment to introduce some kind of rigid linkage, the difference in contraction and expansion of the cylinder casting and the valve stems would soon result in an appreciable gap between the valves and their seats, which, in turn, would be the cause of gas leakage, poor compression, pre-ignition, back-firing and other well-known gas engine troubles; hence, the apparent necessity for a linkage with one or more "broken joints," a cam to open the valve, and a spring to close it.

It is an admitted fact that by far the greater portion of the noise caused by the modern automobile engine is due to its valves. As the noise is due directly to the pounding action of the valve gear at its broken joints and at the valve seat, no improvement along this line can be expected until designers turn their attention to the study of the various cam shapes and their respective dynamic effects.

Brief History of Development of Automobile Engine Cams

The design and construction of power plants of the early motor cars were based largely on two elements: guesswork and the then established practice in stationary and marine gas engine work. In the latter class of engines a cam of the type shown in Fig. 6 was used almost exclusively, so there is but little wonder that it was also adopted by the early automobile manufacturers. This cam is still retained in automobile engines when a so-called "mushroom" type of follower is employed; but for a roller-follower it was displaced entirely by the so-called "tangential" cam.

Some eight years ago the Buick Motor Co., then located in Detroit, Mich., and engaged in the construction of marine engines, was experimenting with its first model of self-propelled

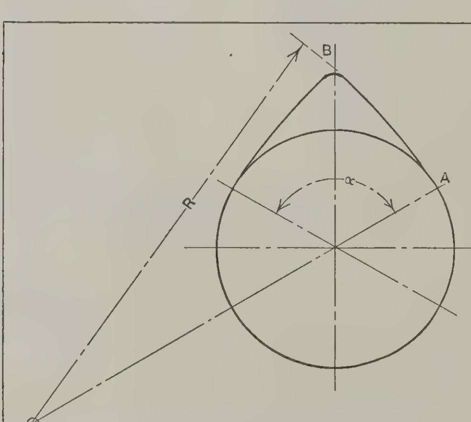


Fig. 6. Cam used on Early Automobile Engines

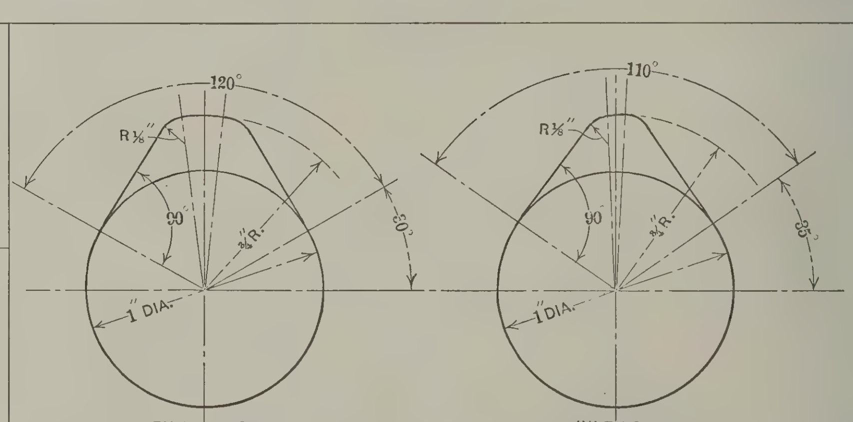


Fig. 7. Dimensions of Exhaust and Inlet Cams

vehicles. It was not long before it was discovered that the old marine type of cam was altogether too noisy on high engine speeds. In searching for a more suitable shape of cam, it was observed that the noise seemed to decrease as the radius of the arc *AB*, Fig. 6, was increased. In the light of this discovery, the next idea that naturally suggested itself was to make the radius of the arc infinite, or, in other words, to make the arc *AB* a straight line. The results obtained were so gratifying that this new cam—now known as tangential—was immediately adopted, and the Buick Motor Co. was soon

followed in this by other manufacturers. At present, the vast majority of the motor car engines are equipped with tangential cams.

Whether the Buick Motor Co. deserves the entire credit for the introduction of the tangential type of cam or not, is, of course, pretty difficult to say. There is no doubt, however, that the tangential cam is merely a product of experimental development, whereas the uniformly accelerated and retarded motion cam is a product of study based on the well-known laws of falling bodies. The fact that the simple contour of the tangential cam makes it an easy manufacturing proposition and permits of ready detection of error in the inspection room, undoubtedly hastened its general adoption in the motor car field; but the very simplicity of its shape has aroused suspicion in the minds of many as to its other advantages, and has been the cause of many proposals to have it replaced by the uniformly accelerated and retarded motion cam. Perhaps one of the earliest proposals made in this country was

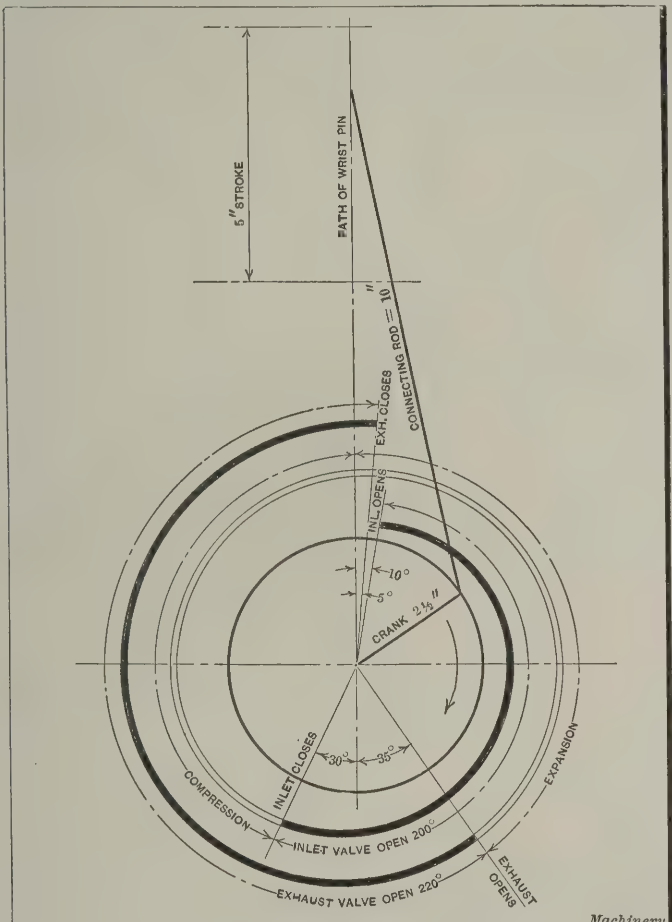


Fig. 8. Timing Diagram for Cams

published in 1905 by Mr. P. M. Heldt, editor of the *Horseless Age*. This question was again referred to in that publication in 1911 (issue of June 28, page 1083), which indicates that an opposite view—if one were ever held by anybody—was never given any publicity, or, at least, not sufficiently proved.

The author wishes to state at the outset that until a short time ago he shared Mr. Heldt's opinion, and that he was greatly puzzled by the results of a practical experiment which turned out contrary to his expectations. When he started the present investigation it was his purpose to prove the superiority of the uniformly accelerated and retarded motion cam over its tangential rival, but his logic brought him to entirely different conclusions.

Analysis of Tangential Cam

Let us now first take an actual case from practice and analyze the working conditions. Suppose an engine of 4-inch bore and 5-inch stroke is to have the following timing and general dimensions:

Exhaust opens 35 degrees ahead of the lower dead center.
Exhaust closes 5 degrees past the upper dead center.
Inlet opens 10 degrees past the upper dead center.
Inlet closes 30 degrees past the lower dead center.
Cam to be of the tangential type.
Base circle of the cam = 1.000 inch diameter.
Cam roller circle = 1.000 inch diameter.
Lift of cams = ¼ inch.
Radius of cam fillet = ⅛ inch.
Clearance angle = 5 degrees.
Maximum speed of the engine at which quiet operation of valves is expected, to be between 1600 and 1700 R. P. M.

In regard to timing, the reader is referred to the article, "Timing an Offset Automobile Engine," in MACHINERY, engineering edition, February, 1911. The problem of clearance and clearance angle will be taken up in detail later on.

Fig. 8, known as a timing diagram, represents the path of the piston, length of connecting-rod, length of crank, and the crank circle. The opening and closing points of the valves are referred to the latter. Thus the inlet valve of the first cylinder begins to open at the instant the first crank pin is 10 degrees past the upper dead center, etc.

It is evident then from Fig. 8 that the exhaust valves are open during 220 degrees and the inlet valves during 200 degrees of the crankshaft motion. Since the camshaft revolves at one-half the speed of the crankshaft, the angles of exhaust and inlet cams will be 110 degrees and 100 degrees, respectively. To these angles we must add 10 degrees (twice the clearance angle), giving 120 degrees for the exhaust and 110 degrees for the inlet cam. This is shown in Fig. 7. The dimensions given are those found on a manufacturing drawing. Assuming that the steel cams in their finished forms correspond exactly to the dimensions given in Fig. 7, we shall proceed to analyze their action.

From Fig. 2 it is clear that the motion of the valve gear as a whole is identical with the motion of the cam roller center. The motion of either is referred to the camshaft center, which is regarded as stationary. The camshaft turns in a left-hand direction with a constant angular speed, and the roller center (as well as the rest of the valve gear) moves up and down in a straight line with a variable speed. The relative motion of the cam and roller centers will remain unchanged if we consider the cam stationary and the roller following the contour of the cam.

Exhaust Cam

In Fig. 9 is shown the exhaust cam and its roller. The face of the cam (CC_4) is a straight line, and, as the roller moves along this line, its center A describes a straight line parallel to CC_4. As the roller center assumes its successive positions at A_1, A_2, A_3, etc., its distance from the cam center increases.

If D is the distance of A from O, in inches, corresponding to any angle θ, then:

$$D = \frac{OA}{\cos\theta} = \frac{OC + CA}{\cos\theta} = \frac{\frac{1}{2} + \frac{1}{2}}{\cos\theta} = \frac{1}{\cos\theta}$$

Now, if the roller did not rise at all, its center A would have followed the circular path AB, the center of which lies at O. Consequently, the actual rise of the roller corresponding to θ_1, θ_2, etc., is measured by A_1B_1, A_2B_2, etc.

If L stands for the lift or rise of the roller center in inches, then

$$L = D - OA = \left(\frac{1}{\cos\theta} - 1\right)$$

This equation represents the law governing the motion of the valve gear as long as the roller is in contact with the face of the cam, *i. e.*, from C to C_4. As this law is expressed in terms of θ it is of importance to us to know the limiting values of θ between which it operates.

From Fig. 9 it is clear that the limiting values are zero and the angle AOA_4. The problem is to find the value AOA_4 in degrees. For the sake of clearness, we shall use the right half of the cam; the latter being symmetrical, the same construction would apply to either side. CC_4 is tangent at C to the base circle of the cam and at C_4 to the fillet circle, the center of which lies at F. Hence CC_4 is at right angles to OA at C and to FC_4 at C_4. Draw EF parallel to CC_4. Then EF is at right angles to OA. Also, since A_4C_4 is at right angles to CC_4 at C_4, line FC_4A_4 is a straight line.

By construction,

$$EC = FC_4 = FC_7 = \tfrac{1}{8} \text{ inch.}$$
$$OE = OC - CE = \tfrac{1}{2} - \tfrac{1}{8} = \tfrac{3}{8} \text{ inch.}$$
$$OF = OC_7 - FC_7 = \tfrac{3}{4} - \tfrac{1}{8} = \tfrac{5}{8} \text{ inch.}$$

$$EF = \sqrt{\overline{OF}^2 - \overline{OE}^2} = \sqrt{\tfrac{25}{64} - \tfrac{9}{64}} = \tfrac{1}{2} \text{ inch.}$$

$$EF = CC_4 = AA_4 = \tfrac{1}{2} \text{ inch.}$$

Hence, $\tan AOA_4 = \dfrac{AA_4}{OA} = \dfrac{\frac{1}{2}}{1} = \dfrac{1}{2}$, and angle $AOA_4 = 26$ deg. 34 min.

The first law of motion of our valve gear, as we shall refer to it from now on, is expressed by the equation:

$$L = \frac{1}{\cos\theta} - 1$$

the limiting values of θ being 0 and 26 degrees 34 minutes. Now, let us look into the motion of the valve gear while the roller is traveling on the cam fillet. In order to make our discussion clearer, we shall carry out the geometrical construction simultaneously in Figs. 9 and 10. It is evident from Fig. 9 that, as the periphery of the roller moves along the fillet arc C_4C_7, the center of the roller describes the arc A_4A_7 concentric with C_4C_7. In other words, the roller center moves in an arc of a circle the center of which lies at F and the radius of which is FA_4.

Now, $FA_4 = FC_4 + C_4A_4 = \frac{1}{8} + \frac{1}{2} = \frac{5}{8}$ inch, and $OF = \frac{5}{8}$ inch. Then, if in Fig. 10, with F as a center, we describe a circle of radius FA_4, the circumference of the circle will pass through O. Note, however, that this is not always the case. In this instance it is due to the fact that the roller diameter is equal to the diameter of the base circle of the cam, and also to the fact that the radius of the fillet is made equal to one-half of the cam lift. The roller center, as explained before, describes the arc A_4A_7. Take any position of the roller center, as A_5; its distance from $O = OA_5 = OA_7 \cos\beta_5 = 1.25 \cos\beta_5$ inch.

With O as a center and OA as a radius, strike the arc AB (same as in Fig. 9). The actual lift of the roller center at A_5 equals:

$$B_5A_5 = OA_7 \cos\beta_5 - OB_5 = 1.25 \cos\beta_5 - 1.$$

Since A_5 is any position of the roller center on its path A_4A_7, the same equation will apply to every point on that path. Hence,

$$L = 1.25 \cos\beta - 1.$$

This equation represents what we shall term the second law of the valve gear motion.

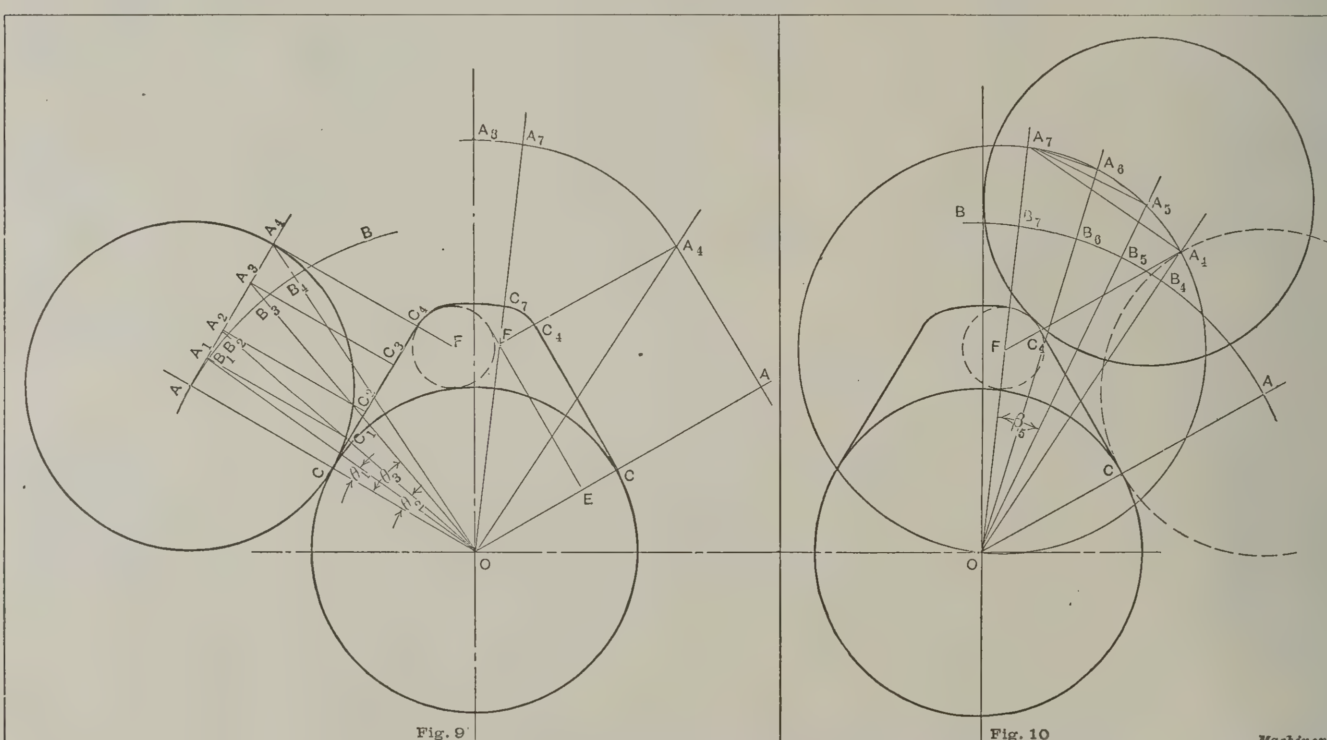
It will be observed that this second law of motion is expressed in terms of a constantly decreasing angle. The lift increases as the angle β decreases. The limits of β are 0 degree and the value of angle A_4OA_7. It remains to determine the value of this angle.

Angle $AOA_4 = FA_4O = A_4OA_7$. But angle $AOA_4 = 26$ degrees 34 minutes. Hence angle $A_4OA_7 = 26$ degrees 34 minutes.

The valve, then, attains its full lift of ¼ inch in 53 degrees 8 minutes of the angular rotation of the cam. During the remaining portion of cam's rotation, known as dwell—equal to 6 degrees 52 minutes, considering only one-half of the cam—the valve remains stationary, and its third law of motion may be expressed as $L = \frac{1}{4}$ inch.

Inlet Cam

Thus far we have considered the exhaust cam only, but it can be easily demonstrated that the motion of the inlet valve gear is identical with that of the exhaust, except that it begins and ends 5 degrees later with respect to the horizontal center line of the camshaft. By comparing Fig. 11 with Figs. 9 and 10, the reader will have no trouble in discovering the truth of this statement for himself. The laws of motion and the limits between which they operate are the same for both the inlet and exhaust valves, and this fact can be taken advantage of in making the valve springs interchangeable, as well as the rest of the valve gear. It may be stated here, in a general way, that, while the roller moves along the face of the cam, the valve has an accelerated motion, and during the roller's contact with the cam fillet, the valve has a retarded motion. In fact, the sole object of the fillet is to serve as a cushion.



Figs. 9 and 10. Diagrams used for the Analysis of the Dynamics of a Tangential Exhaust Cam

There are several camshafts made with the exhaust cam fillet of somewhat greater radius than that of the inlet cam, in the belief that the exhaust cam requires more cushioning. That there is absolutely no reason for it may be demonstrated by the study and comparison of Figs. 9, 10 and 11.

Lift, Velocity and Acceleration

Let

- α = the angle formed at any instant during the upward motion of the valve by the line of cam and roller centers with the line OA. The maximum value of α is 53 degrees 8 minutes, according to Figs. 9, 10 and 11. For the sake of simplicity, we will make it 53 degrees. (Tables I and II, column 1.)
- θ = the angle that enters in the equation of the first law of motion. It is identical with α except that its maximum value equals 26 degrees 30 minutes (one-half of the maximum value of α). (Table I, column 2.)
- β = the angle that enters in the equation of the second law of motion. Like α and θ it represents the angular position of the cam, but is measured from the line

OA_7. In other words, during the required motion of the valve gear, angle β decreases as α increases; the relation between β and α is expressed by the following equation: $\beta = 53$ degrees — α (Table II, column 2).

L = lift of valve gear in inches corresponding to any angle α. The values of L are computed from the equations representing the first two laws of motion (Tables I and II, column 4).

TABLE I. ANALYSIS OF GAS ENGINE EXHAUST CAM

1	2	3	4	5	6	7	8
α	θ	$\frac{1}{\cos\theta}$	L	v	V	a	A
Deg.	Deg.						
0	0	1.0000000	0				
1	1	1.0001524	0.0001524	0.0001524	0.0635	0.0003046	634.6
2	2	1.0006094	0.0006094	0.0004570	0.1904	0.0003059	637.3
3	3	1.0013723	0.0013723	0.0007629	0.31785	0.0003066	638.7
4	4	1.0024418	0.0024418	0.0010695	0.4456	0.0003085	642.7
5	5	1.0038198	0.0038198	0.0013780	0.5742	0.0003105	646.9
6	6	1.0055083	0.0055083	0.0016885	0.7035	0.0003129	651.9
7	7	1.0075097	0.0075097	0.0020014	0.8339	0.0003163	659.0
8	8	1.0098274	0.0098274	0.0023177	0.9657	0.0003201	666.9
9	9	1.0124652	0.0124652	0.0026378	1.0990	0.0003235	674.0
10	10	1.0154265	0.0154265	0.0029613	1.2338	0.0003289	685.2
11	11	1.0187167	0.0187167	0.0032902	1.3708	0.0003336	695.0
12	12	1.0223405	0.0223405	0.0036238	1.5098	0.0003400	708.3
13	13	1.0263043	0.0263043	0.0039638	1.6515	0.0003456	720.0
14	14	1.0306137	0.0306137	0.0043094	1.7955	0.0003529	735.2
15	15	1.0352760	0.0352760	0.0046623	1.9425	0.0003612	752.4
16	16	1.0402995	0.0402995	0.0050235	2.0930	0.0003688	768.3
17	17	1.0456918	0.0456918	0.0053923	2.2467	0.0003781	787.6
18	18	1.0514622	0.0514622	0.0057704	2.4043	0.0003881	808.5
19	19	1.0576207	0.0576207	0.0061585	2.5657	0.0003985	830.2
20	20	1.0641777	0.0641777	0.0065570	2.7320	0.0004104	855.0
21	21	1.0711451	0.0711451	0.0069674	2.9030	0.0004222	879.6
22	22	1.0785347	0.0785347	0.0073896	3.0790	0.0004360	908.3
23	23	1.0863603	0.0863603	0.0078256	3.2607	0.0004504	938.3
24	24	1.0946363	0.0946363	0.0082760	3.4482	0.0004657	970.2
25	25	1.1033780	0.1033780	0.0087417	3.6423	0.0004821	1004.4
26	26	1.1126018	0.1126018	0.0092238	3.8430	0.0005005	1042.6
27	27	1.1223261	0.1223261	0.0097243	4.0515	0.0005197	1082.6
28	28	1.1325701	0.1325701	0.0102440	4.2680		

v = the velocity of the valve gear in inches per degree of the angular motion of the cam. By definition, velocity is the time-rate of change of position, and since our time unit is that corresponding to an angular movement of one degree, the numerical difference between any two successive values of L will represent the average velocity during that interval of time. (Tables I and II, column 5.)

a = acceleration in inches per degree per degree of the angular motion of the cam. By definition, acceleration is the time-rate of change of velocity, and, again, since our time unit is one degree, the numerical difference between any two successive values of v is the average acceleration during that interval of time. (Tables I and II, column 7.)

V = velocity of valves in feet per second corresponding to any value of v. (Tables I and II, column 6.)

A = acceleration in feet per second per second corresponding to any value of a. (Tables I and II, column 8.)

The last two quantities, V and A, are both expressed in gravitational units and are of great importance in our investigation. V and A can be computed from v and a respectively, but in order to do so it is necessary to establish the numerical relation between the time unit measured in seconds and the time unit as expressed in degrees.

From our specifications, the maximum speed of the engine equals from 1600 to 1700 R. P. M.; assume it to equal 1680 R. P. M. Since the camshaft revolves at one-half the speed of the engine shaft, its speed is equal to 840 R. P. M., or 14 revolutions per second. Since one revolution equals 360 degrees, the camshaft turns through $360 \times 14 = 5040$ degrees in one second. Therefore, the time unit corresponding to one degree is 1/5040 second. For the sake of simplicity we shall assume one degree = 1/5000 second, or one second = 5000 degrees. Hence,

$$V = \frac{5000\,v}{12} \quad \text{(Tables I and II, column 6.)}$$

$$A = \frac{5000 \times 5000 \times a}{12} = \frac{25{,}000{,}000\,a}{12}$$

(Tables I and II, column 8.)

It may occur to some that in carrying out the values of L, column 4, Tables I and II, to seven decimal places one loses "the sense of values," and that in practice both the cam and the roller will vary enough to affect the third decimal place by one or two units. Indeed, were we to attach importance to any one value of L, it would be folly to carry it out beyond the third decimal place, but what we aim to determine is not the individual values of L, but the succession of these values. This method gives us four significant places for the values of a (column 7) which is not too much. If the cam and its follower were a few thousandths of an inch below or above their standard dimensions, the relative differences would be the same throughout columns 3 and 4 of both tables. The values of a would all be changed, but these new values would differ from one another in the same manner as those given in Tables I and II.

It must be borne in mind that the method pursued for finding v and a is an approximate one. The exact values of v and a at any instant can be obtained only by differential calculus. However, since the values of L were taken close together (one degree apart) this method gives as accurate results as are required for our purpose.

Tables I and II cover only the upward motion of the valve, but a little thought will show that the same values of

TABLE II. ANALYSIS OF GAS ENGINE EXHAUST CAM

1	2	3	4	5	6	7	8
α	β	1.25 cos β	L	v	V	a	A
Deg.	Deg.						
25	28	1.1036845	0.1036845				
26	27	1.1137582	0.1137582	0.0100737	4.1970	−0.0003394	−707.1
27	26	1.1234925	0.1234925	0.0097343	4.0557	−0.0003421	−712.7
28	25	1.1328847	0.1328847	0.0093922	3.9134	−0.0003451	−719.0
29	24	1.1419318	0.1419318	0.0090471	3.7694	−0.0003479	−724.8
30	23	1.1506310	0.1506310	0.0086992	3.6245	−0.0003502	−729.6
31	22	1.1589800	0.1589800	0.0083490	3.4788	−0.0003537	−736.9
32	21	1.1669753	0.1669753	0.0079953	3.3312	−0.0003549	−739.3
33	20	1.1746157	0.1746157	0.0076404	3.1833	−0.0003577	−745.2
34	19	1.1818984	0.1818984	0.0072827	3.0344	−0.0003606	−751.2
35	18	1.1888205	0.1888205	0.0069221	2.8842	−0.0003618	−753.7
36	17	1.1953808	0.1953808	0.0065603	2.7334	−0.0003641	−758.5
37	16	1.2015770	0.2015770	0.0061962	2.5815	−0.0003660	−762.5
38	15	1.2074072	0.2074072	0.0058302	2.4292	−0.0003672	−765.0
39	14	1.2128696	0.2128696	0.0054624	2.2758	−0.0003695	−769.8
40	13	1.2179625	0.2179625	0.0050929	2.1220	−0.0003709	−772.7
41	12	1.2226845	0.2226845	0.0047220	1.9674	−0.0003726	−776.2
42	11	1.2270339	0.2270339	0.0043494	1.8122	−0.0003736	−778.3
43	10	1.2310097	0.2310097	0.0039758	1.6565	−0.0003753	−781.8
44	9	1.2346102	0.2346102	0.0036005	1.5001	−0.0003756	−782.4
45	8	1.2378351	0.2378351	0.0032249	1.3436	−0.0003774	−786.2
46	7	1.2406826	0.2406826	0.0028475	1.1864	−0.0003779	−787.2
47	6	1.2431522	0.2431522	0.0024696	1.0289	−0.0003785	−788.5
48	5	1.2452433	0.2452433	0.0020911	0.8712	−0.0003794	−790.4
49	4	1.2469550	0.2469550	0.0017117	0.7132	−0.0003799	−791.4
50	3	1.2482868	0.2482868	0.0013318	0.5549	−0.0003800	−791.6
51	2	1.2492386	0.2492386	0.0009518	0.39657	−0.0003809	−793.5
52	1	1.2498095	0.2498095	0.0005709	0.23786	−0.0003804	−792.0
53	0	1.2500000	0.2500000	0.0001905	0.07937		

v and a and of V and A taken in reverse order will apply to the downward motion as well, with a changed sign of acceleration. The tables for the inlet cam will be precisely the same. The tables as well as the acceleration curve plotted from them (see Fig. 12) show that

the cam starts the valve gear on its upward journey with an ever-increasing acceleration. Readers familiar with mechanics know that even were the acceleration constant, the cam and its follower would be in contact under pressure, for a constant acceleration of the follower can be due only to a constant force acting on it, *i. e.*, a constant pressure of the cam on the follower. Since, in our case, the acceleration is of a gradually increasing nature, it is more than sufficient to keep the cam in contact with its follower, and consequently the pressure of the spring is unnecessary as long as the roller moves along the face of the cam.

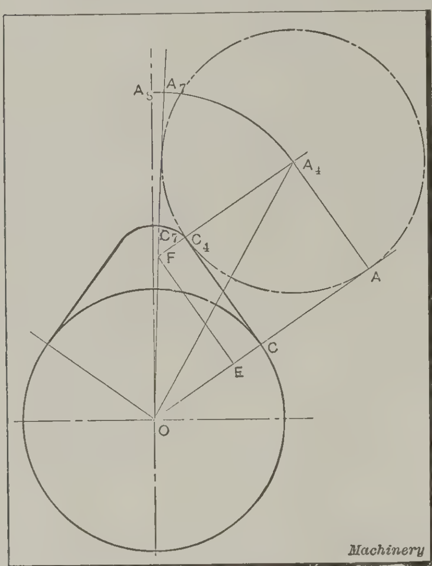


Fig. 11. Analysis of Tangential Inlet Cam

At $a = 26$ degrees 30 minutes (point B in acceleration diagram, Fig. 12), the state of things changes. Acceleration vanishes instantly, but by this time the valve gear has acquired a definite velocity. Owing to this velocity it possesses a certain amount of energy which is consumed in compressing the valve spring through a certain distance. The spring absorbs this energy at the expense of the now decreasing velocity of the valve. A decreasing velocity can be due only to a negative acceleration; in other words, the spring does all the work of retardation (neglecting slight friction and force of gravity). It can do it in a number of different ways, but the best way is plainly the one that will insure contact (under slight pressure) of the cam with its follower, and, in order to do that, the spring must exert pressure sufficient to produce accelerations somewhat greater than those shown in Column 8, Table II, and represented in Fig. 12 by the portion BC of the curve.

The first part of the downward motion of the valve is due entirely to the pressure of the spring. The motion is symmetrical with that of the last part of the upward motion and a spring designed for this will be satisfactory for both motions. At D, Fig. 12, the acceleration changes sign and becomes negative—this time the cam doing all the work of retardation. If the spring pressure is to vanish instantly at this point, the cam will retard the valve just as effectively.

TABLE III. DATA FOR DRAWING SPRING PRESSURE CURVE

L	A	T	L	A	T
0.114	707	35.35	0.227	778	38.9
0.142	725	36.25	0.238	786	39.3
0.175	745	37.25	0.245	790	39.5
0.202	763	38.2	0.250	792	39.6
0.218	773	38.7	.....	...	....

Valve Springs

There remains now only the problem of designing a suitable valve spring. Let,

T = pressure of the spring in pounds at any point between B and C, Fig. 12.

A = acceleration (in feet per second per second) necessary at that point to keep the cam in contact with its follower.

m = mass of the reciprocating parts of the valve gear, including one-half the mass of the spring itself.

Then, $T = m \times A$.

Assuming the weight w of the reciprocating parts to be 1.6 pound,

$$m = \frac{w}{g} = \frac{1.6}{32} = \frac{1}{20}$$

$$T = A \times \frac{1}{20} = \frac{A}{20}$$

The valve springs most commonly used on automobile engines are of the type shown in Figs. 2 and 3. Any helical spring develops pressure in direct proportion to the amount of distortion it undergoes, provided its elastic limit is not exceeded. It will, therefore, prove useful to plot a curve BC, Fig. 14, using lifts for abscissas and spring pressures for ordinates. This can be easily accomplished by selecting, from Table II, eight or ten values of L and the corresponding values of A. Table III is made up of these values selected at random; the third column of this table gives the spring pressures in pounds. In Fig. 14, the curve BC corresponds to curve BC in Fig. 12.

The compression curves of the springs shown in Figs. 2 and 3 are straight inclined lines (within the elastic limit), and in accordance with our preceding discussion the compression curve of our spring must be slightly above BC, if the cam and its follower are to be kept in contact under pressure. There are two more conditions to which our spring must conform. The first of these is that the maximum safe load of the spring should not be exceeded when the valve reaches its full lift. The second condition is that, when the piston is drawing in a fresh charge, the spring pressure must be sufficient to keep the exhaust valve tight on its seat against the back pressure of the exhaust gases in the muffler.

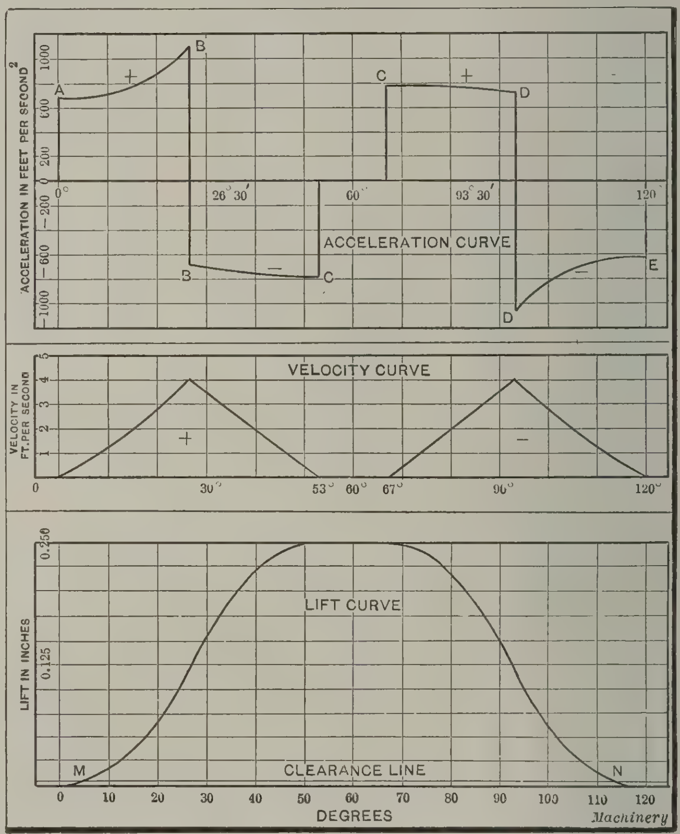


Fig. 12. Acceleration, Velocity and Lift Curves of Tangential Cam

Suppose that the valve is of the dimensions shown in Fig. 13, that the back-pressure of exhaust gases is about 8 pounds gage, or about 23 pounds absolute, and that the pressure in the cylinder on the suction stroke drops to 12 pounds absolute. Total difference in pressures on valve head is:

$$23 \times \frac{\pi}{4} \times \left[(1\tfrac{1}{4})^2 - \left(\frac{5}{16}\right)^2 \right] - 12 \times \frac{\pi}{4} \times \left(1\frac{11}{16}\right)^2 = 12$$

pounds.

When the valve is closed, *i. e.*, when $L = 0$, the spring pressure must be somewhat in excess of 12 pounds or else gas-tightness at the seat will not be secured. In practice, probably nothing short of 30 pounds would do. There are two reasons for this discrepancy between theory and prac-

tice: 1. The pressure in the exhaust header, which is located in the immediate neighborhood of the exhaust valves, must, on account of restricted passages, be somewhat higher than the back-pressure in the muffler; 2. The exhaust of burnt gases does not take place in a continuous stream, but comes in "puffs," and, thus, the pressure in the header is of a pulsating nature, with a maximum instantaneous value considerably in excess of the muffler pressure.

In designing a spiral spring, the two following formulas

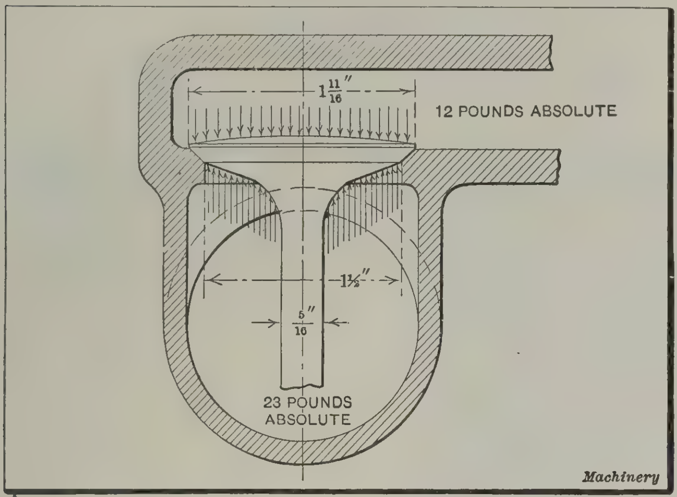


Fig. 13. Section through Exhaust Valve

given by Unwin (Part I, page 39) are generally used by designers:

$$P_1 = \frac{180{,}000\, d^4}{nr^3} \qquad (1)$$

$$P = \frac{12{,}000\, d^3}{r} \qquad (2)$$

where $P =$ maximum safe load of the spring in pounds.
$P_1 =$ pressure on spring in pounds per inch of deflection,
$n =$ number of full coils,
$d =$ diameter of wire in inches,
$r =$ mean radius of the spring.

Cut and try methods are generally applied to Formulas (1) and (2). Practical considerations, however, greatly reduce the tedious work of calculating the springs. The amount of room available for springs limits their outside diameter; in

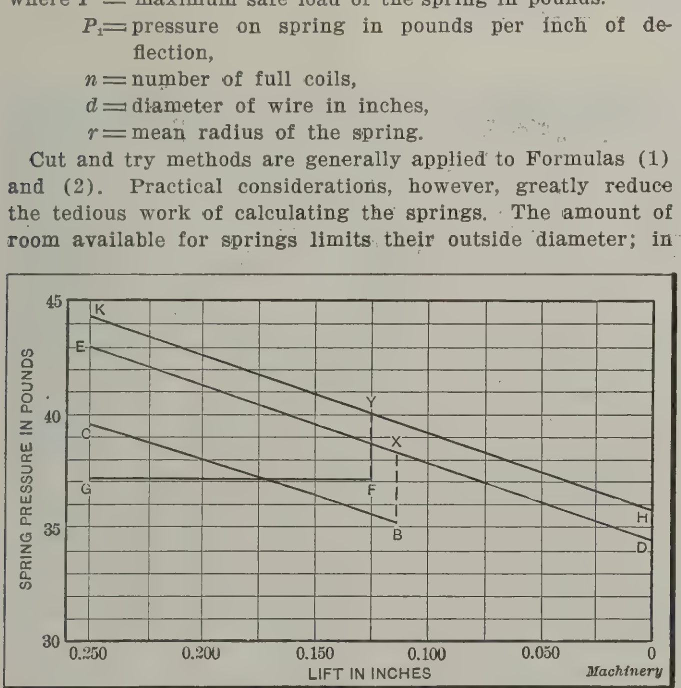


Fig. 14. Spring Pressure Diagram for Tangential and Uniformly Accelerated Motion Cams

other words, it limits r. According to Table III, the maximum pressure of the spring need not exceed 40 to 45 pounds. Making $P = 45$ pounds, and $r = \frac{1}{2}$ inch, and substituting these values in Equation (2) we get $d = 0.123$ inch.

The nearest size of wire is No. 11 B. W. G., which is equal to 0.120 inch. Therefore, making $d = 0.120$, retaining 45 for the value of P, and solving for r in Equation (2), we get $r =$ 0.462 inch.

In Equation (1) d and r are now practically determined. Referring to Table III it will be seen that the spring pressure must increase by about 4 pounds with a corresponding compression of about ⅛ inch; in other words the spring pressure per inch of deflection $= \frac{4}{1/8} = 32$ pounds.

Making $P_1 = 35$ pounds in Equation (1) and solving for n, we get $n = 10.8$ coils.

If we make the spring with eleven free coils:

$$P_1 = \frac{180{,}000 \times 0.00020736}{11 \times 0.0986} = 34.4 \text{ pounds.}$$

Now, if the spring be made 1 inch longer in its free state than when it is in place with the valve closed, its initial pressure will amount to 34.4 pounds, and with the valve at its full lift, the final pressure of the spring will amount to $34.4 \times 1.25 = 43$ pounds. The pressure line of the spring is represented graphically by line DE in Fig. 14. It will be observed that the spring thus designed fulfills all requirements. The ideal spring pressure line is the one that will practically coincide with line BC.

So far as design is concerned, our problem is now completely solved. However, if we wish to look further into the advantages and disadvantages of the tangential cam, we must compare it with some other type of cam. This method of comparison is a very useful one, for it eliminates the necessity of several assumptions, and at the same time brings out definitely both the desirable and the undesirable features of cams. A comparison with the uniformly accelerated and retarded motion cam will be made in the next installment of this article.

* * *

EDUCATION IN ACCIDENT PREVENTION

At the accident prevention meeting of the Conservation Congress at Indianapolis, October 2, Mr. Melville W. Mix, president of the Dodge Mfg. Co., Mishawaka, Ind., read a paper in which the general principles of accident prevention in his plant were outlined, and from which we have made the following extract:

"With the development of the new doctrine of indemnity in the case of occupational accidents, which disregards the assumption of risk, negligence of fellow employes or contributory negligence, as defenses to the employer, it becomes necessary to consider the question from a purely educational standpoint, establishing collaterally therewith the doctrine of prevention of accidents.

"In order to bring the matter of safety directly to the employes of the Dodge Mfg. Co., the management has prepared a plan of education and competition between departments and their foremen. This is in the form of a percentage score board, such as indicates the standing of teams in the base ball leagues. The starting point is 1000. Each division is penalized according to its accidents, minor accidents of less than one day's absence not, as yet, being considered. Each day's absence bears a percentage charge in proportion to the total number of men-days per month in each division.

"The foremen of all the divisions scoring 1000, or those holding the first three places below 1000 will receive prizes for personal interest each month. The foreman scoring the largest number of first monthly prizes for one year will receive a special prize at the end of the year. All divisions holding a percentage for the year of 1000, or the highest annual percentage, will receive two days' extra pay."

The plan is in a rather crude form at present, but it will be of daily interest because of its competitive nature, and will facilitate the inculcation of preventive measures and of individual care and forethought, as well as speedy and prompt attention to reduce the severity of the accident and shorten the time of absence. The interest in the daily score board, which is 24 feet long and erected at the main works entrance, will influence all the workers.

* * *

The council of the International Association of Chemical Societies, which met in Berlin last April, unanimously approved of Prof. Ostwald's suggestion in favor of a series of uniform sizes for chemical publications. It was recommended that all the affiliated societies adopt, for their publications, the uniform size of 16 by 22.6 centimeters (about 6 5/16 by 8 7/8 inches.). It certainly would be desirable if book publishers in general could agree on certain standard sizes for all scientific and mechanical books.

MILLING SAD IRONS

This seems to be the age of the milling machine, as it is used on work hitherto thought to be entirely out of its range. Automobile manufacturers early appreciated the possibilities of this type of machine and have achieved wonderful results from its use. It is interesting to note, however, that other manufacturers have also awakened to the possibilities of milling on certain classes of work, and have in some cases increased the output greatly. An excellent example of the application of the Becker vertical type of milling machine to the manufacture of sad iron bases was obtained in the shop of the Dover Mfg. Co., Canal Dover, Ohio.

The former method of machining these sad iron bases—removing ⅛ inch of material from the base—was to hold one base at a time in a chuck, and remove the material with a single cutting tool. A row of the machines formerly used for this purpose is shown in Fig. 1, where it will be seen that they resemble somewhat in appearance an old type lathe. Fig. 3 shows a closer view of the tool-slide and chuck in which a sad iron base is retained.

Fig. 1. "Old Lathes" formerly used for machining Sad Iron Bases

The drive is from a countershaft to the pulley A, which is held on the back-gear shaft carrying the pinion B, this gear meshing with the large gear C on the work spindle D, Fig. 1. Located on the rear end of the work spindle is another pinion E, which through the medium of an intermediate gear F, drives the back shaft G. Shaft G, through bevel gears, rotates the screw H, which imparts the traverse movement to the slide I. A pinion J, held on the front end of the screw, provides a means for rotating the latter by hand through the gear K and the handle shown.

The chuck used for holding the work is a rather antique looking affair, consisting of a plate screwed to the spindle, and recessed to receive the two jaws L and M, which are milled out to suit the shape of the casting. The work is clamped by the set-screws N and O, the screw O extending through the jaw L, while the screw N bears on a spring plunger that pinches the casting. It is only necessary to operate the set-screw N to clamp the work, when the set-screw O has once been properly set. (Note the fancy guard for the set-screw.)

These machines were arranged in a row so that one man could attend to the "gang", removing and inserting the work, keeping the cutting tools sharp, etc. Great difficulty was experienced in producing a smooth surface at the extreme ends of the sad iron base, owing to the cutting tool P springing when leaving and approaching the work. This necessitated rotating the work slowly by means of the back-gear arrangement, and using a fine feed. With five of these machines (only four are shown in Fig. 1) it was possible by keeping them going continually to turn out 1000 sad irons per day—at a rate of one casting from each machine every three minutes.

Upon the installation of the two Becker vertical milling machines shown in Fig. 2, which were equipped with rotary fixtures, this production was increased by 300 per cent (to 4000 sad iron bases per day), with a corresponding increase in the quality of the work. Instead of one man attending to five machines, each machine is attended by an operator whose attention is confined to removing and inserting the work. The milling is accomplished with a high-speed steel inserted tooth milling cutter, having fourteen blades, which support each other, obviating chatter and enabling the use of a coarse feed.

A closer view of the rotary milling fixture used is shown in Fig. 5, while Fig. 4 shows the construction of the clamping arrangement. The fixture consists of a circular base A, which is clamped, as shown, to the rotary table and is provided with cast projections forming the base of a three-point support for the sad iron base. As shown in Fig. 4, the sad iron base rests on a hardened block B, and is supported and clamped on the forward end by two hardened studs C which are beveled to grip the casting securely, when it is forced against them by the strap D. This strap is provided with a heel, and is located in a machined recess in the lug E to which the hardened block B is also fastened. The clamping strap is held against the work by a winged nut F, screwed onto a stud that is located in the cast lug.

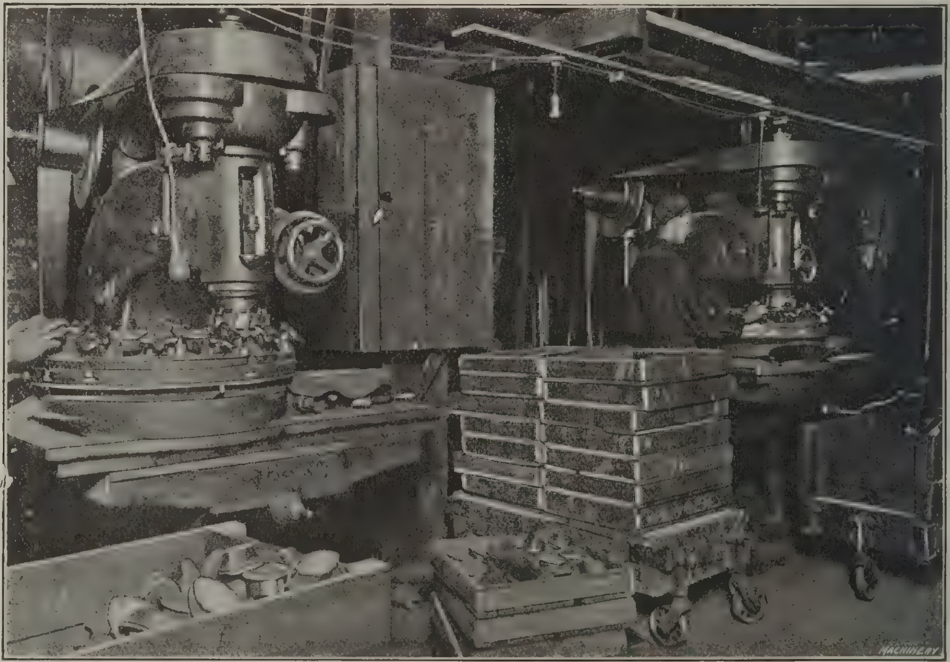


Fig. 2. The Improved Method of machining Sad Iron Bases

In operation, as the table rotates, the operator releases the clamping nut, removes the casting, brushes off the "seats," and inserts a rough casting, repeating this order as the castings are machined. It requires approximately 2½ minutes for the fix-

ture to make one revolution, and in this time 14 sad iron bases are machined, as against one sad iron base in 3 minutes by the old method. As before, ⅛ inch of material is removed from the base of the castings.

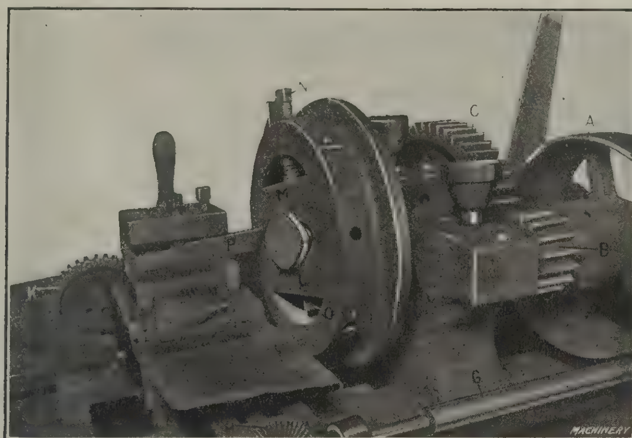


Fig. 3. View showing Construction of Old Chuck and Tool-slide

The machining of these sad iron bases is an excellent example of the application of rotary continuous milling fixtures to the manufacturing of castings in large quantities, and illustrates in a forceful manner the advance made in manufacturing methods. The fixtures used were designed and built by the Becker Milling Machine Co., Hyde Park, Mass.

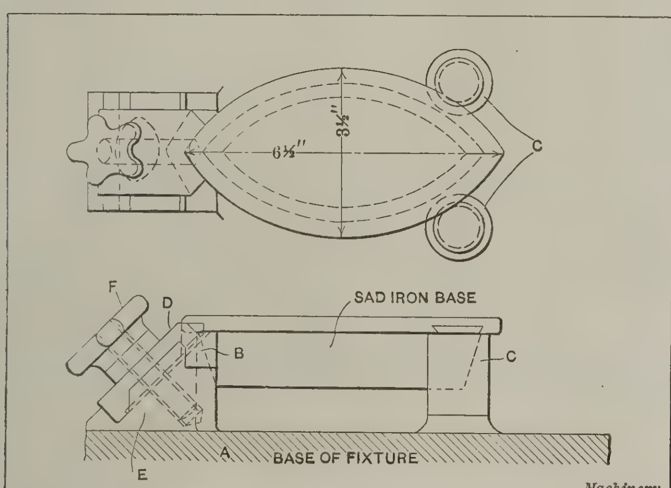


Fig. 4. Method of Clamping the Sad Iron Bases on the Continuous Rotary Milling Fixture

* * *

The Minneapolis, St. Paul & Sault Ste. Marie Railway has posted a notice in its car shops to the effect that employes will not be permitted to wear neckties or torn overalls while at work. This order has been issued with a view to reducing the danger of accidents in the shops, as many injuries have been due to the men having been drawn into machinery by their neckties or by ragged garments being entangled in the mechanism.

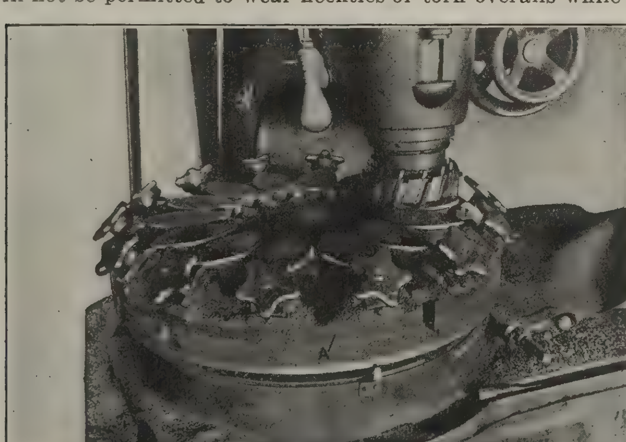


Fig. 5. Continuous Rotary Milling Fixture used on the Becker Vertical Milling Machines for holding the Sad Iron Bases while machining

FLUTING ANGULAR MILLING CUTTERS AND TAPERED REAMERS*†

BY GEORGE W. BURLEY‡

The "lands" which are formed on the teeth of all kinds of milling cutters and reamers, except those which are of the formed variety and those which are eccentrically relieved, whether cylindrical or conical, usually have a uniform width from one end of the cutter or reamer to the other. It is, of course, quite possible to arrange the cutter or reamer blank in the milling machine dividing head for the fluting or grooving operation so that the lands which are formed on the teeth will be tapered. The latter form of land is, however, never used in connection with axial and radial teeth, in good practice, and is very rarely used in connection with inclined teeth—that is, teeth on angular milling cutters and tapered reamers.

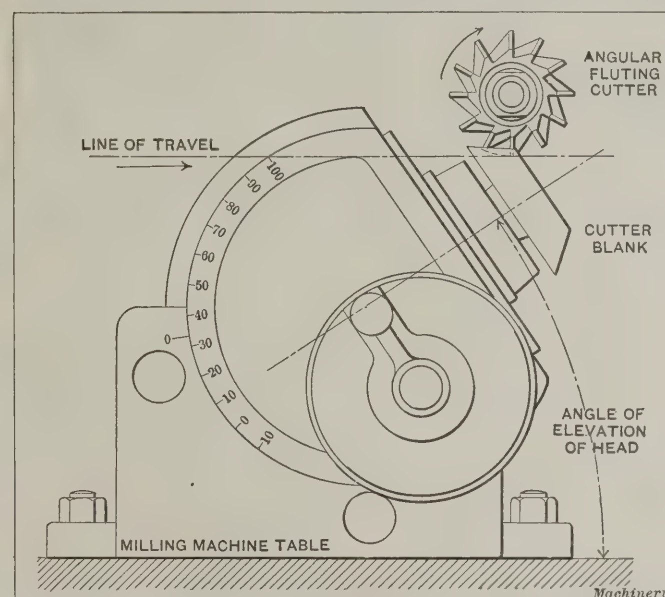


Fig. 1. Dividing Head set for Milling Teeth in Angular Cutter

For the formation of lands of uniform width on radial teeth on the sides and ends of cylindrical milling cutters and on inclined teeth on the conical surfaces of angular milling cutters and tapered reamers, it is necessary to set the axis of the cutter or reamer and, therefore, the axis of the dividing head, at a definite angle with respect to the horizontal axis of the dividing head and footstock centers. This angle depends upon several factors, which, in the case of angular milling cutters and tapered reamers, are enumerated and dealt with below. This angle is known as the "angle of elevation" of the dividing head (see Fig. 1). For cutters having radial teeth, the question of its determination and that of the depth of cut required was discussed in the November and December, 1911, numbers of MACHINERY by the present writer. The problem involving the determination of the values of this angle and the required depth of cut for angular cutters and tapered reamers is, however, more complicated, and is considered in the present article.

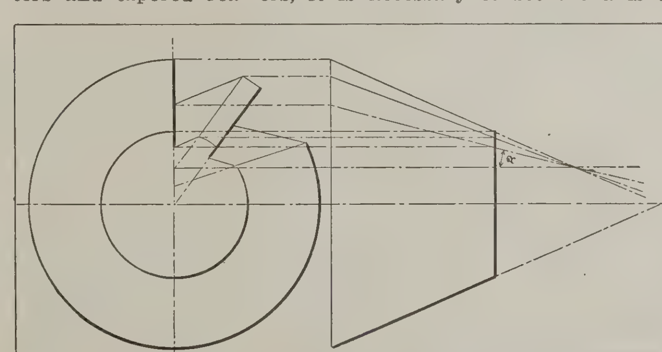


Fig. 2. Diagrammatical Representation of Principles involved in Milling Teeth in Angular Cutters

* With Data Sheet Supplement.
† See also MACHINERY, March, 1912, "Milling Axial Teeth in Cutter and Reamer Blanks," and the articles there referred to.
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TABLES V AND VI. ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS

Number of Teeth in Cutter to be Fluted = 16										
Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	46° 20′		0.4025		0.3813		0.3389		0.2965
	50	49° 39′		0.3500		0.3314		0.2942		0.2570
20	60	55° 40′	0.020	0.2491	0.040	0.2359	0.080	0.2095	0.120	0.1831
	70	60° 26′		0.1670		0.1581		0.1403		0.1225
	80	64° 36′		0.0946		0.0895		0.0794		0.0693
	45	37° 40′		0.4145		0.3925		0.3485		0.3045
	50	40° 51′		0.3575		0.3385		0.3005		0.2625
30	60	46° 20′	0.020	0.2574	0.040	0.2438	0.080	0.2166	0.120	0.1894
	70	50° 40′		0.1767		0.1673		0.1485		0.1297
	80	54° 28′		0.1052		0.0996		0.0884		0.0772
	45	30° 10′		0.4176		0.3954		0.3510		0.3066
	50	32° 50′		0.3640		0.3446		0.3058		0.2670
40	60	37° 33′	0.020	0.2662	0.040	0.2520	0.080	0.2236	0.120	0.1952
	70	41° 20′		0.1860		0.1760		0.1560		0.1360
	80	44° 40′		0.1144		0.1084		0.0964		0.0844
	45	26° 24′		0.4270		0.4042		0.3586		0.3130
	50	28° 58′		0.3698		0.3500		0.3104		0.2708
45	60	33° 25′	0.020	0.2686	0.040	0.2542	0.080	0.2254	0.120	0.1966
	70	36° 51′		0.1897		0.1787		0.1567		0.1347
	80	39° 55′		0.1185		0.1121		0.0993		0.0865
	45	23° 35′		0.4200		0.3970		0.3510		0.3050
	50	25° 30′		0.3678		0.3482		0.3090		0.2698
50	60	29° 21′	0.020	0.2621	0.040	0.2495	0.080	0.2243	0.120	0.1991
	70	32° 30′		0.1925		0.1821		0.1613		0.1405
	80	35° 14′		0.1220		0.1155		0.1025		0.0895
	45	17° 25′		0.4114		0.3896		0.3460		0.3024
	50	18° 40′		0.3705		0.3510		0.3120		0.2730
60	60	21° 38′	0.020	0.2750	0.040	0.2603	0.080	0.2309	0.120	0.2015
	70	24° 0′		0.1979		0.1871		0.1655		0.1439
	80	26° 7′		0.1278		0.1210		0.1074		0.0938
	45	11° 0′		0.4330		0.4098		0.3634		0.3170
	50	12° 14′		0.3727		0.3527		0.3127		0.2727
70	60	14° 14′	0.020	0.2770	0.040	0.2622	0.080	0.2326	0.120	0.2030
	70	15° 50′		0.2008		0.1900		0.1684		0.1468
	80	17° 15′		0.1328		0.1267		0.1115		0.0973
	45	5° 30′		0.4269		0.4040		0.3582		0.3124
	50	6° 3′		0.3745		0.3545		0.3145		0.2745
80	60	7° 3′	0.020	0.2799	0.040	0.2649	0.080	0.2349	0.120	0.2049
	70	7° 51′		0.2038		0.1929		0.1711		0.1493
	80	8° 35′		0.1343		0.1271		0.1127		0.0983

Number of Teeth in Cutter to be Fluted = 18										
Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	49° 26′		0.3513		0.3297		0.2865		0.2433
	50	52° 18′		0.3040		0.2852		0.2476		0.2100
20	60	57° 31′	0.020	0.2162	0.040	0.2029	0.080	0.1763	0.120	0.1497
	70	61° 45′		0.1435		0.1347		0.1171		0.0995
	80	65° 24′		0.0802		0.0752		0.0652		0.0552
	45	40° 31′		0.3570		0.3350		0.2910		0.2470
	50	43° 20′		0.3109		0.2919		0.2539		0.2159
30	60	48° 7′	0.020	0.2238	0.040	0.2100	0.080	0.1824	0.120	0.1548
	70	51° 58′		0.1516		0.1422		0.1234		0.1046
	80	55° 19′		0.0885		0.0831		0.0723		0.0615
	45	33° 2′		0.3615		0.3395		0.2955		0.2515
	50	35° 5′		0.3153		0.2959		0.2571		0.2183
40	60	39° 14′	0.020	0.2290	0.040	0.2149	0.080	0.1867	0.120	0.1585
	70	42° 33′		0.1591		0.1493		0.1297		0.1101
	80	45° 30′		0.0963		0.0904		0.0786		0.0668
	45	28° 48′		0.3650		0.3430		0.2990		0.2550
	50	31° 0′		0.3211		0.3011		0.2611		0.2211
45	60	34° 57′	0.020	0.2340	0.040	0.2196	0.080	0.1908	0.120	0.1620
	70	38° 0′		0.1622		0.1522		0.1322		0.1122
	80	40° 43′		0.0993		0.0932		0.0810		0.0688
	45	25° 25′		0.3660		0.3440		0.3000		0.2560
	50	27° 20′		0.3225		0.3025		0.2625		0.2225
50	60	30° 45′	0.020	0.2356	0.040	0.2211	0.080	0.1921	0.120	0.1631
	70	33° 33′		0.1648		0.1546		0.1342		0.1138
	80	35° 59′		0.1020		0.0958		0.0834		0.0710
	45	18° 48′		0.3665		0.3445		0.3005		0.2565
	50	20° 6′		0.3238		0.3038		0.2638		0.2238
60	60	22° 45′	0.020	0.2371	0.040	0.2225	0.080	0.1933	0.120	0.1641
	70	24° 53′		0.1677		0.1573		0.1365		0.1157
	80	26° 45′		0.1060		0.0995		0.0865		0.0735
	45	12° 20′		0.3670		0.3450		0.3010		0.2570
	50	13° 13′		0.3250		0.3050		0.2650		0.2250
70	60	15° 0′	0.020	0.2395	0.040	0.2251	0.080	0.1963	0.120	0.1675
	70	16° 27′		0.1701		0.1596		0.1386		0.1176
	80	17° 43′		0.1095		0.1027		0.0891		0.0735
	45	6° 2′		0.3700		0.3476		0.3028		0.2580
	50	6° 33′		0.3260		0.3058		0.2654		0.2250
80	60	7° 26′	0.020	0.2401	0.040	0.2257	0.080	0.1969	0.120	0.1681
	70	8° 10′		0.1730		0.1622		0.1406		0.1190
	80	8° 48′		0.1129		0.1059		0.0919		0.0779

The lands on the teeth of any milling cutter or reamer are invariably finally formed in the grinding operation, but they can be—and usually are—initially formed in the operation of milling the flutes or grooves between the teeth. This reduces the duration and cost of both the milling and the grinding operations. This case is illustrated in Fig. 2, where angle a represents the angle of elevation of the indexing or dividing head. It could be conceived, however, that the fluting or grooving cutter and the cutter or reamer blank were so arranged with respect to each other that the cutter penetrated the blank to such a depth that each tooth was formed in the fluting operation with a sharp edge which possessed none of the characteristics of a land. This case is illustrated in Fig. 3, where the angle of elevation of the indexing or dividing head is represented by a. A comparison of Figs. 2 and 3 will show a marked difference between the two cases. In the first case, the bottom of the flute or groove does not pass through the apex of the cone of which the cutter or reamer blank is a frustum; in the second case, it does. It does not follow as a

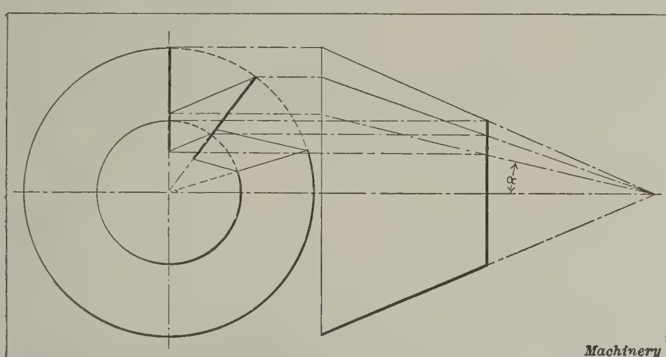

Fig. 3. Conditions obtaining if Tooth were milled to a Sharp Point

corollary, however, that, for similar conditions and dimensions (with the exception of the width of the land), the angles of elevation for the two cases are different, since it can be very readily demonstrated that the width of the land in any case has no influence upon the angle of elevation of the dividing head. This being the case, it is of no material importance which of the cases is considered for determining this angle; we shall, however, take the latter case (that is, the one involving no land-width), as it is the simpler of the two to treat.

There are two ways in which the angle of elevation can be determined. The first is the direct method, by means of which the value of a is calculated without any intermediate steps or operations. It is, however, an exceedingly complicated and cumbersome method, and not nearly as simple as the second one in its application. The second method involves three separate steps or operations: 1. The determination of the

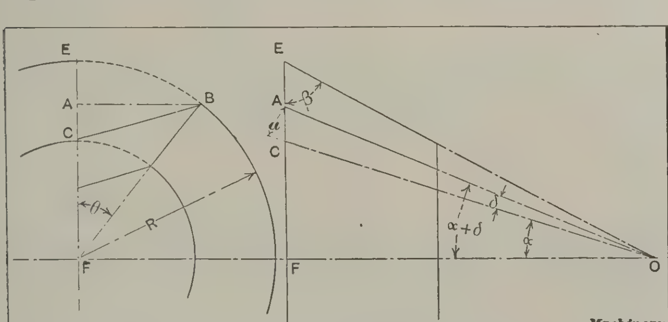

Fig. 4. Diagram for Deduction of Formula for finding Setting Angle for Dividing Head

value of the angle $(a + \delta)$, Fig. 4; 2. The calculation of the angle δ in the same figure; 3. The obtaining of the difference between these two angles.

The conditions of the problem are indicated in Fig. 4, in which O represents the vertex of the cone of which the blank is a part or frustum; FE and FB represent the radius of the large end of the blank and are, therefore, equal to each other; CO represents the bottom of the flute produced to the vertex O; and ECB represents the flute at the large end of the blank.

Let $R =$ the radius of large end of blank,

$\theta =$ tooth-angle of the blank (this angle is equal to 360 ÷ number of teeth to be milled in blank, the teeth being supposed to be spaced uniformly around the periphery of the blank),

$\beta =$ angle of blank (this angle is measured as indicated in Fig. 4),

$\gamma =$ angle of fluting cutter (this being assumed to be a single-angle cutter),

$a =$ angle of elevation of dividing head.

Then $FA = FB \cos\theta = R\cos\theta$, and

$$\tan(a+\delta) = \frac{FA}{FO} = \frac{R\cos\theta}{FO}.$$

Now, $\dfrac{FO}{FE} = \tan\beta = \dfrac{FO}{R}$; therefore $FO = R\tan\beta$. Hence

$$\tan(a+\delta) = \frac{R\cos\theta}{R\tan\beta} = \frac{\cos\theta}{\tan\beta} \qquad (1)$$

Since θ and β are known for any particular case, the values of $\cos\theta$ and $\tan\beta$ can be obtained from a table of trigonometrical ratios, and the value of $\tan(a+\delta)$ calculated, and the value of the angle $(a+\delta)$ obtained.

The second part of the process of finding the value of the angle of elevation of the head involves the determination of angle δ. In Fig. 4 $\sin\delta = \dfrac{a}{AO}$. Now, from an examination of Fig. 5, which is a section normal to the bottom of the flute or groove and passing through line AB, and by comparing it with Fig. 4, we see that $a = AB\cot\gamma$. Further,

$$AO = \frac{AF}{\sin(a+\delta)} = \frac{AB}{\sin(a+\delta)\tan\theta}. \text{ Therefore}$$

$$\sin\delta = \frac{AB\cot\gamma}{\dfrac{AB\cot\theta}{\sin(a+\delta)}} = \cot\gamma\tan\theta\sin(a+\delta) \qquad (2)$$

This expression will give the value of $\sin\delta$, since at this stage all the other quantities involved are obtainable from the given data, and from $\sin\delta$ the value of angle δ is obtained.

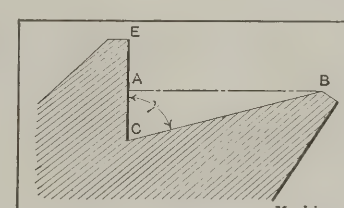

Fig. 5. Section Normal to Bottom of Tooth

It will now be observed that the values of the angles $(a + \delta)$ and δ can be calculated from the furnished data, and that their difference is the angle a required (the angle of elevation of the dividing head).

As the expressions above, however, are obviously altogether too cumbersome to admit of their use in ordinary machine shop practice, the accompanying Data Sheet Supplement has been prepared, giving the values of the angles of elevation of the dividing head for a large number of combinations of number of teeth to be milled in blank, angle of blank, and angle of fluting cutter. For any combination not provided for, the "simple proportion" method of determining the values of angle a from the values given in the tables will usually give a result sufficiently close for practical purposes. To illustrate this point, let us take the case of a cutter blank in which 15 teeth have to be milled, the angle of the blank (β) being 65 degrees, and the angle of the fluting cutter (γ) being 55 degrees. Consulting the tables and applying the "simple proportion" method in steps, we find that $a = 15$ degrees 58 minutes for this case, while if calculated by means of Equations (1) and (2), the value of the angle equals 16 degrees 3 minutes, the difference of 5 minutes being negligible, as it is not possible to set the dividing head spindle to within 10 minutes, in the majority of cases.

In addition to the angle of elevation of the dividing head, it is necessary to know the depth of cut required to form the width of land selected. This is also given in the accompanying Data Sheet Supplement. The mathematical deductions required to obtain the values given in the tables will be dealt with in the following.

TABLES VII AND VIII. ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS

Number of Teeth in Cutter to be Fluted = 20

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	51° 43′		0.3119		0.2904		0.2474		0.2044
	50	54° 18′		0.2688		0.2504		0.2136		0.1768
20	60	58° 59′	0.020	0.1897	0.040	0.1767	0.080	0.1507	0.120	0.1247
	70	62° 44′		0.1258		0.1172		0.1000		0.0828
	80	66° 0′		0.0692		0.0644		0.0548		0.0452
	45	43° 0′		0.3142		0.2927		0.2497		0.2067
	50	45° 15′		0.2744		0.2556		0.2180		0.1804
30	60	49° 30′	0.020	0.1960	0.040	0.1826	0.080	0.1558	0.120	0.1290
	70	52° 56′		0.1325		0.1234		0.1052		0.0870
	80	55° 55′		0.0766		0.0713		0.0607		0.0501
	45	34° 39′		0.3220		0.2999		0.2557		0.2115
	50	36° 47′		0.2779		0.2589		0.2209		0.1829
40	60	40° 30′	0.020	0.2008	0.040	0.1870	0.080	0.1594	0.120	0.1318
	70	43° 30′		0.1375		0.1281		0.1093		0.0905
	80	46° 7′		0.0823		0.0767		0.0655		0.0543
	45	30° 29′		0.3300		0.3076		0.2628		0.2180
	50	32° 37′		0.2829		0.2595		0.2227		0.1859
45	60	36° 9′	0.020	0.2028	0.040	0.1896	0.080	0.1607	0.120	0.1330
	70	38° 53′		0.1407		0.1311		0.1119		0.0927
	80	41° 19′		0.0846		0.0788		0.0672		0.0556
	45	27° 3′		0.3250		0.3026		0.2578		0.2130
	50	28° 47′		0.2820		0.2627		0.2241		0.1855
50	60	31° 51′	0.020	0.2051	0.040	0.1906	0.080	0.1616	0.120	0.1326
	70	34° 20′		0.1432		0.1334		0.1138		0.0942
	80	36° 31′		0.0879		0.0819		0.0699		0.0579
	45	20° 0′		0.3232		0.3010		0.2566		0.2122
	50	21° 15′		0.2831		0.2637		0.2249		0.1861
60	60	23° 36′	0.020	0.2079	0.040	0.1933	0.080	0.1649	0.120	0.1365
	70	25° 30′		0.1460		0.1360		0.1160		0.0960
	80	27° 10′		0.0920		0.0857		0.0731		0.0605
	45	13° 0′		0.3321		0.3093		0.2637		0.2181
	50	14° 0′		0.2860		0.2663		0.2269		0.1875
70	60	15° 36′	0.020	0.2122	0.040	0.1972	0.080	0.1672	0.120	0.1372
	70	16° 54′		0.1479		0.1377		0.1173		0.0969
	80	18° 0′		0.0952		0.0887		0.0757		0.0627
	45	6° 30′		0.3250		0.3030		0.2590		0.2150
	50	6° 56′		0.2871		0.2675		0.2283		0.1891
80	60	7° 45′	0.020	0.2106	0.040	0.1962	0.080	0.1674	0.120	0.1386
	70	8° 25′		0.1480		0.1379		0.1177		0.0975
	80	8° 59′		0.0953		0.0888		0.0758		0.0628

Number of Teeth in Cutter to be Fluted = 24

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	55° 0′		0.2531		0.2321		0.1901		0.1481
	50	57° 12′		0.2169		0.1989		0.1629		0.1269
20	60	61° 2′	0.020	0.1522	0.040	0.1396	0.080	0.1144	0.120	0.0892
	70	64° 7′		0.1000		0.0918		0.0754		0.0590
	80	66° 50′		0.0540		0.0495		0.0405		0.0315
	45	46° 5′		0.2549		0.2339		0.1919		0.1499
	50	48° 0′		0.2202		0.2020		0.1656		0.1292
30	60	51° 30′	0.020	0.1563	0.040	0.1434	0.080	0.1176	0.120	0.0918
	70	54° 20′		0.1045		0.0959		0.0787		0.0615
	80	56° 48′		0.0590		0.0541		0.0443		0.0345
	45	37° 39′		0.2559		0.2348		0.1926		0.1504
	50	39° 15′		0.2230		0.2046		0.1678		0.1310
40	60	42° 20′	0.020	0.1598	0.040	0.1466	0.080	0.1202	0.120	0.0938
	70	44° 48′		0.1083		0.0994		0.0816		0.0638
	80	46° 59′		0.0629		0.0577		0.0473		0.0369
	45	33° 45′		0.2569		0.2357		0.1933		0.1509
	50	36° 15′		0.2251		0.2065		0.1693		0.1321
45	60	37° 50′	0.020	0.1620	0.040	0.1486	0.080	0.1218	0.120	0.0950
	70	40° 7′		0.1102		0.1011		0.0829		0.0647
	80	42° 7′		0.0653		0.0599		0.0491		0.0383
	45	29° 40′		0.2578		0.2366		0.1942		0.1518
	50	30° 52		0.2270		0.2082		0.1706		0.1330
50	60	33° 25′	0.020	0.1639	0.040	0.1503	0.080	0.1231	0.120	0.0959
	70	35° 30′		0.1120		0.1027		0.0841		0.0655
	80	37° 20′		0.0664		0.0610		0.0502		0.0394
	45	21° 50′		0.2602		0.2386		0.1954		0.1522
	50	22° 52′		0.2276		0.2090		0.1714		0.1340
60	60	24° 50′	0.020	0.1650	0.040	0.1514	0.080	0.1242	0.120	0.0970
	70	26° 27′		0.1136		0.1042		0.0854		0.0666
	80	27° 50′		0.0690		0.0633		0.0519		0.0405
	45	14° 25′		0.2610		0.2394		0.1962		0.1530
	50	15° 5′		0.2290		0.2102		0.1726		0.1350
70	60	16° 25′	0.020	0.1676	0.040	0.1537	0.080	0.1259	0.120	0.0981
	70	17° 33′		0.1147		0.1053		0.0865		0.0677
	80	18° 30′		0.0700		0.0643		0.0529		0.0415
	45	7° 5′		0.2682		0.2460		0.2016		0.1572
	50	7° 30′		0.2300		0.2111		0.1733		0.1355
80	60	8° 10′	0.020	0.1684	0.040	0.1545	0.080	0.1267	0.120	0.0989
	70	8° 43′		0.1177		0.1079		0.0883		0.0687
	80	9° 13′		0.0715		0.0657		0.0541		0.0425

In the foregoing the formulas required for calculating the angle to which to set the dividing head when milling angular cutters or taper reamers are given. The question of determining the depth of the cut required for any given width of land will now be dealt with. As will be shown in the following, the depth of cut required depends, among other factors, upon the selected width of land, and, therefore, a change in the depth of cut will cause a land of another width to be formed.

The conditions of this part of the problem are represented in Fig. 6. In this figure, W represents the width of the land. Now, as has already been explained in previous articles by the present writer in MACHINERY, the width of the land formed in the grinding operation is a straight-line quantity, but W in the figure is a circular width (that is, it is measured on the circumference of the blank circle). In the majority of cases, however, the difference between the two quantities is of infinitesimal dimensions and may, therefore, be neglected. Hence, in our treatment of the case, we shall assume that the two are equal. This circular land-width W (measured, in this

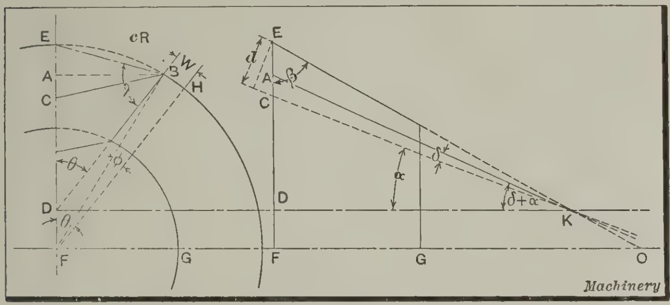

Fig. 6. Diagram for Deduction of Formula for finding Setting Angle for Dividing Head

instance, on the circumference of the circle representing the large end of the blank) subtends an angle ϕ at the center of the circle, the value of ϕ, in degrees, being $\frac{W}{R} \times 57.3$. The chord cR is the chord which subtends the angle $(\theta - \phi)$ at the center of the circle, the coefficient c being the length of this chord when $R = 1$. The line AB has already been referred to in connection with Figs. 4 and 5; d is the depth of cut required, and is measured in a direction normal to the bottom of the flute and from the edge of the blank.

An examination of Fig. 6 will show that:

$$d = EK \sin \{90 - (\alpha + \beta)\} = EK \cos(\alpha + \beta) \quad (3)$$

Now, $EK = \frac{ED}{\cos \beta}$, and $ED = \frac{cR \sin \lambda}{\sin \theta}$. But $\lambda = \left(90 - \frac{\theta + \phi}{2}\right)$;

hence, $\sin \lambda = \sin\left(90 - \frac{\theta + \phi}{2}\right) = \cos \frac{\theta + \phi}{2}$. Therefore:

$$EK = \frac{cR \cos \frac{\theta + \phi}{2}}{\cos \beta \sin \theta}, \text{ and}$$

$$d = \frac{cR \cos \frac{\theta + \phi}{2} \cos(\alpha + \beta)}{\cos \beta \sin \theta} = KR \quad (4)$$

in which

$$K = \frac{c \cos \frac{\theta + \phi}{2} \cos(\alpha + \beta)}{\cos \beta \sin \theta}$$

and is the depth of cut required for a blank having unit radius.

To make this expression of practical utility, the values of K corresponding to the combinations of number of teeth N, and angles β and γ selected in the case of the angle of elevation of the dividing head, and several values of $\frac{W}{R}$ are given in Tables V, VI, VII and VIII, along with the angles of elevation of the head. Intermediate values (that is, values not covered by the combinations adopted in these tables, are obtainable within very close limits by means of the "simple proportion" method, as in the case of the angle of elevation of the head.

To illustrate the application of this method, let us take the case of a cutter blank in which 20 teeth have to be milled, the angle of the blank (β) being 45 degrees, and the angle of the fluting cutter (γ) being 60 degrees. Let the selected value of $\frac{W}{R}$ be 0.030. Then the depth for unit radius, when $\frac{W}{R} = 0.020$, equals 0.203 inch; and when $\frac{W}{R} = 0.040$, the depth equals 0.190 inch. Hence, when $\frac{W}{R} = 0.030$, the depth for unit radius equals

$$\frac{0.203 + 0.190}{2} = 0.1965 \text{ inch.}$$

The radius of the blank is invariably made a trifle larger than the radius of the finished cutter or reamer in order to allow for grinding after hardening, in which case, theoretically, it is necessary to make an allowance for the difference between the two radii in the expression giving the depth of cut. The modified expression is:

$$d = KR + (R_1 - R) \cos \alpha$$

in which R_1 = the radius of the large end of the blank, and R = the radius of the large end of the finished cutter or reamer.

* * *

METHOD OF PRODUCING SOUND INGOTS

The trouble experienced by railroads with broken rails, especially in countries where low temperatures prevail in winter, has demonstrated the necessity of producing sound rails. To produce sound rails means that the ingots from which the rails are made must also be quite sound and free from piping, segregation and blow-holes. Unless the ingots fulfill these requisites, trouble is bound to be experienced with the rails rolled from them.

The defects mentioned are caused by the conditions that existed in the ingot during the cooling process. Trouble from piping is caused by unequal contraction of the metal during cooling. This is due to the fact that the outer sections solidify first. Solidification continues little by little, the center being the last to reach the solid form. This means that an unequal degree of contraction takes place in the ingot, and as the space made void by this contraction is filled by liquid metal flowing down from the top, a cavity or "pipe" is formed in the upper section.

It is an established fact that defective ingots cannot be rolled into sound rails. The method of doing away with defects from piping employed by Sir Robert Hadfield and described in a paper read before the September 1912 meeting of the Iron and Steel Institute, consists of placing charcoal or other combustible material on top of the ingot mold after it has been filled. A layer of cupola slag is placed between the charcoal and the molten steel in order to protect the latter from the oxidizing effect of a blast of air which is directed on top of the ingot to facilitate the combustion of the charcoal. The ingot mold is fitted with a sand top, holding a supply of metal which is kept in a molten condition by the heat generated by the charcoal. This molten metal descends in the mold as contraction takes place and eliminates any tendency toward piping which would otherwise result from the contraction that takes place during cooling. The addition of small quantities of metallic aluminum tend to "quiet the metal", that is to say the aluminum combines with oxygen which is present and carries it away in the form of slag. This reduces the tendency toward the formation of blow-holes. Fortunately it has been found that a remedy which overcomes the tendency toward piping also tends to check the formation of blow-holes or segregated sections. Consequently ingots produced according to this process are particularly free from defects, and the additional expense is more than offset by the reduction in the quantity of material which must be discarded during subsequent processes.

RELATION OF PRICE OF TOOL STEEL TO MANUFACTURING COSTS

BY D. G. CLARK*

A short time ago we received an order from an up-to-date concern, bearing this notation: "This steel, which costs twice as much, must give at least double the production of our present steel in the operation in which it is to be used, otherwise it will be returned." The buyer in this concern was one of the men who believe that if one tool steel costs fifty per cent more per pound than another, it must do fifty per cent more work to justify the price. As a matter of fact, if one steel does five per cent more work than another it is well worth fifty per cent more per pound on all usual operations. There are many ways of proving this. One is to take any machine in the shop and learn the relation of tool cost to total costs. For illustration, we have selected a lathe using tools made from 1½ by ¾ inch steel. How much high-speed steel is used a day? Our observations, estimates and averages show that the daily consumption is one-twelfth pound of high-speed steel on the average lathe, doing fairly hard work at a good speed. This is based on work requiring the tool to be ground five or six times a day. If the tools cut all day on one grinding it indicates that they are cutting considerably below capacity, although this is sometimes necessary owing to local conditions. The one-twelfth pound daily consumption of steel is arrived at in the following way:

High-speed Steel used Daily on 20-inch Lathe

Size of tool: 1½ by ¾ inches. Average number of grindings: six per day.

Steel ground away each grinding......	1/32 inch
Steel ground away each day (six grindings)	3/16 inch
Steel ground away each week (six days)	1 inch (approx.)

Then the tool needs redressing. In redressing and retempering, a small piece of steel is cut off. Making liberal allowance, this waste is about one-half inch of steel.

The waste of steel in redressing is..............	½ inch
The amount of steel ground away is (see above)	1 inch
The weekly consumption of steel................	1½ inches

One-and-one-half lineal inches of 1½ by ¾ inch high-speed steel weighs one-half pound. The daily consumption, therefore, is one-sixth of one-half pound, or one-twelfth pound.

The Daily Cost of Tool Steel

On the basis of one-twelfth pound steel consumption per day, if equal quantities were used:

High grade high-speed steel at 71 cents per pound costs, per day..	$0.06
Cheap high-speed steel at 48 cents per pound costs, per day	.04
Increased first cost of higher priced steel, per day......	$0.02

The Cost of Operating

On a lathe such as we are using for illustration,

The machinist's hourly rate, about.....................	$0.36
The overhead (including power)......................	.24
The total hourly rate..................................	$0.60
The day rate (eight hours)...........................	$4.80

The Value of the Product

If the man operating the lathe which we are using for illustration turns out 100 units of work daily, each piece costs the manufacturer 1/100 of $4.80 or 4.8 cents, and just that much value is produced. If the higher priced steel enables the machinist to turn out one piece more daily, thus increasing the output only one per cent, we have the following results:

Value of one extra piece produced....................	$0.048
Increased first cost of the steel.......................	.020
Net daily profit on one per cent increase..............	$0.028

In this case a one per cent increase would warrant buying a good grade of steel costing fifty per cent more than cheap steel.

With a steel like "Blue Chip," for example, increases in production as high as fifty per cent or one hundred per cent are often secured, but the object of this article is to show that a five per cent increase in production justifies paying much more than a fifty per cent increase in first cost.

Taking the same illustration from another point of view: With the higher priced steel at 71 cents per pound,

The man's time per day.............................	$2.88
The "overhead" per day............................	1.92
Steel per day..	0.06
Daily total..	$4.86

With cheap steel at 48 cents per pound,

The man's time per day...........................	2.88
The "overhead" per day............................	1.92
Steel per day..	0.04
Daily total...	$4.84

The total daily cost has been increased less than one-half of one per cent; one-half of one per cent of $4.84=2.4 cents. Therefore if the higher priced steel does one-half of one per cent more work, it is the cheapest, although the price per pound may be fifty per cent higher than the steel formerly used.

Saving in Grinding

There is another point of view from which the price of tool steel should be considered, and that is the saving in grinding. Some tool steel users think that if the steel costs twice as much, it must require grinding only one-half as many times, but in the foregoing illustration, if one grinding is saved in two days, it justifies paying fifty per cent more for the steel. We arrive at this conclusion through the following: We have found that sixty cents an hour is a conservative estimate of the cost of a man's time and the overhead expense. On this basis every grinding which requires about five minutes means a loss of time and production worth five cents. The excess first cost of steel at seventy-one cents, as compared with a forty-eight-cent steel on the machine we are using for illustration, amounts to two cents a day. Therefore, if tools made from the higher priced steel save one grinding in two days, they warrant an increase of fifty per cent in the price per pound.

In addition to the profit and saving resulting from increased production and fewer grindings, there are also secondary savings to be considered. For instance, tools made from the higher priced steel will require redressing and rehardening less frequently, and the cost department knows what this means in the way of economy. Another saving results through a reduction in the amount of steel used. This has not been brought into our figures, but it should be considered in discussing tool steel costs. Less of the high-priced steel will be required than is the case where cheap steels are used.

Another important saving that is often forgotten, and which cannot be computed, is the time saved on break-down or emergency jobs. There are times in many shops when the management would gladly pay as much as the monthly tool steel bill to save an hour on a repair part, the lack of which holds up a large shipment, or stops work throughout the shop.

A number of minor savings have not been mentioned, but they are not needed to prove the wisdom of paying fifty per cent more for a steel which does five per cent more work. In conclusion, it may be stated that this method of considering tool steel costs may be applied on any machine, regardless of the kind of steel used. In nearly every case the higher priced steel, whether in ordinary tool steel grades or in high-speed steel grades, will be found cheapest if it brings about even a slight increase in the efficiency of cutting tools.

[The indirect relation of the cost of the tools of production to the cost of production so clearly set forth by Mr. Clark in the foregoing, applies all along the line. The first cost of a machine is of little importance in comparison with its productive capacity during its lifetime. A lathe costing $1000 may in the course of ten years, earn $10,000 for the shop in which it is used, while another of the same nominal capacity but of superior design and workmanship, costing say $1100, might earn $12,500 in the same period, or sufficiently more than the other to wipe out the original cost and the interest on the investment.—EDITOR.]

* * *

Many a carefully guarded trade secret is a huge joke. Ostriches can hide from each other, you know, by all thrusting their heads into the sand.—*Webster Method.*

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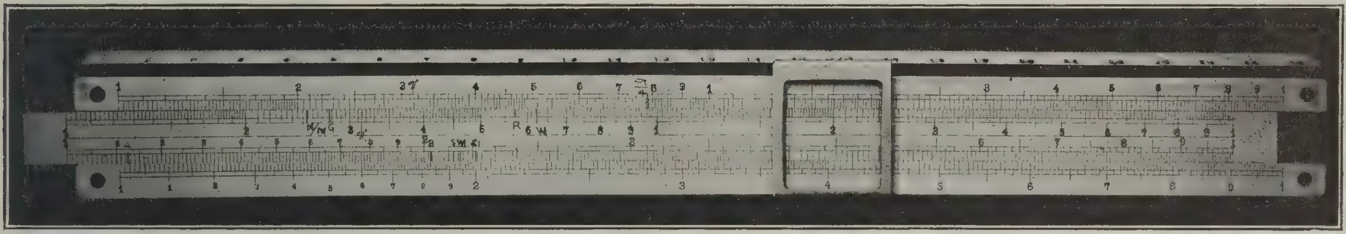
SLIDE-RULE CONSTANTS

BY A. LAURENS

The illustration which appears in connection with this description shows the writer's slide-rule on which several useful constants have been laid out. These constants refer to quantities which are frequently used by designers and estimators, and their use enables the weight of disks or rings of various metals to be rapidly determined. The metals in question are indicated on the rule by the following letters laid out on scale 3 of the slide-rule: *S*, for steel; *WI*, for wrought iron; *CI*, for cast iron; and *B* for brass. On the same scale there is marked a constant *V* that is used to determine the volume of disks or rings. In using the rule, on which these constants are marked, to obtain the weight of a disk or ring of the metal in question, it is only necessary to bring the symbol for the particular metal over the figure for diameter on scale 4 of the rule. The required weight or volume is then read on scale 1 of the rule above the thickness of the disk on scale 2. These results will be found accurate enough for almost any class of work and this method of calculation is far more rapid than the customary arithmetical process.

To illustrate the use of these constants, the reader is referred to the setting of the rule shown herewith. Here it will be seen that the constant for cast iron is set for a disk 20 inches in diameter. To get the weight of such a disk 3 inches thick, the reading of 245 pounds is obtained on scale 1 directly above the figure 3 on scale 2. To obtain the volume of a disk 20 inches in diameter and 3 inches thick, the constant *V* on scale 3 would be brought up to the figure 20 on scale 4. The volume of 944 cubic inches is then read on scale 1 over the figure 3 on scale 2. For the sake of checking the accuracy of this method, the same problem is carried through in the ordinary way. The weight of this disk will be $\frac{\pi D^2}{4} \times$ thickness $\times$ weight per cubic inch of cast iron. The weight of a cubic inch of cast iron is 0.26 pounds and substituting the other known values, a figure of 245.3 pounds is obtained for the weight of the disk. The volume of the disk is $\frac{\pi D^2}{4}$ $\times$ thickness $=$ 943 cubic inches. These figures correspond closely enough for all practical purposes with the one obtained by using the constants. Even allowing that the arithmetical method can be worked out on a slide-rule, it will be granted that such a method takes longer than the one where the constants are used. With the constants, only one setting of the rule is required, and after this setting has been made any number of weights or volumes can be read off at once. In obtaining the weight or volume of a ring of metal, the process has to be repeated, and one reading subtracted from the other, the method being that of finding the difference in weight or volume between two disks of metal of the outer and inner diameters of the ring.

It will be seen that several other constants have been laid out on scale 2 of the rule. These are $M/M = 25.4$ which represents the number of millimeters in an inch. $G = 277$, which is the number of cubic inches in a gallon. This is the number of cubic inches in the British Imperial gallon and for the use of American engineers it would be better to give this figure a value of 231, which represents the number of cubic inches in the standard U. S. gallon. $R = 57.3$, which is the number of degrees in a radian. $W = 62.3$, which is the number of pounds per cubic foot of water. These are constants which engineers frequently need to use, and having them marked directly on the face of the rule saves a lot of time.



Slide-rule laid out with Some Useful Constants

HOW A LITTLE SHOP GREW

BY A. P. PRESS

One evening we were out on the back door-step, and Billy, our next-door neighbor, came to the fence and called us over. Now, we had known Billy a long while. He was a pretty good fellow. He didn't drink or use any red paint, had a wife and two kids who, although they used to stone our cat once in a while, were pretty good boys after all. Billy had learned his trade with us some six years ago, and then he got out and went with the B. & H. Co., and had been with them ever since, and while we knew that he had been tinkering down cellar we were kind of surprised at what he wanted.

"Say, Mr. Press, haven't you got an attic over in your shop there that isn't working very hard?"

"Yes, Billy, I guess so."

"Well, I've been doing a little manufacturing on the side the last year. In the summer time I did it down cellar, and last winter I moved it up in the bed-room. Now it's getting kind of thick, and I thought perhaps you could let me have that back attic, and put all the junk up there."

"That's all right, Billy," we said. "Go ahead and put it in. You probably won't need any power, but if you do we'll cut a hole through the floor and run a belt up. What do you want to run?"

"Oh, nothing much; just a power press and a drill press, and possibly a lathe."

"Well, Billy, go ahead. The attic is not very big, but if you can stand it we can."

So Billy went ahead. He moved in one Saturday afternoon, and from then on there was more or less noise from the back attic that indicated that Billy was working. We didn't butt in on him, but when he had been there about six months we took a notion one evening to go in and see him, and we were surprised. He had a nice little lathe, drill press, power press and foot press, all in that 10 by 14 attic, and he was turning out some of the neatest little tool attachments we had ever seen.

"Well, Billy, where did you get those ideas?"

"Oh, I kind of picked them up, and put them through the patent office, and I suppose they are mine now."

We went away and let Billy alone. Six months more passed by, and Billy came around one night and said:

"Well, Mr. Press, I guess I'll have to move out next month."

"Why, how's that?"

"Well, you see, it's kind of crowded, and so I'm going to build a little shop in the back-yard."

So Billy built his "little shop" (it was about 20 by 40 feet) and moved his tools in. There was a smart looking boy working steady every day, but Billy was only there evenings, for he still held his position with the B. & H., where he had risen to be master mechanic, and was drawing a good salary.

For a whole year we watched Billy nights and Saturday afternoons (the place was shut tighter than a drum Sundays) and one Monday we noticed Billy hanging around the place all day. The next morning we happened to see him over the fence, and sang out to him.

"How's that, aren't you working this week?"

"No," said Billy, "not this week. You see it was like this. The orders were piling in on me for those little tool attachments, and I got so many ahead that I was kind of worried. So I told them down to the factory that I wanted two weeks off, and while they put up an awful howl, I said it was either that or fire me. They didn't want to fire me, so they gave me the two weeks. I guess I will catch up in that time."

Two weeks passed, and we saw Billy again.

"Say, Mr. Press, you don't know where I could get a good man to take my job down to the B. & H., do you?"

"Why, what's the matter?"

"I thought I could catch up with my orders here in two weeks, but instead of that I'm farther behind than I was when I came out. So I went down and told them, and they put it up to me good and plenty that I either had to go back or else get them a man to take my job, so I'm looking for the other man."

Well, to make a long story short, Billy found the "other man." He has been out in the little shop nearly a year now, and it has been running 313 days. Sundays and Christmas are the only days that Billy doesn't work, and from the ink stains that I saw on Mrs. Billy's fingers the other day, I should say that she runs the bookkeeping end of the job.

We were in to see him not long ago (our power was shut down and we wanted to grind a chisel) and he had the nicest little shop that we have seen for a long time. It was crowded, and Billy says:

"I can't seem to get caught up on the work, and the only thing that I can see is to add on some floor space somewhere. I haven't much money, but I went and told all my customers just how it is, that I've got to turn my money over pretty often to make both ends meet, so as to take care of Mrs. Billy and the kids, and they have all done fine."

It doesn't take much of a vision to look into the future (not very far, either) and see Billy holding down an arm chair with a roll top desk, and with the business increasing to support the same.

Now, if any of you boys are planning to follow in Billy's footsteps, and want the secret of his success, it is very easy to get. It is work, work hard, and then work some more. We will try and keep tabs on Billy for at least a year or so more and tell you about him again. If you are a young man it will do you good. If you are an old fellow it wont hurt you any.

* * *

CROSS-SLIDE REAMING ATTACHMENT FOR THE CLEVELAND PLAIN AUTOMATIC

It is generally recognized that the plain type of automatic screw machine built by the Cleveland Automatic Machine Co., Cleveland, O., lends itself admirably to the rapid production of parts requiring the use of only one turret tool; hence in some shops this type of machine is confined to work requiring the use of one turret tool exclusively. The chief advantage gained in using the plain type of machine is that most of the idle movements common to the turret type are eliminated, thus cutting down the production time considerably.

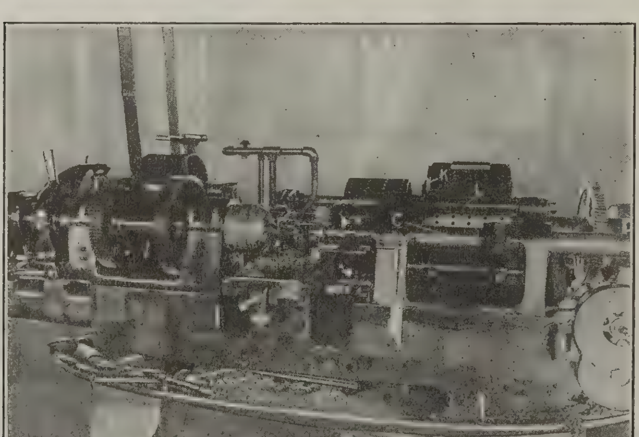


Fig. 1. Method of Gaging Work to Length

The piece shown in Fig. 2 is a good example of work, which with a little thought on the part of the designer can be produced economically on the plain type of machine. As can be seen, this piece, if made on the turret machine, would require three turret tools: stop, drill and reamer.

The method of "tooling" the plain machine for producing this piece is shown in Figs. 1 and 3. Here a drill A is held in a split holder B, the latter being retained in the tailstock spindle C. Enveloping the tailstock spindle is a collar D, which is provided with a notched lug fitting the bent end of the push-rod E.

The reamer F is held in a spindle G, which is a sliding fit in the bracket H clamped to the front cross-slide. Fastened to the front end of the spindle G, is an arm I, which extends down and is provided with a hole through which the push-rod E passes. This push-rod is threaded on the end passing through the arm, and is provided with adjusting nuts located on either side of the arm. These nuts are used for adjusting

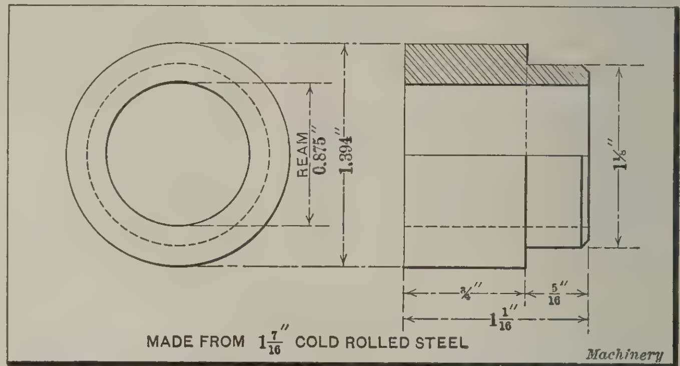


Fig. 2. Type of Work profitably made on Cleveland Plain Automatic

the push-rod, so that its bent end will always enter the slot in the collar D, the coil spring S always returning this rod to the same position, ready to be engaged again when the cross-slide is advanced to bring the reamer into position.

In operation, the stock is fed out, and is gaged to length by the swinging stop J, which is operated by a cam block K in Fig. 1. This stop is returned to the "up position" by a twisted spring L. After the stock is gaged to length, the cross-slide is advanced and the work turned to the required shape and diameter by a flat forming tool M. The cross-slide

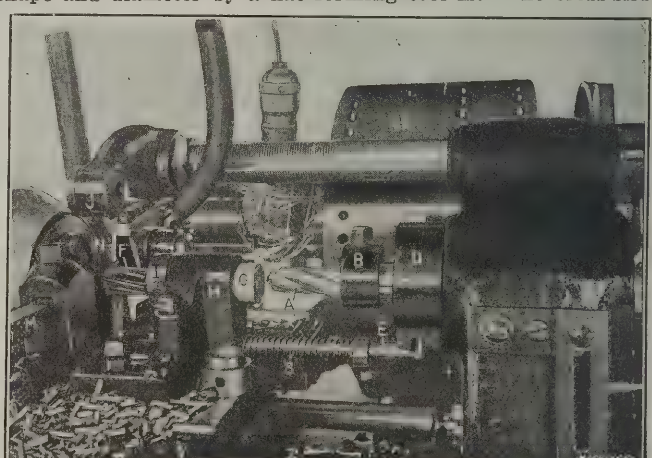


Fig. 3. The Method of "Tooling" the Machine

then retreats, and the tailstock spindle carrying the 0.865-inch drill A is advanced, producing the hole.

The tailstock spindle now retreats into the position shown in Fig. 3; then the cross-slide advances and the bent end of the push-rod engages with the slot in the collar. The tailstock spindle then advances and as it is connected with the reamer holder by the push-rod, it follows that the 0.875-inch reamer is forced into the work.

Before the reamer has finished cutting, the rear cross-slide is advanced, carrying the cut-off blade N, which severs the completed piece from the bar. While the work is being severed, the tailstock spindle recedes, and as it reaches the "back position", the push-rod is disconnected from the collar by the cross-slide dropping back, thus clearing the machine ready for this cycle of operations to be repeated.

The cams are timed on all of the various drums, so that each tool just clears, thus cutting down the idle time to a minimum. The work is rotated, in a forward direction, at 334 R. P. M., and it requires 84 seconds to complete one piece. The feeds given the various tools are:

Drill	0.008 inch per revolution,
Reamer	0.012 inch per revolution,
Form	0.003 inch per revolution,
Cut-off	0.003 inch per revolution.

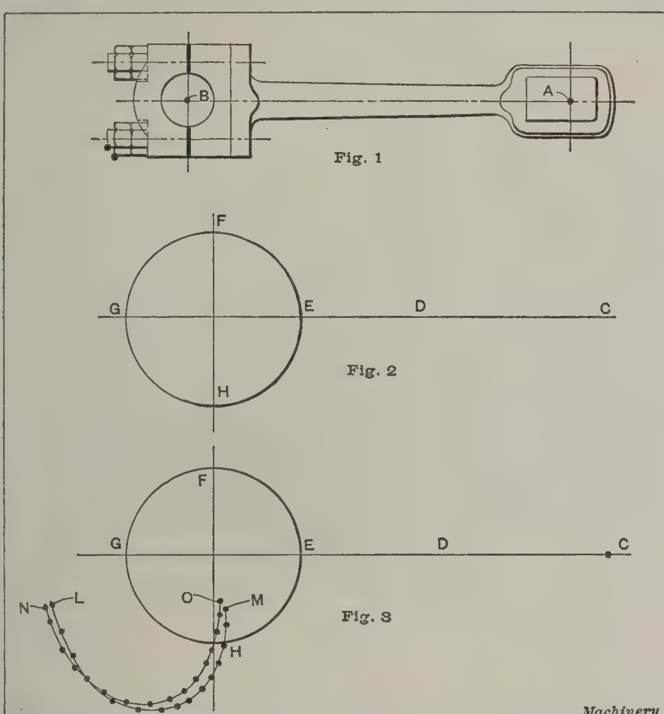
D. T. H.

SOME PROBLEMS SOLVED BY THE USE OF TRACING CLOTH

BY JOHN S. MYERS*

The designer sometimes wastes considerable time trying to determine whether he has allowed proper clearance for a moving part. The method of laying out the part in several different positions in an attempt to determine whether there is any interference is the longest way around. Some draftsmen draw a circle or a straight line which is termed the "clearance line" and to which they work. However, if properly developed, the actual clearance boundary is often a peculiar curve which differs considerably from a circle or a straight line. Methods of this kind often compel the erector to get the required clearance by chipping off ribs which are actually needed for strength. The cost is increased, the designer loses prestige, and there is annoyance all around.

The best and simplest way for investigating the clearance requirements is to roughly trace the moving part on transparent paper or tracing cloth and move it over the layout with a motion similar to that of the moving part. In this way accurate clearance boundaries may be quickly established, and while this method is quite generally known, the writer believes that its value is not sufficiently appreciated, and that advantage is not taken of this method as often as would be advisable. The following will illustrate its use.



Figs. 1 to 3. Methods used in Investigating the Clearance Requirements by Means of Tracing Cloth

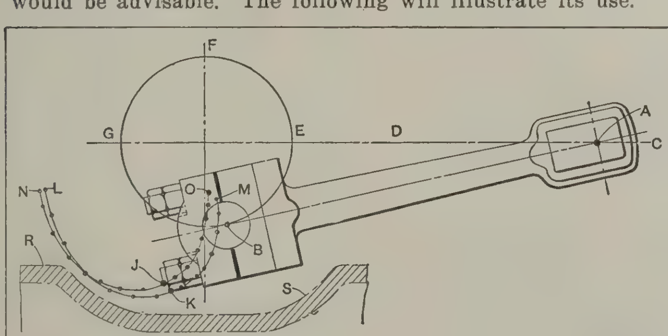


Fig. 4. The Clearance Determined

In Fig. 1 is shown a connecting-rod, the clearance for the crank-end of which is to be determined. First draw the lines indicated in Fig. 2 on the drawing paper. Here the line *CD* represents the path of point *A*, Fig. 1, while circle *EFGH* represents the path of point *B*. The connecting-rod in Fig. 1 is drawn on tracing cloth, and this may now be laid on top of the lines drawn on the drawing paper in Fig. 2, as indicated by Fig. 4. The connecting-rod on the tracing cloth is then moved about, point *A* being kept on the line *CD* and point *B* on the circle *EFG*. The points *J* and *K* then describe the clearance curves required at the further end. These can be pricked with a pin, and the curves *LM* and *NO* drawn through the points thus determined.

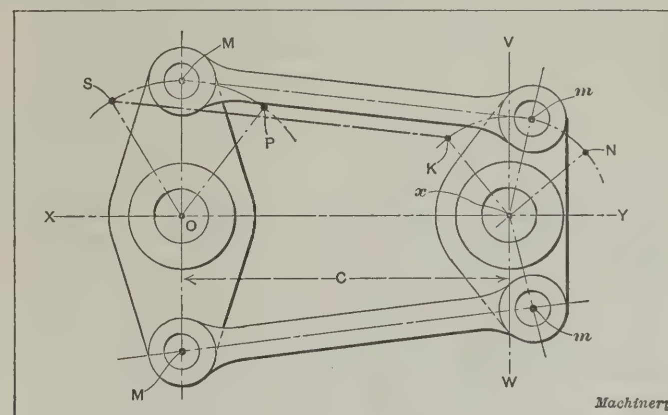
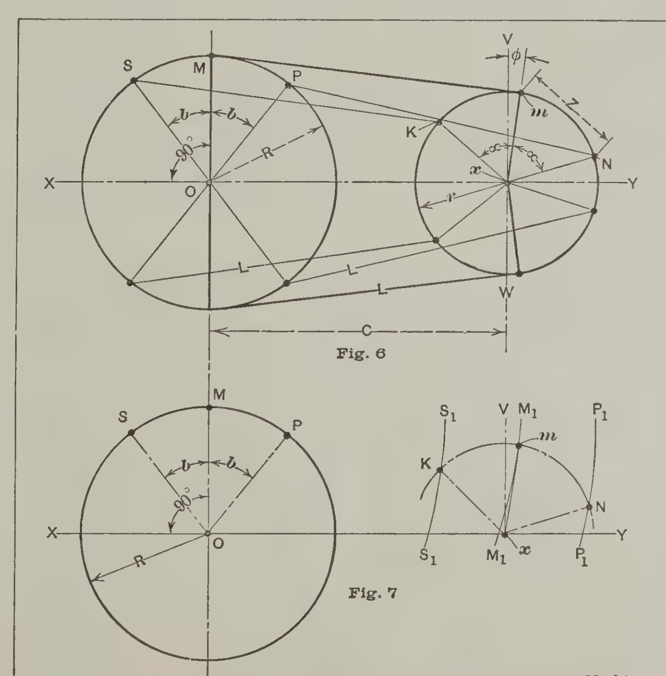


Fig. 5. A Mechanism involving a Complex Geometrical Problem

Another kink which can be made use of in connection with tracing cloth may be of interest. In making the blueprint from which Fig. 4 is reproduced, the writer did not wish to redraw the complete connecting-rod, yet it had to be shown to make the illustration complete. The method pursued was as follows: Fig. 1 was laid on top of Fig. 2 and the points of curves *LM* and *NO* pricked through and the curves drawn, which resulted in a drawing as shown in Fig. 3. The tracing in Fig. 1 was now placed on top of the tracing of Fig. 3, in correct position, and secured to it by adhesive tape; then a blueprint was made with sufficient extra exposure to allow for the double thickness of tracing cloth. The result then was a blueprint as indicated by the illustration shown in Fig. 4, to which, of course, was later added the dash-dotted lines showing the bed of the engine. The white spots left on the blueprint by the adhesive tape can be trimmed off and all evidence of the use of two tracings disappears. The contour of the bed casting *RS*, Fig. 4, is shown merely to indicate the reason for determining the clearance lines. The case chosen for illustration is a simple one, but the methods used are applicable to a wide range of work.



Figs. 6 and 7. Method of Solving the Geometrical Problem involved in the Linkage in Fig. 5

The draftsman also sometimes meets with geometrical problems which would prove difficult to a professor of mathematics; yet he must find some quick and practical solution.

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By the use of a piece of tracing cloth the designer may often solve problems which mathematically are so involved as to seem almost hopeless. Such a case is given in the following.

In the linkage shown in Fig. 5, point M oscillates between points S and P, being actuated by point m moving along curve KmN. The object of the construction is to obtain a toggle joint action as point m approaches points K and N. A skeleton diagram is shown in Fig. 6. Point O is a fixed center, while, due to the angularity of the links Mm, point x moves on line XY, making center distance C a variable quantity. It was found that by putting point m at some angular position ϕ away from line VW, the movement of point x along line XY could be very materially reduced. The problem then was to determine a value for ϕ such that the movement of point x would be a minimum. The mathematical solution by the aid of calculus seemed very difficult, and after some experimenting it was decided that if center distance C was the same for the central position of the links Mm as for the extreme positions SK and PN, the movement of point x would be reduced to practically a minimum. The problem then reduced itself to this: R, r and L being known, find values of C, α, and ϕ such that C will be constant for positions OS, OM and OP of the linkage. The solution is as follows:

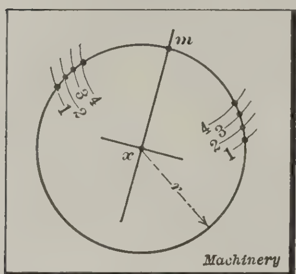

Fig. 8. The Lay-out made on Tracing Cloth

With radius R draw the circle in Fig. 7 and lay out the maximum angular movement b, thus locating points S, M and P. Draw XY through O perpendicular to OM. With radius L draw arcs S_1S_1, M_1M_1, and P_1P_1, S, M and P being their respective centers. On a transparent sheet draw a circle of radius r, x being its center, see Fig. 8. Choose some point on this circle, as m, and draw (with any convenient radius known to exceed Z in Fig. 6) the arcs 1, 1; then with slightly smaller radii draw arcs 2, 2; 3, 3; 4, 4; etc. Number these arcs 1, 2, 3, 4, etc.

Lay Fig. 8 on top of Fig. 7 and shift it around until, with point m lying on arc M_1M_1 and x lying on line XY, a position is found in which two similarly numbered points such as 1, 1, 2, 2, or 3, 3 lie upon arcs S_1S_1 and P_1P_1. When this position is found, prick through these numbered points, and also through points x and m; they will then represent the points similarly marked in Fig. 6. Mark these points found on Fig. 7, and draw lines xK, xm, xN, and xV, the latter being perpendicular to XY. Now $Ox = C$, angle $mxK = \alpha$, and angle $mxV = \phi$, the three unknown quantities which were to be found.

With a value of ϕ determined by the above method, the center distance C will be exactly the same in value for the links in position Mm, SK, or PN, but for any intermediate position, C will be slightly increased, or if angle b be exceeded, C will decrease.

There are a great number of difficult problems which may be solved in a somewhat similar manner by the employment of a little ingenuity. The writer's object in presenting the foregoing examples has simply been to call attention to the methods available and the value of a piece of tracing cloth.

* * *

DIMENSIONS OF LEAD PIPE

BY S. E. FERRY*

Some time ago I had occasion to use some lead pipe, and as it was necessary to know the inside as well as the outside diameters of the pipe (the space being limited) and the safe working pressures, I sought for the information in various books, but was surprised to find that the data was not available in the references at hand. After considerable hunting through the lead manufacturers' and plumbers' supply books, I was able to compile the accompanying table, which gives the outside diameter, inside diameter, thickness, weight per foot, approximate bursting pressure and safe working pressure of lead pipe from ⅜ inch to 2 inches inside diameter, in double extra strong, strong, medium and light weights.

DIMENSIONS OF LEAD PIPE

Inside Diameter	Outside Diameter	Thickness	Weight per Foot		Approximate Bursting Pressure in Pounds per Square Inch	Safe Working Pressure in Pounds per Square Inch	Commercial Designations		Inside Diameter	Outside Diameter	Thickness	Weight per Foot		Approximate Bursting Pressure in Pounds per Square Inch	Safe Working Pressure in Pounds per Square Inch	Commercial Designations	
							Lead Pipe Manufacturers	Plumbing Supplies Catalogues*								Lead Pipe Manufacturers	Plumbing Supplies Catalogues*
Inch	Inch	Inch	Lbs.	Oz.					Inches	Inches	Inch	Lbs.	Oz.				
⅜	0.74	0.183	1	12	2150	430	AAA	D. E. S.	1	1.42	0.210	4	0	900	180	A	Strong
⅜	0.72	0.173	1	8	2000	400	AA	E. S.	1	1.36	0.180	3	4	775	155	B	Medium
⅜	0.66	0.143	1	4	1650	330	A	Strong	1	1.28	0.140	2	8	600	120	C	Light
⅜	0.63	0.128	1	0	1500	300	B	Medium	1	1.23	0.115	2	0	500	100	D	E. L.
⅜	0.58	0.103	0	12	1250	250	C	Light	1	1.17	0.085	1	8	400	80	E	Aqueduct
⅜	0.55	0.088	0	10	1050	210	D	E. L.	1¼	1.82	0.285	6	12	1000	200	AAA	D. E. S.
⅜	0.51	0.068	0	7	800	160	E	Aqueduct	1¼	1.75	0.250	5	12	900	180	AA	E. S.
7/16	0.66	0.111	1	0	1165	230	B	Medium	1¼	1.67	0.210	4	12	750	150	A	Strong
7/16	0.63	0.096	0	13	1000	200	C	Light	1¼	1.59	0.170	3	12	600	120	B	Medium
½	1.01	0.255	3	0	2000	400	AAA	D. E. S.	1¼	1.52	0.135	3	0	475	95	C	Light
½	0.87	0.185	2	0	1600	320	AA	E. S.	1¼	1.50	0.125	2	8	450	90	D	E. L.
½	0.84	0.170	1	12	1500	300	A	Strong	1¼	1.45	0.100	2	0	350	70	E	Aqueduct
½	0.76	0.130	1	4	1150	230	B	Medium	1½	2.11	0.305	8	8	900	180	AAA	D. E. S.
½	0.71	0.105	1	0	900	180	C	Light	1½	2.04	0.270	7	8	800	160	AA	E. S.
½	0.67	0.085	0	12	700	140	D	E. L.	1½	1.96	0.230	6	8	700	140	A	Strong
½	0.63	0.065	0	9	550	110	E	Aqueduct	1½	1.88	0.190	5	0	550	110	B	Medium
⅝	1.13	0.253	3	8	1700	340	AAA	D. E. S.	1½	1.82	0.160	4	4	475	95	C	Light
⅝	1.05	0.213	2	12	1500	300	AA	E. S.	1½	1.78	0.140	3	8	400	80	D	E. L.
⅝	1.02	0.198	2	8	1300	260	A	Strong	1½	1.75	0.125	3	0	350	70	E	Aqueduct
⅝	0.96	0.167	2	0	1150	230	B	Medium	1¾	2.42	0.335	10	0	850	170	AAA	D. E. S.
⅝	0.88	0.128	1	8	900	180	C	Light	1¾	2.26	0.255	8	8	650	130	AA	E. S.
⅝	0.80	0.088	1	0	600	120	D	E. L.	1¾	2.21	0.230	7	0	600	120	A	Strong
⅝	0.77	0.073	0	12	500	100	E	Aqueduct	1¾	2.15	0.200	6	0	500	100	B	Medium
¾	1.31	0.280	4	12	1900	380	AAA	D. E. S.	1¾	2.09	0.170	5	0	450	90	C	Light
¾	1.21	0.230	3	8	1400	280	AA	E. S.	1¾	2.03	0.140	4	0	375	75	D	E. L.
¾	1.16	0.205	3	0	1150	230	A	Strong	2	2.59	0.295	11	12	650	130	AAA	D. E. S.
¾	1.07	0.160	2	4	950	190	B	Medium	2	2.51	0.255	9	0	550	110	AA	E. S.
¾	1.01	0.130	1	12	750	150	C	Light	2	2.45	0.225	8	0	500	100	A	Strong
¾	0.94	0.095	1	4	550	110	D	E. L.	2	2.41	0.205	7	0	450	90	B	Medium
¾	0.91	0.080	1	0	450	90	E	Aqueduct	2	2.37	0.185	6	0	375	75	C	Light
1	1.59	0.295	6	0	1300	260	AAA	D. E. S.	2	2.26	0.130	4	12	275	55	D	E. L.
1	1.51	0.255	4	12	1100	220	AA	E. S.	......	......	......	......		......	......	......	......

The above table is based on 2240 pounds per square inch as the tensile strength of lead with 5 as a safety factor.

* D. E. S. = double extra strong; E. S. = extra strong; E. L. = extra light.

* Address: Care of Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

MULTIPLE-SHOULDER SHAFT TURNING ON THE CLEVELAND AUTOMATIC

An excellent example of multiple shoulder shaft turning in a Cleveland plain type automatic screw machine, is shown in Fig. 2. As can be seen, this shaft has six different diameters —three on each end. All of these various diameters are turned and the shaft completed in one operation. The end of the shaft next to the chuck is turned by a cross-slide tool arrangement carrying three turning tools, and operated transversely by the tailstock spindle, as shown in Figs. 1 and 3.

By referring to Fig. 1 it will be seen that a long connecting-rod *A* is held free to slide in an arm *B*, which is clamped to the tailstock spindle *C*. The rear end of this connecting-rod is threaded and furnished with check-nuts, the function of which will be explained later.

The cross-slide arrangement consists of a block *D*, fastened to the T-slot of the regular cross-slide and provided with a dovetailed top face to which an auxiliary top-slide *E* is fitted. This slide is furnished with a gib to compensate for wear, and is machined to retain the three tool-holders *F*, which can be adjusted so as to bring the shoulders on the work the required distance apart.

The end of the shaft facing the tailstock spindle is turned by a box-tool carrying three cutters and provided with roller

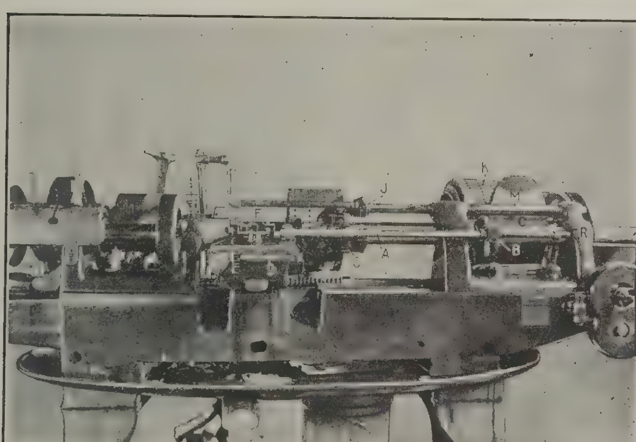

Fig. 1. Turning a Multiple Shoulder Shaft on the Cleveland Plain Automatic

supports to steady the work, as in Fig. 3. This box-tool *G* has a shank which is held in the regular manner in the tailstock spindle. The turning tools are retained in holders *I*, which can be adjusted along the body of the box-tool to the required positions.

In operation, the stock is fed out by a special cam on the stock-feed drum, and at the same time, the swinging stop *J* is brought down to gage the stock to length by a cam on drum *K*, see Fig. 1. When the chuck closes, the stop *J* is returned to the "up position" by the twisted spring *M*. The box-tool is now advanced, bringing the first tool *N*, Fig. 2, into operation, and at the same instant the regular cross-slide is advanced, feeding the tools *O*, *P*, and *Q* in to the proper depth. The cross-slide then retreats, and remains stationary with the tools clear of the work until the arm *B* approaches the check-nuts on the connecting-rod *A*. Just as this takes place, the regular cross-slide is again advanced, bringing the turning tools in to the correct depth.

The cross-slide turning tools which are now ready to turn the work to the required diameter, are advanced longitudinally on the work when the advancing arm *B* contacts with the check-nuts. The connecting-rod *A*, which acts as a link joining the tailstock spindle and auxiliary slide *E*, is pivotally connected to the latter. When the roll reaches the end of the lobe of the tailstock spindle operating cam, the spindle is returned by a spring, but does not carry the top-slide *E* with it until the arm *B* reaches the check-nuts *R*. By this time the regular cross-slide has withdrawn the tools from the work, thus clearing the machine for the finished piece to be severed from the bar by the cut-off blade *S*, held on the rear cross-slide.

The material from which this shaft is made is cold-rolled steel 1⅛ inch in diameter. The turning tools are operated

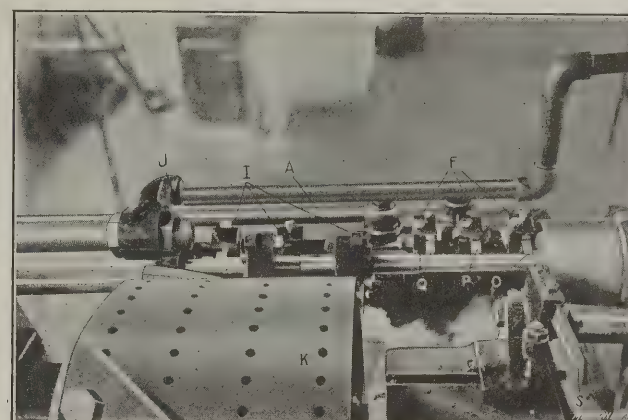

Fig. 3. Arrangement of Tools and of Adjustable Stop

at a surface speed of approximately 85 feet per minute, and finish the bar to the required diameter in one cut. The box-tool cutters when working alone, are advanced at a rate of 0.008 inch per revolution. The cross-slide tools when being fed in to the desired depth, receive a feed of 0.002 inch per revolution, and when the box-tool and cross-slide tools are working together, the rate of advance is 0.006 inch per revolution. The work is cut off with a feed of 0.004 inch per revolution. This shaft, which is 16 1/16 inches long, is completed in 5½ minutes. D. T. H.

* * *

LARGEST TESTING MACHINE IN THE WORLD

The issue of the *Engineering Record* for September 28 contains an interesting description of what is believed to be the largest testing machine in the world. It was designed by Mr. Tinius Olsen of Philadelphia, and has a capacity of 10,000,000 pounds. The machine was built for the structural materials testing laboratory of the United States Geological Survey, which is now part of the laboratory of the Bureau of Standards, located in Pittsburg, Pa., and was placed in operation on September 12. At this time, a number of members of the International Association for Testing Materials were present to witness its operation, and among their performances, a square brick column twelve feet high and four feet on each side, was broken; a load of 6,580,000 pounds was required to complete this test. The machine is designed with a capacity for testing pieces up to 60 feet in length and the distance between tension screws, is 6 feet. These dimensions fit the machine for testing exceedingly large columns as well as slabs, and by placing an extension table on the lower platen, the largest beams may be broken.

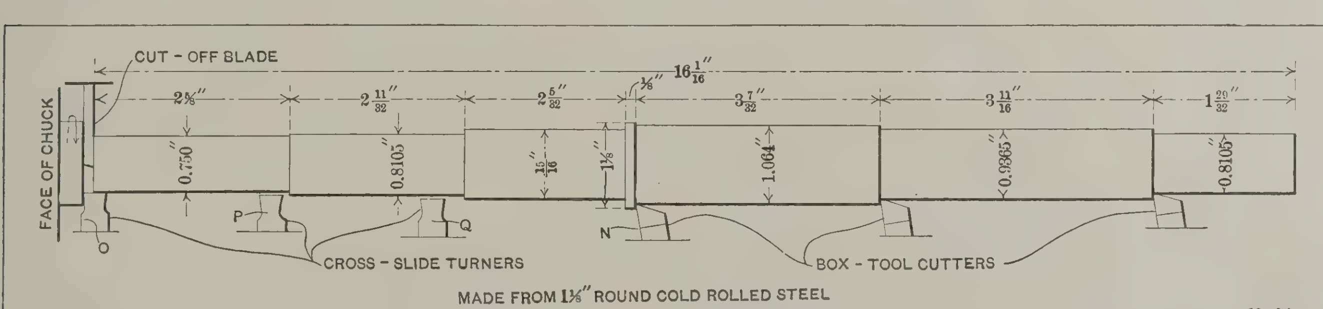

Fig. 2. Tools used in finishing the Shaft in One Operation

A SEMI-AUTOMATIC SLOTTING FIXTURE

BY J. H. HARRIS

The fixture to be described in this article is used by the Remington Typewriter Co. for the rapid and economical slotting of the part shown in Fig. 5. The fixture is semi-automatic in its action. It is carried on a shaft driven by the back-gears of a milling machine and all the operator has to do is to place the work between the jaws as they come around. As the fixture revolves, the work is fed against the cutter where it is slotted; it is then carried on to the discharge point and dropped into a pan provided for the purpose.

In starting to give a detailed description of this fixture, reference is first made to Fig. 1 where a plan view is shown. Here it will be seen that the fixture is carried on the horizontal driving shaft *A*. This shaft is supported at its outer end by the bracket *B*, which is clamped to the table by means of three cap-screws, and equipped with a bronze-bushed bearing *C* that carries the shaft.

A machine steel plate *D* is secured to the inner face of the bracket and two cams *E* are carried by this plate. Two elongated holes are cut in the bracket through which the cap-screws *F* are passed to secure the plate *D* to the bracket. These elongated holes give sufficient play to the screws so that the cams may be adjusted to exactly the required position. The arrangement of the bracket plate and cams is clearly shown in Fig. 2. The work is located in V-blocks *I*, against hardened steel buttons *J* that are carried by the casting *G* shown in detail in Fig. 3. This casting bears against the shoulder *H* on the driving shaft.

The clamping mechanism is carried by two castings *K* and *L*, which are doweled together and screwed to the casting *G*, as shown in Fig. 1. These three castings are secured to the driving shaft by means of the nut and washer *N* which force them against the shoulder *H*. The casting *K* is shown in detail in Fig. 6, where it will be seen that there are fourteen lugs in which the clamping members *P* are pivoted.

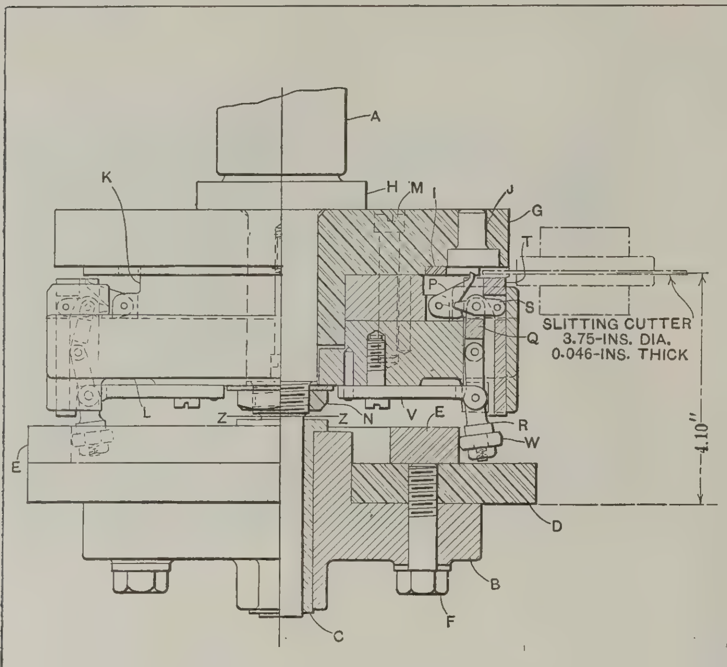

Fig. 1. Plan View of Slotting Attachment

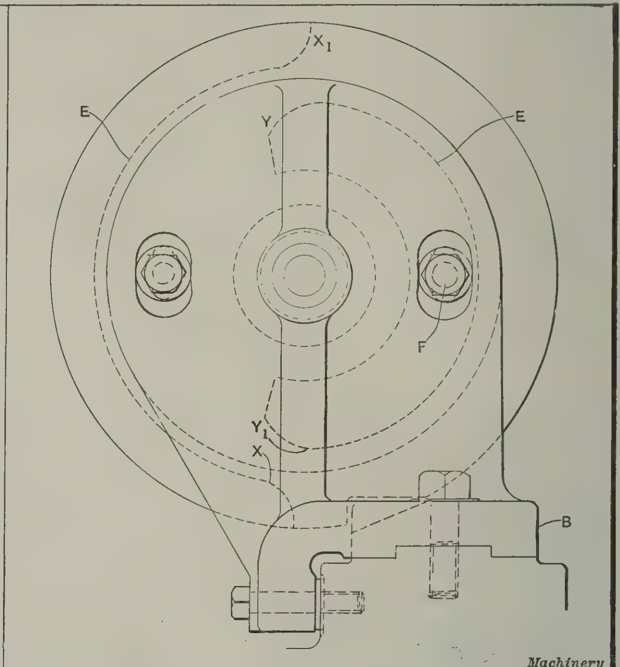

Fig. 2. End View, showing Arrangement of Cams and Bracket

Each clamp is operated by means of a pair of toggle jointed levers *R* and *Q* and a link *S*. As the link *S* is moved toward the back of the fixture it forces the sharp edge of the clamp *P* against the work. The opposite end of the link *S* engages with the clamp member *T* which slides in a hole in the casting *L*, as shown in Fig. 4. Each pair of clamping members *P* and *T* is thus forced simultaneously against the work by the action of the toggle levers, transmitted through the link *S*.

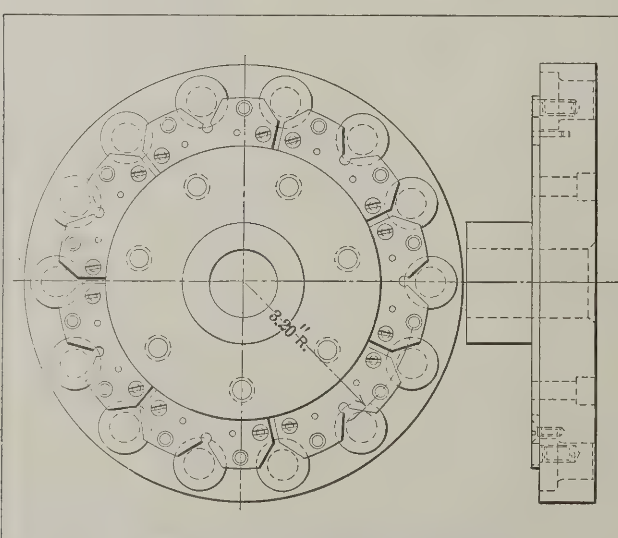

Fig. 3. Casting G, showing Method of Locating Work

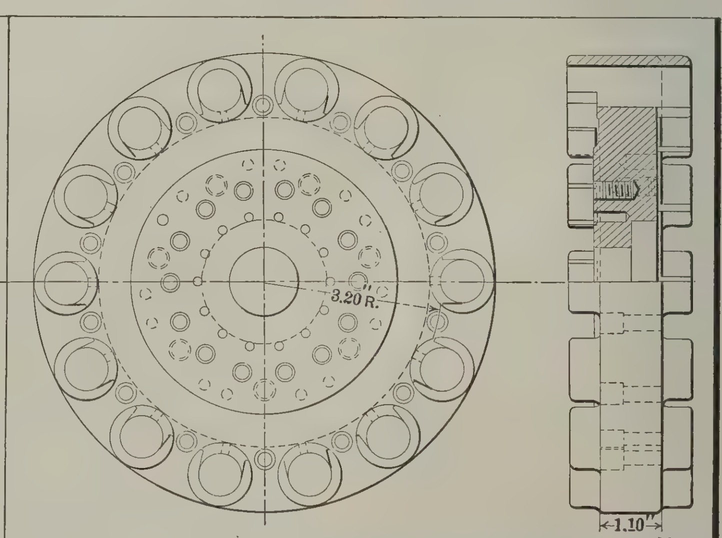

Fig. 4. Casting L, showing Holes for Clamps T

To explain the operation of the toggle levers, reference is made to Fig. 1, where one of the fourteen plates *V* that are screwed and doweled to the casting *L* is shown. These plates have a bearing at their outer ends in which the members *R* are pivoted. It will be apparent that any move- of the end of *R* will open or close the clamping members *P*

and T on the work through the pivoted connections between these members and S, Q and R. The required movement of the end of the levers R is secured through the action of the rollers W on the cams E. Referring to Fig. 2, it will be seen that the rollers at the ends of R bear against the inner sides of the cam plate at the left of the fixture from X to X_1. This holds the clamps open until the point Y is reached; from this point to Y_1, the roller bears against the outside edge of the cam on the right and between these two points the clamps are closed.

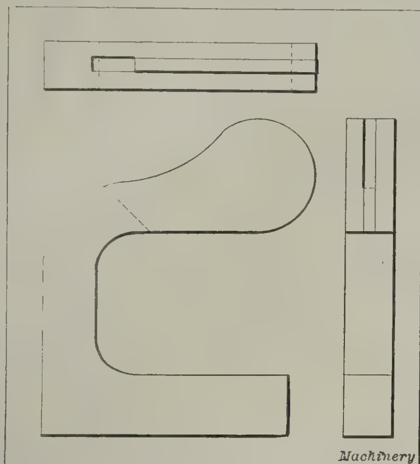

Fig. 5. Typewriter Part slotted as shown

It will be seen from this description that the work is placed in the fixture on the left hand side, where the clamps are open. It is then carried around to the right, where the clamps close before the work is fed to the cutter. The work is still held in the fixture until it has

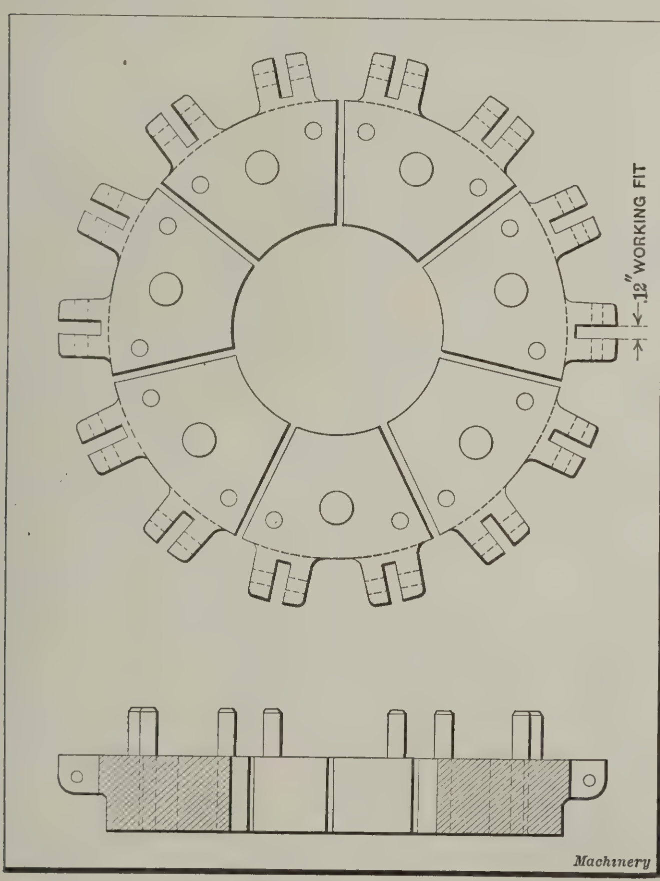

Fig. 6. Casting K, showing Method of pivoting Clamp P

reached the point X. Here each successive clamp opens and drops its work into a pan conveniently placed for the purpose. As the operation of the fixture is continuous, it enables the work to be rapidly handled at a consequently low cost.

* * *

Some interesting data is given in *Teknisk Tidskrift*, from a German source, of the large hydro-electric development at present being planned at Lyons, France. A dam is to be built across the Rhone which will produce a head of about 225 feet. The average amount of power that can be developed throughout the year is 350,000 horsepower. Present calculations indicate that it will be possible to deliver power from this development at the price of slightly less than one cent per kilowatt hour. It is planned to distribute the power over an area having a radius of between two and three hundred miles.

A PATENT OFFICE PARADOX

BY ROBERT MILLER*

Much has been published recently about proposed changes in the patent laws of this country. Numerous statesmen have drafted bills to remedy the evils that have been apparent for years. All this proposed legislation deals, however, only with the scope of the patent, and not one single sentence attempts to correct the one crying abuse of the entire system—interference.

When an inventor has his first dealings with the patent law he imagines that, except for whatever may be revealed by a search, and patent office citations against his application, he is fairly secure in his possession of protection for that which his brain has conceived. Yet, should an interference be declared, he awakes with a rude shock. It may be proper to first explain the term "interference." An interference is a proceeding instituted for the purpose of determining the question of priority of inventions, between two or more parties claiming substantially the same patentable invention. This sounds simple, but in its amplified form it can readily be made the means of the rankest injustice. For instance, A has a patent which has been issued for some time; if B files an application for the identical invention, an interference may be declared, provided B's application is filed within two years of the date of issue of A's patent. If the subject of the patent is a very valuable one and B happens to represent a powerful corporation, A, being a private individual, may be unable to fight for his rights.

The proceedings in an interference may be very costly, and are as follows: A notice of interference is sent to each party by the examiner of interferences; each party is then required to set forth, under oath, all of the details and circumstances, with dates, regarding the invention. These affidavits must be filed with the examiner before a certain date, and are termed preliminary statements. The examiner then appoints a time when testimony may be taken by each party to establish his position. During these proceedings an applicant or his attorney may cross-examine witnesses.

All this, of course, takes time, and, being legal procedure, also considerable money. Any patent attorney, therefore, would much rather handle a nice, complicated interference, than half a dozen ordinary applications. It might be possible, under the two-year clause, for a powerful interest to have an application filed after the issue of a patent, copying it, line for line and word for word, and by means of false witnesses prove priority, and thus have the original patent nullified and a new patent issued to itself. Further, the patent office itself, by its complicated rules, does not help to simplify the matter.

The writer will now describe an actual case, using some of the phraseology of the patent office. In this case A applied for a patent on a device in March, 1910; except for a few trivial references cited against the application, it was a clear case, and the claims were allowed in May of the same year. Being in no hurry to have his patent issued, he allowed almost the legal six months to elapse before making his final payment of twenty dollars. The patent was issued in December, 1910. The patent received considerable attention in the trade press, as the device was of a type just then of considerable interest to the industry.

In August of the following year A received notice of an interference with B. The usual preliminary statements were filed, and it was learned that B had filed his application in July, 1909, almost a year before A had. The drawings and specifications showed that both were identical in so far as the idea of the device was concerned. The claims were different, yet any novice could see that here were two applications lying together in the same class and sub-class, for a patent of the same device. Yet, the patent office did not declare an interference at this time, but waited until after the issue of the patent to A.

An industry might have been organized on the strength of A's patent, which would have prospered for a short time, and which would then either have been forced out of business, or been obliged to pay B large royalties—all this after having

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obeyed the letter and spirit of the law, acceding to every requirement of the patent office and paying the just dues.

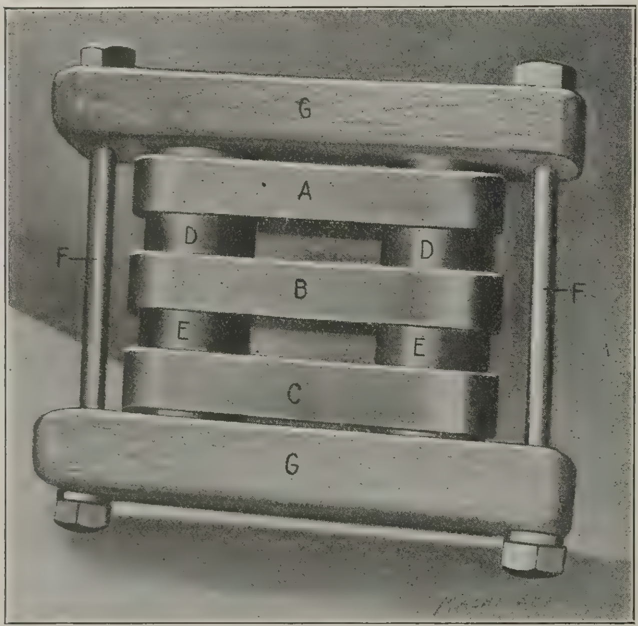
A direct appeal was made to the commissioner to explain this peculiar occurrence, asking why the interference had not been declared before the issue of the patent. The reply was that as the claims were different, "it was not proper to suggest A's claims to B." A case was then cited to the commissioner in which the office had suggested claims to both parties for the purpose of causing an interference. The reply to this communication quoted some obscure rule that was supposed to fit the case. The patent was, of course, granted to B as it should have been in the first place. For this same patent, therefore, two complete fees were paid, and to the man in the street it would seem as if there ought to be a refund. To a lawyer this would seem to be a square deal—with about ten thousand interferences a year the profession should prosper; to the man trying to improve things, it is discouraging.

* * *

A BUILT-UP LIMIT GAGE

At the shops of the New Departure Mfg. Co., Bristol, Conn., a type of limit gage is used by the inspectors that has the advantage of being easily kept in good condition. The illustration represents the general appearance of the gage.

The openings in the gage are the spaces between plates *A* and *B* and *B* and *C*. The space between *A* and *B* is regulated by size blocks *DD;* in this particular instance the size blocks are 0.4999 inch. The opening between *B* and *C* in this gage is regulated by size blocks *EE* which are 0.5001 inch in thickness. The strips *A*, *B*, and *C* may be of any convenient thickness and, of course, they are hardened and



A Built-up Limit Gage

the gaging surfaces are ground and lapped. The important parts of the gage, parts which regulate its accuracy, are the size blocks *EE* and *DD*, which, of course, must first be very carefully ground and lapped to size. After the size blocks have been placed between the gaging strips, small disks are applied to the outside of the strips *A* and *C* and the entire built-up gage is clamped together by bolts *FF* which pass through wooden strips *GG*. The object of the wooden strips is to provide a means for handling, without affecting the accuracy of the gage by the heat of the hand.

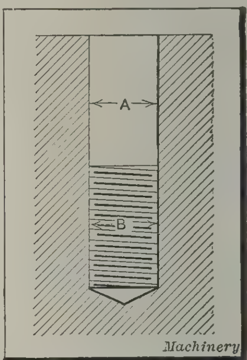
To maintain the accuracy of such gages it is only necessary from time to time to release the tension upon bolts *FF*, remove strips *A*, *B* and *C*, and regrind and relap the four gaging surfaces. It is not necessary to touch the size blocks as no wear comes upon their surfaces. C. L. L.

* * *

When cold-rolled stock is used, an allowance must be made in the bore, as this stock comes exactly to size or a trifle over size. When turned shafts are used, the bore should always be made standard, and the allowance made in the journal.

THE SCREW THREAD STANDARDS

Since a few years ago when the tap makers agreed to start a campaign against the sharp V-thread, the use of this form of thread has steadily diminished. Some of the tap makers, however, state that they still make as much as forty per cent of their taps with V-threads, while others make only from thirty down to ten per cent of their total production with this kind of thread, the remainder being the United States standard. An interesting reason given for the continued use of the V-thread by one of the largest machine tool building firms in the country, is that a V-thread tap permits the tapping of the bottom of a counterbored hole with the same diameter thread as the diameter of the counterbore. In the accompanying illustration the diameter of the counterbore *A* and of the thread *B* is nominally the same. When a sharp V-thread tap is used, of correct angle diameter, it will not be over the standard size on the outside diameter, on account of the small flat necessarily provided on the top of the threads. It can, therefore, enter the counterbored hole and tap the thread without scratching or marking the sides of the counterbored hole, which, in many cases, is required to be a good fit for the stud entering into it. If a U. S. standard thread tap were used, instead, the outside diameter of this tap would ordinarily have to be a certain amount over size, and hence, it would scratch or mar the counterbored portion of the hole when entering. To avoid this, most designers have been in the habit of making the counterbore larger in diameter than that of the threaded portion, but this, of course, necessitates a shoulder on the stud and a larger diameter of stock. It would seem, however, that the condition mentioned would be met with in machine design so seldom, comparatively speaking, that it should not be necessary to maintain two standard screw threads on this account. The committee appointed by the American Society of Mechanical Engineers to investigate into allowances and working limits for the U. S. standard thread, will probably take up this question and suggest some means of overcoming the difficulty even when a U. S. standard thread is used. It is not desirable to have the two thread forms continued side by side, especially since—as has been repeatedly pointed out in these columns—there is no accepted standard dimensions for the sharp V-thread, the different manufacturers making taps with this thread to different standards or gages.



A Condition where the Sharp V-thread has shown Advantages over the U. S. Standard Thread

There may be cases where the U. S. standard thread is not the best one for the purpose, but they are comparatively few. One is staybolt taps which are being more and more generally made with a Whitworth thread on account of the decreased tendency of the staybolts to break when this thread is used. On account of the unequal expansion of the side sheets, the staybolt is bent back and forth, and if there is a sharp corner at the bottom of the thread, as in the case of the U. S. standard or the V-thread, a crack is more liable to develop than when the bottom is rounded, as in the case of the Whitworth thread.

The A. S. M. E. standard for machine screws seems to gain ground rapidly. Some tap makers state that they make nearly all their machine screw taps according to this standard, while others still make from thirty to fifty per cent of the old V-thread standard. There is a tendency among the larger concerns to adopt the A. S. M. E. standard exclusively, while the smaller concerns, to whom the expense for new gages is more serious, still retain the old standards. It would be a great advantage to the tap and screw makers, as well as to the mechanical trade in general, if the old standards could be entirely eliminated. It would seem possible for the tap makers to agree to make the old standard thread only to order, and to charge a higher price for taps with this kind of thread so as to discourage the use of the V-thread on both the machine screw sizes and on larger dimensions of screws and taps.

DESIGNING A HOB FOR HOBBING SPUR GEARS*

DETERMINING THE THREAD SHAPE, NUMBER OF FLUTES, AND GENERAL DIMENSIONS

BY JOHN EDGAR†

A reader of MACHINERY has requested information regarding the design of a hob to cut spur gears. The gears to be cut are cast-iron, and have 120 teeth, 16 diametral pitch and 5/8 inch width of face. The pitch diameter, hence, is 7½ inches. The hole in the hob for the spindle is to be 1¼ inch in diameter with a ¼-square inch keyway, the hob to be run at high speed.

The first thing to be settled is the form and dimensions of the tooth or thread section of the hob. If the form is to be the standard shape for the involute system with a 14½-degree pressure angle, the dimensions of the hob tooth would be as

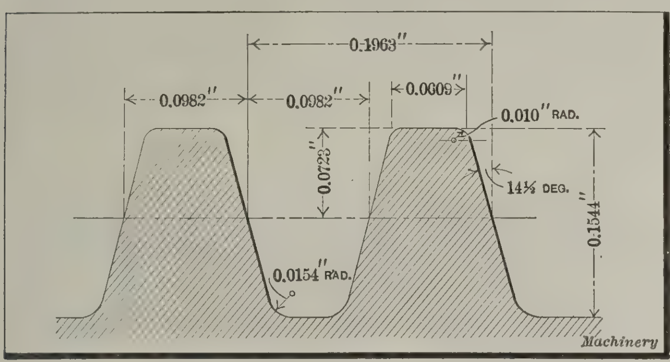


Fig. 1. Standard Hob Tooth Dimensions

shown in Fig. 1. A modification of this shape may in some cases be advisable, and will be referred to later in this article. The standard rack-tooth shape with straight sides, as shown in Fig. 1, however, is the easiest to produce, and unless gears with a very small number of teeth are to be cut, it is entirely satisfactory.

The circular pitch corresponding to 16 diametral pitch is 0.1963 inch which is obtained by dividing 3.1416 by 16. The thickness of the tooth on the pitch line is one-half of the circular pitch, or 0.0982. The height of the tooth above the pitch line is equal to the reciprocal of the diametral pitch plus the clearance, which latter is equal to 0.1 of the thickness at the pitch line. Hence, the height of the tooth above the pitch line equals 0.0625 + 0.0098 = 0.0723 inch. This distance equals the space in the gear below the pitch line.

The depth of the tooth of the hob below the pitch line is usually made greater than the distance from the pitch line to the top of the tooth. The extra depth should be equal to from one-half to one times the clearance. On small pitches, one times the clearance is not too great an allowance, and, therefore, the depth below the pitch line is made equal to 0.0723 + 0.0098 = 0.0821, making the whole depth of tooth equal to 0.1544. The extra depth at the root of the thread is to allow for a larger radius at the root, so as to prevent cracking in hardening. The radius may then be made equal to two times the clearance, if desired. In the illustration, however, the radius is made equal to 0.1 of the whole depth of the tooth. The top corner of the tooth is rounded off with a corner tool to a radius about equal to the clearance, or say 0.010 inch. This corner is rounded to avoid unsightly steps in the gear tooth flank near the root. Having obtained the hob tooth dimensions, the principal dimensions of the hob may be worked out with relation to the relief, the diameter of the hole and the size of the keyway.

The proper relief for the tooth is a matter generally decided by experience. We may say that, in general, it should be great enough to give plenty of clearance on the side of the tooth, and on hobs of 14½-degree pressure angle the peripheral relief is, roughly speaking, about four times that on the side. For cutting cast iron with a hob of the pitch in question, a peripheral relief of 0.120 inch will give satisfactory results; for steel, this clearance should be somewhat increased. The amount of relief depends, necessarily, also upon the diameter of the hob.

With a peripheral relief of 0.120 inch, the greatest depth of the tooth space in the hob must be 0.1544 + 0.120 = 0.2744. The gash will be made with a cutter or tool with a 20-degree included angle, 3/32 inch thick at the point, and so formed as to produce a gash with a half-circular section at the bottom. The depth of the gash should be 1/16 inch deeper than the greatest depth of the tooth space, or about 11/32 inch.

The radius of the hob blank should be equal to 5/8 + 1/8 + 11/32 + the thickness of the stock between the keyway and the bottom of the flute. If we use a 3-inch bar we can turn a hob blank 2¾ inches in diameter from this, which would allow sufficient stock to be turned from the outer portion of the bar to remove the decarbonized surface. If we make the blank 2¾ inches in diameter we have 9/32 inch of stock over the keyway, which is sufficient.

The number of gashes or flutes depends on many factors, some of which have been previously discussed in MACHINERY. (See the article "How Many Gashes Should a Hob Have?" in the January, 1909, number.) In Fig. 2 is shown an end view of a hob with twelve gashes. This number gives plenty of cutting teeth to form a smooth tooth surface on the gear without showing prominent tooth marks. A larger number of gashes will not, in practice, give a better tooth form, but simply increases the liability to inaccuracies due to the forming process and to distortion in hardening. This number of gashes also leaves plenty of stock in the teeth, thus insuring a long life to the hob.

The question whether the gashes should be parallel with the axis or normal to the thread helix is one that is not easily answered. It must be admitted that when the angle of the thread is great, the cutting action at both sides of the tooth is not equal in a hob with a straight gash; but in cases

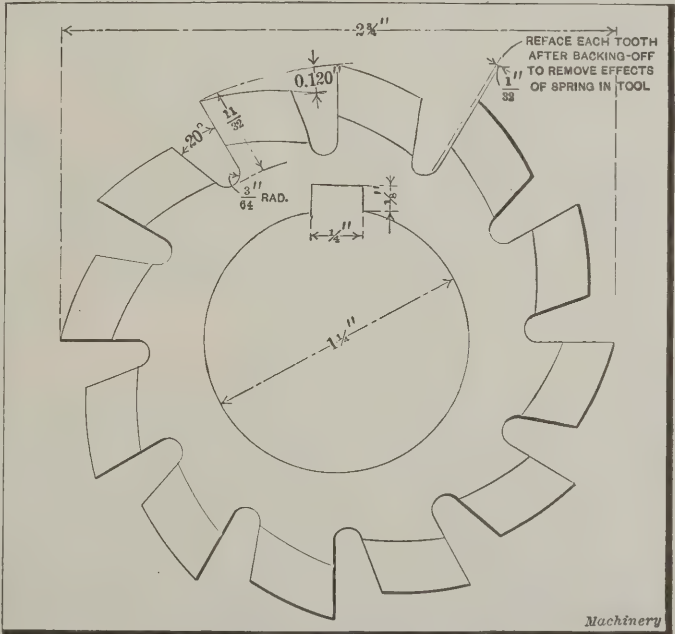


Fig. 2. Hob with Twelve Gashes or Flutes

of hobs for fine pitch gears, where the hobs are of comparatively large diameter, thus producing a small thread-angle, the parallel gash is more practical because it is much easier to sharpen the hobs, and the long lead necessary for spiral gashes, in such cases, is not easily obtained with the regular milling machine equipment. However, when it is desired to obtain the very best results from hobbing, especially in cutting steel, the gash should be spiral in all cases when the thread angle is over 2½ or 3 degrees. In our case the thread angle figured at the pitch diameter of the blank is equal to 1 degree 22 minutes; hence, straight flutes are not objectionable.

* See also MACHINERY, July, 1912, "Hobs for Spur and Spiral Gears," and the articles there referred to.

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The linear pitch of the hob and the circular pitch of the gear, when considered in action, are to each other as 1 is to the cosine of the thread angle. In the present case they do not differ appreciably and may be considered as equal. In cases where the difference is over 0.0005, the true linear pitch should be used.

The change-gears for the lathe may be figured by the formula:

$$\frac{\text{Gear on lead-screw}}{\text{Gear on stud}} = \frac{\text{lead of lead-screw}}{\text{linear pitch of hob}}$$

On a lathe with a lead-screw of six threads per inch, or a lead of 1/6 or 0.1667 inch, the gears that would give accurate enough results for the present hob would be 28 teeth on the lead-screw, and 33 teeth on the stud.

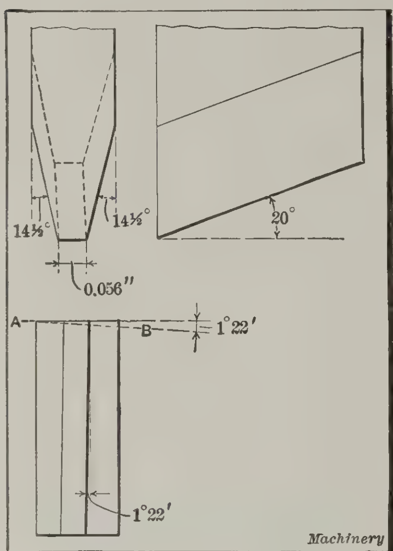


Fig. 3. Threading Tool for Hob

In Fig. 3 is shown the hob thread relieving tool. The front of the tool is relieved with a 20-degree rake for clearance. The sides are ground straight at a 14½-degree angle to form the sides of the thread, and are at an angle of 1 degree 22 minutes with the vertical to clear the sides of the thread. A tool made like this can be sharpened by grinding across the top without losing its size or form. If the gashes were made on the spiral, the top of the tool should be ground to the angle of the thread, as shown by the dotted line *AB*. In cases where the angle of the thread is considerable, the angle of the sides of the tool must be corrected to give the proper shape to the hob tooth. (See MACHINERY, May, 1905, or MACHINERY'S Reference Book No. 32, "Formula for Planing Thread Tools.") The point of the tool should be stoned to give the proper radius to the fillet in the bottom of the hob tooth space.

The best practice in making the hob is to anneal it after it has been bored, turned, gashed and threaded, the annealing taking place before relieving the teeth. Before hardening, the hob ought to be re-gashed or milled in the groove, removing about 1/32 inch of stock from the front side of the tooth to eliminate chatter marks and the effect due to the spring in the tool, which always leaves the front edge of the teeth without relief. In hardening, do not attempt to get the hob too hard, as the required high heat and quick cooling would distort the teeth badly.

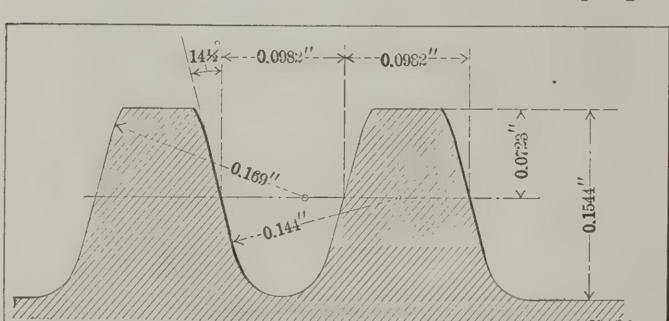


Fig. 4. Special Hob Tooth Dimensions

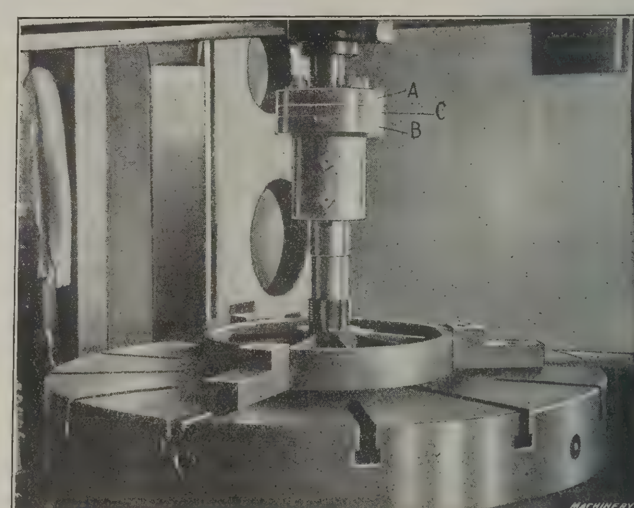
In case the 120-tooth gear is to run with a pinion of a small number of teeth and is the driver, as in small hand grinders where gears of this size are often used, it would be advisable to make the tooth shape as shown in Fig. 4. This shape will obviate undercutting in the pinion and relieve the points of the teeth in the gear so as to obtain a free-running combination. This shape is more difficult to produce and requires more care in forming. If the hob is made of high-speed steel, it should run at about 115 revolutions per minute for cutting an ordinary grade of cast iron with a feed of 1/16 inch per revolution of the blank. The feed may be increased considerably if the gear blank is well supported at the rim. The best combination of speeds and feeds in each case can be found only after considerable experimenting.

* * *

METHOD OF TAPPING FACEPLATES ACCURATELY IN A BORING MILL

At the New Haven Mfg. Co., New Haven, Conn., an interesting application of the familiar "Oldham" coupling is made use of in tapping the spindle holes of faceplates. Formerly considerable trouble was experienced when tapping faceplates, because if the work was not located exactly true with the boring machine spindle the tap would invariably cut large. By using the coupling shown in the illustration, trouble from this source has been overcome.

The upper half *A* of the coupling is held in the boring machine spindle and the lower half *B* supports the tap. Both these parts have on their inner faces shallow rectangular slots approximately ¼ inch deep by 1½ inch wide. The central part *C* of the coupling has on its upper face a tongue to fit the slot in the upper half and on its lower face a tongue is provided at right angles with the one on the upper face fitting in the slot in the lower half of the coupling. Four large cap-screws are provided which are threaded into the lower half of the coupling but pass through enlarged holes in the central and upper halves of the coupling. These screws serve merely to hold the parts together and do not prevent the parts of the coupling from adjusting themselves while the tapping operation is being performed. With this fixture the tap quickly finds a central location in the faceplate and the result is that the holes are quickly and accurately tapped.



Tapping Faceplates in a Boring Mill

C. L. L.

* * *

A Bureau of Mines paper states that all commercial explosives owe their power of doing work to the expansive force of the great volume of gas evolved from them at the moment of explosion. The pressure exerted by this gas in the drill hole or other confined space in which the explosion is brought about is what makes explosive substances of value in mining or other industries and is the primary cause of all those manifestations of energy that follow the firing of a charge. Common black blasting powder, on explosion, produces about 390 times its own volume of permanent gases: 40 per cent dynamite produces about 530 times its own volume of permanent gases; and nitroglycerin produces somewhat more than 747 times its own volume of permanent gases. These proportions of volume of gases to volume of explosive are those that would be found if the gases were measured under normal conditions of temperature and pressure, but at the moment of explosion the gases are highly heated, and therefore tend to occupy a volume much greater than the figures given above.

MOLDING DIES FOR FIBER INSULATION

BY EVERETT CHIPMAN*

The black fiber insulations shown in Fig. 1 are formed in molding dies which it is the purpose of this article to describe. The stock consists of fiber tubes which are made by rolling material of the thickness of paper on iron bars. During the rolling process, heat is applied in such a way that the material, which consists of pulp from wood fiber, is joined together to form a solid tube. The tubes are received in lengths of about 3 feet, and of varying diameters; they are sawed up into blanks of the right size for the different insulations and are then transferred to the forming presses.

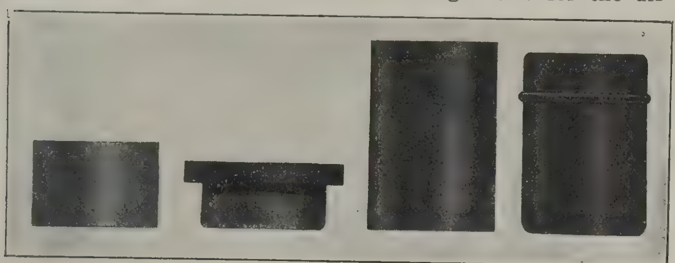


Fig. 1. Blanks and Fiber Insulations formed from them

Fig. 2 shows the punch and die used for molding the insulation shown at the left-hand side in Fig. 1. In this operation the shoulder is formed at the top and the lower edge is rounded at the same time. During this forming process the pressure applied causes a certain amount of shortening to take place; consequently it is necessary to allow enough extra on the length of the blanks to make up for this compression. The blanks are fed into the die by hand.

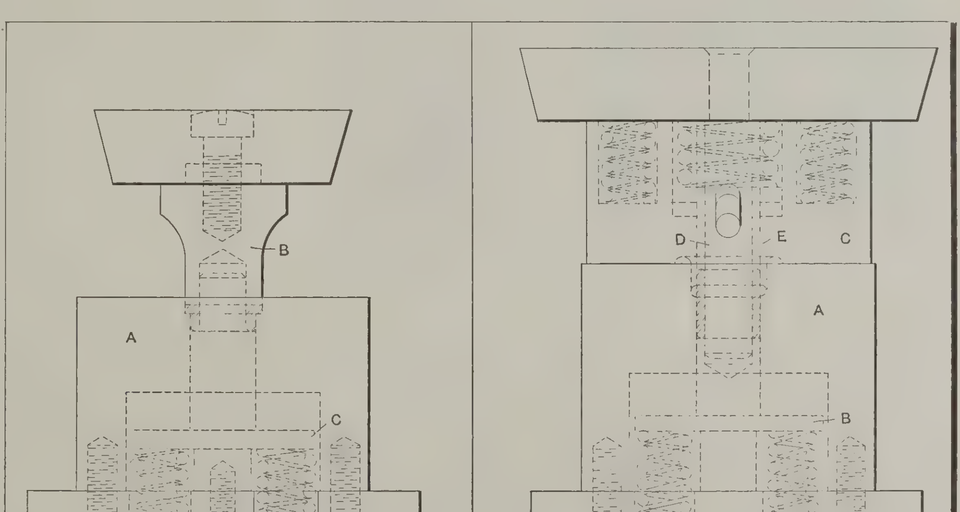
Reference to Fig. 2 will make the design of the punch and die used for this operation readily understood. *A* is the mold or form in which the outside of the blank is shaped. *B* is the plunger which is fastened to the head block of the press. *C* is the stripper for the form *A; C* also acts as a locating plug and forms the radius on the lower end of the blank. The plunger *B* has a recess into which the central stud of *C* enters as the press descends. The work is then formed in the space left between the mold *A*, the punch *B* and the locating plug *C* on the stripper, after the stripper has been pressed down to its lowest position. When the forming operation is completed, the finished blank is ejected by the action of the springs under the stripper. The finished insulation is held on the central plug of the stripper when the plunger has reached the top of its stroke, and can be readily removed with a fork-shaped piece of metal which lifts it off by means of the shoulder. This mold is used in a press having a ½-inch stroke and the work is produced with a variance of only two or three thousandths of an inch.

Fig. 3 shows a rather more complicated punch and die which is used for forming the insulation shown at the right-hand side in Fig. 1. This die represents the result of about three months experimental work during which time a number of methods were tried out and discarded.

In forming this insulation both the upper and lower edges are rounded and a shoulder is formed on the side as shown. It was the method of forming this shoulder which constituted the difficult point in designing the punch and die. The following notation has been adopted in Fig. 3 for refering to the different parts of the punch and die. *A* is the mold; *B*, the stripper for the mold; *C*, the punch; *D*, the stripper for the punch; and *E*, the central or locating plug. It will be noted that in this case the locating plug is carried by the punch stripper instead of by the mold stripper as in the preceding case.

The blanks formed in this mold fit into the recess in the die and rest on top of the stripper. The die is bored out to the outside size of the shoulder for a depth of about ⅜ of an inch, and there is an annular ring on the punch which comes down and fills the space between the outer wall of the blank and the outer diameter of the recess in the die. The lower edge of this ring is rounded and with the base of the counterbore in the die forms a semi-circular cavity in which the shoulder is formed. As the punch descends the central pin locates the blank and then enters the recess in the mold stripper which has been provided to receive it. The blank holds the two strippers apart against the tension of the springs until each stripper has reached its stop. The pressure is then increased, and since the only relief is in the ring at the point where the shoulder is formed, the fiber gives at this point and conforms to the desired shape. The punch and die stripper are of such a form that they round the corners at the top and bottom of the insulation as shown. During the return stroke of the press the strippers force the bushing to leave both the punch and die, and the finished work is left on the lower end of the locating pin, from which it can be readily removed.

During both of these forming operations there seems to be a slight movement between the layers of material in the blanks. The finished work, however, is perfectly compact, and if such a movement does take place it is probable that the heavy pressure of the forming operation generates sufficient heat to reunite the layers before the operation is completed. In each case the use of these dies has meant a great saving over the former method, which was the use of a molded paste composition for the smaller and screw machine work for the larger piece. The press method also produces more accurate work with less breakage.



Figs. 2 and 3. Punches and Dies used for Forming Insulations shown in Fig. 1

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* * *

WHAT IS SPACE?

In a paper on the fourth dimension, published in the *Polytechnic Engineer* for 1912, William J. Berry states that a serious difficulty presented in discussing mathematical subjects is the variety of meanings attached to words. A word may have one meaning to the physicist, another to the mathematician, and still another to the man in the street. "The average layman thinks of space, if indeed he thinks of it at all, as a huge box or hollow sphere in which all things lie—a sort of frame for the material universe. This idea is crude and vague. . . . . . Space is an idea caused by the perception of simultaneous groups of phenomena. Space is not a phenomenon or a group of phenomena, though without phenomena there can be no idea of space." The idea of space is subjective, and is distinguished in three forms, *i. e.*, visual space, tactual or feeling space and motor or traveled space.

ACTION OF PEENING STRAINS IN A CAST-IRON BENCH PLATE

BY DOUGLAS T. HAMILTON*

A cast-iron bench plate was recently brought to the Cleveland Machine Tool Co., Cleveland, Ohio, for machining, which was sprung out of shape, being 3/16 inch high in the center lengthwise and 1/8 inch high crosswise. This bench plate, which is shown in Figs. 1 and 2, is 7 feet long by 3 feet wide, the plate portion being 1½ inch thick before machining.

To straighten this plate, it was carefully clamped to the planer table, and a 3/16-inch cut taken over its entire surface. After taking this cut, a straightedge was placed on the plate which to the astonishment of the operator was found to be 3/16 inch low in the center. The supports under the center portion of the plate were held so tightly that they could not be moved, while the supports under the ends were loose. Another 3/16-inch cut was then taken and when the straightedge was applied, the plate was found to be 1/32 inch high in the center. A 1/32 inch cut was then taken, the straps released a slight amount and a final cut about 1/64 inch removed, which brought the surface of the plate back to a true plane.


Fig. 1. View of Bench-plate showing Triangular Ribbing

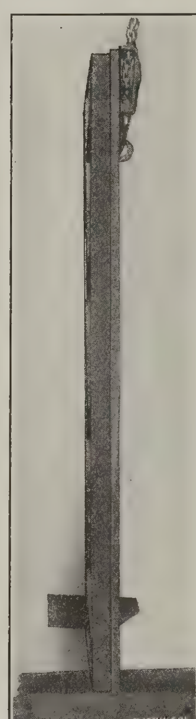
Fig. 2. Condition of the Plate after Machining

In clamping, particular care had been taken not to spring the plate, so that the action just mentioned cannot be due to that cause, and as is evident in the illustration Fig. 1, the plate was well ribbed and supported. The only conclusion which can be drawn from this peculiar action of springing, is that the plate had been used more in the center than at the ends, and that the surface had become stretched and hardened due to the continued peening action caused by hammering and placing work on it. Then when this hard scale was removed, the plate returned to its normal state—the fibers straightening out—this action being similar to that which takes place in a rod of cold-rolled steel, when only a portion of it is machined.

It is reasonable to assume that this same condition exists to a slight extent in a planer table which has been subjected to considerable use and abuse. The action of this plate also shows that extreme care is necessary in handling work on a planer table; it should not be used either as an anvil or a straightening plate, but simply as a means for holding the work while machining. Another point brought out by the action of this plate is that one cut cannot be relied upon to straighten a surface when it has become sprung. Some mechanics, when they get a job to do on the planer which must be accurate, put a broad tool in the holder and take a skin cut from the platen, thinking that by so doing they are producing a true plane. The fact of the matter is that in nine cases out of ten they have only partially relieved the strain and inaccuracy, especially if the planer has been in use for some time and has received rough usage. After taking a cut, the truth of the table should be proved with a dial test indicator held in the tool-holder, and it is generally advisable to take two cuts instead of one, that is, if the table is not sprung much, the dial test indicator being used to ascertain when the table has been brought back to a true plane.

* Associate Editor of MACHINERY.

* * *

THE INSPECTOR

BY JOHN F. WINCHESTER*

Writers in mechanical magazines often dwell on the importance of inspection systems and their relation to modern shop practice, but they seldom mention the qualifications necessary for a man to suitably fill the position of inspector, or the training that a man receives by occupying one of them. When it is considered that the keystone of success in many of our large manufacturing establishments is the inspection system, it can be seen that the human element should receive no small amount of consideration.

The requirements necessary for a man to fill satisfactorily the position of inspector vary with the concern for which he works and with the work to be done. In some factories there are inspectors who do nothing but measure duplicate parts; this particular branch of inspection can be filled by specialists with little training. In these same factories, however, there are inspectors who pass upon the final product. These men are held strictly responsible for the satisfactory operation of the product, and fill highly responsible positions.

Since the advent of the automobile, there has been a demand for another class of inspectors who are to pass upon all material that is to be used in the process of manufacture. These men test the material from the steel and iron mills and foundries, to ascertain if it meets with the required specifications. They are chemists or metallurgists, and generally have a college education or special training in that particular branch. This field is not closed to the shop-trained man, however, for with the correspondence schools, and with special courses in the engineering schools that now abound, it is within reach of him.

A man who had been promoted to an inspector was asked how he liked his new duties. He answered, "At its best, it is a thankless faultfinding position." This man did not possess the tact or proper ability to successfully fill his position and was mistaken in his estimate of it. It is not faultfinding when an inspector endeavors to detect the possible mistakes of others and report them to his superior, in order to prevent inferior goods from being produced.

The concern which employs the grades of inspector before mentioned usually has a chief inspector whose duty it is to oversee the inspection system and decide all important matters relating to it. This man must possess good mechanical training, have a decided, but not too aggressive, manner of passing on questions, and have an absolute knowledge of the details of the work being inspected.

The advantages of holding a position of inspector are numerous. He has a chance to learn by the mistakes of others, and meets with many perplexing problems, the solving of which gives him good training. He also enjoys the association of those higher up; associations count in any line of work, and the inspector, through being in contact with the executive heads of the establishment, is always in line for future promotion. Have we not here one of the ideal positions in a machine shop? I say "one of," for with the difference of opinion that always exists as to an ideal, I dare not put it stronger. It is one to which the apprentice with his boyish ambition may attain, and one which the elderly man who has held positions of greater responsibility, but with whom fortune has not dealt kindly, can accept and yet retain the dignity that he has acquired through his years of service.

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EXPORT TRADE*

SOME OF THE CONDITIONS AFFECTING THE FOREIGN MACHINE TOOL BUSINESS

In no line of exports has the American spirit of ingenuity and invention proved itself greater than in the machine tool line. It is a field in which our conditions of labor made it especially necessary to invent machines to take the place of hand workmen. Following the Civil War there was a particular growth in machine design, and in 1876 the Centennial Exhibition at Philadelphia showed something of this new line of work. Up to this time a few of the manufacturers had been exporting in a quiet kind of way, had done a good deal of business, and had earned for American tools a reputation that was a desirable one. Greater developments in design came about, until seventeen years later at Chicago we had a magnificent showing of machinery that was instructive to ourselves as well as to the foreigners who came in great numbers. The best of the engineering ability not only visited the exhibition, but visited our shops and were received with open arms. Progress had been made in foreign countries, but not to the extent that was shown in America, and after the exhibition we had a very voluminous trade. Be it said to the honor of the machine tool builders that most of the material that went abroad was material that stood upon its merits and added to the reputation that our tools had already attained abroad. There were, unfortunately, some cases where unprincipled advantage was taken of the opportunity, but the great majority of the manufacturers seemed to appreciate the real value of the opportunity.

Since that time our foreign friends have no more stood still than have we, and in the reports obtained from those who visit the foreign market to study conditions we get confirmation of what we see with our own eyes when visiting these countries—that designs are constantly improving, and that the workmanship is approaching that which we furnish from this side. That we are copied to a greater or less extent may be sincere flattery, and while we can accept as a fact that a copy can be but second best, it is dangerous from a commercial standpoint for the reason that many are persuaded that it is as good; and the lower price that can be quoted by reason of the elimination of designing and experimental costs, to say nothing of difference in wages, adds to the difficulties in competition.

Neither our own nor any other country can or should have all of the business in machine tools. As our lines develop, there is no question but that one foreign country may excel another and ourselves in a given line of development, and when such a fact is realized, we should be as open-minded and as ready to purchase as we are to desire others to consider and purchase from us.

As a people we sometimes pride ourselves on our business spirit. So much have we talked about it that some of our foreign competitors have become so imbued with the fact that they call us not only aggressive, but egotistical, tricky and even brutal in competition. We admit we try to be aggressive, denying the remaining allegations as being too strong, but when we study the methods of some of our foreign competitors in working for export trade, we wonder if we are aggressive even, and our wonder increases as we compare foreign exports with our own. Are we inspired with the possibilities before us, and willing to add perspiration to inspiration?

Export business is no different from any other business in its principles. In our domestic trade there is no lathe nor milling machine tool builder who does not take such steps to sell his goods as will cause them to be purchased rather than the goods of a competing lathe or milling machine manufacturer. In such a case the manufacturer studies the market, and does what he considers is necessary to interest the prospective customer. In export business, instead of dealing with a neighbor who lives within a comparatively short distance of us, speaking the same language and living in the same general atmosphere of business and social conditions, we are dealing with customers who, except in the case of the English, speak another language, and all of whom live under conditions of life and are inheritors of business principles and methods that differ from ours.

What do we do to get domestic business? We try to get designs that are satisfactory and for which there is or can be secured a demand. We try to offer workmanship that is of a high order, and if we have competitors who have equally good designs and present equally good workmanship, we sometimes feel that by manufacturing more cheaply we can sell more cheaply, and thus obtain a market.

To sell goods abroad there are different courses open. The sales can be effected through agents who will act as representatives, through direct travelers, or through general agents who are but little more than commission merchants. There are representatives and representatives. If you sell through a representative that is thoroughly in sympathy with you, who will work for your interests, and who will represent you alone in your line, you are in a position to reciprocate and work for him. Such a representative must be taken into your confidence; you must listen to his requirements, and while it is by no means possible to grant all of the requests that he might make, it is possible to obtain from him suggestions that will help you in obtaining a share of the business that you are seeking. When selling through such a representative you are dealing with a concern that knows the people with whom it deals, knows their peculiarities, and can more readily make a trade than could a direct representative.

To think of sending a direct representative who cannot speak the language is so far from anything that any of us would do that it is hardly necessary to discuss this feature of the question; but given one who understands the language, he has to meet, as a direct representative, conditions that it is not easy for the home people to understand, so that it almost precludes this form of representation. When, however, you second the efforts of your representing agents with the services of a direct representative, results are oftentimes obtained that show that such services are an imperative necessity. This element is one that cannot call forth positive rules. If your machine is a type of special machinery, the need is far greater than when it is a type of standard machinery, and where to draw the line is a matter of opinion.

When goods are sold abroad through representatives, it is imperative that the house selling should have first-hand knowledge of conditions existing in their foreign trade. Your agents will write until they are black in the face, and get no response from you, when—did you but know a little of what they are contending with—one letter would have sufficed to place matters in order.

We all have something of an idea of what it means to have our literature in the language of the people that are to use the goods. Yet while we spend large amounts of money on our domestic business—on circulars and all kinds of printed material—we are apt to hesitate at printing in a foreign language when we are looking for the export business. This also brings up the matter of correspondence. Are we as apt to be as prompt in answering our foreign correspondents as we are our domestic friends, especially if the latter are not more than a hundred or two hundred miles away? Are we not a little apt to think, "Well, he has been waiting for ten days, a day or two more will make no difference," rather than to think, "He has been waiting for ten days, and how tedious it must be to have to wait another ten days; therefore this letter will be answered ahead of our New York letter." As a general rule do we watch the sailings of the mail ships as closely as the foreigner and attempt to make certain that given letters and documents reach New York in time to make the best connections?

Have not some of us felt the export business was a splendid thing in bad times, but a nuisance in good times? Have we not been rather apt to give, not a *just* delivery to our foreign friend, but to give him the delivery that was left over after our domestic friends were taken care of? When we are called upon

* Abstract of paper read by Mr. W. A. Viall of the Brown & Sharpe Mfg. Co., Providence, R. I., before the National Machine Tool Builders' Association Convention in New York City, October 16, 1912.

to put up some special form of packing to meet certain conditions, do we not feel that our representative is perhaps a little over particular, if not cranky, and make him feel that what is good enough for us is good enough for him, rather than to attempt to judiciously follow his wishes? Do we visit our representatives or have them visit us so often that we can talk over the things that are going on and become more closely allied? If we do, we are backing up our representative as thoroughly as we are backing our own salesman on our own ground, but if we do not we are merely playing with our foreign business.

The United States is not the only country that has customs' regulations. We find that foreigners take the utmost pains to conform to our American customs' requirements when exporting goods to this country; but when we export to their country, are we not rather apt to consider it more or less of a nuisance to carry out in detail the requirements of those countries, and work half-heartedly, with the result that the receiver of our goods abroad is put to such trouble that he will prefer to buy from the foreigner who meets him, rather than from the American who holds off?

In the case of the foreigner we find that he goes into neutral territory, and we are informed that he will give precedent to the foreign over the domestic business. While this may be hard on his domestic customer, yet there is a national feeling at times that makes him think that he can handle his home trade rather differently from his foreign trade, to the advantage of his home trade, on the theory that he is building up his nation. Our country has not been noted, in the machine tool business at least, as being willing to use foreign countries as dumping grounds of our manufactures in the way of prices, charging all of the overhead expense to the domestic trade, and figuring the prices of the export at flat labor cost without overhead charge, but this is a thing that we are meeting in competition with foreign countries.

Wages are an important element in cost, but they are not standing still abroad. There are those who want to see lower tariffs, which will mean lower cost of living and lower wages, and then perhaps there will be a competition that will be carried forward on a basis we have not yet been able to attain, and many of us hope we shall not attain.

We have one difficulty in getting into European markets that our European competitors do not have, in that we have a great distance to travel, and this oftentimes prevents our sending men, and lessens the number of visitors—conditions which do not prevail among European manufacturers. When the South American and the Far Eastern markets are considered, however, the Europeans have as far to go as we have.

Many of us are of English descent and have inherited some of the English traits. The matter of language is one of them. How often we hear the American saying that the English language is good enough for him and let the other fellow learn English. When we go abroad, however, we find everywhere people that are speaking English. Most of us are acquainted with the young men who come to America for the main purpose of learning English (and, incidentally, to learn some of our methods), and then in turn become the men who are doing business. A knowledge of foreign languages is not an absolute necessity for the export business, but it is certainly one of the advantages that those who possess it have. We would do well to consider whether it would not pay to send more of our young men over, if for nothing more than to acquire one or two of the languages of countries where we want to do business.

If we follow closely the publications of other countries, we find in some of them indications of a spirit of cooperation not always evident in our own country. One of the purposes of our association is to draw together manufacturers so that we can act as a whole, so that we can go forth as a body of American manufacturers rather than as individuals—and results have already appeared in this direction.

In the year 1911 the United States exported to Italy, in metal- and wood-working machinery, 1,000,000 kilograms, and to Germany 6,000,000 kilograms; in 1910 America exported machinery into Switzerland to the value of 500,000 francs and into Germany to the value of 4,000,000 francs; and in 1909 America exported into France machinery to the value of 45,000,000 francs and into Germany to the value of 110,000,000. Considering these figures, is it not time that we carried into effect as individuals, and, when necessary, as an association, that attention to the requirements and desires of the foreign customer that we are giving to our domestic customer every day? In view of the figures quoted, it goes without saying that we must constantly maintain the highest standard of design and workmanship. But beyond this, what is the matter with our American export trade? Are our goods not fitted to the foreign market, or are they not properly presented to the buyer, or are the prices too high?

* * *

MAKING HINDLEY WORM-GEARING AT THE BROOKLYN NAVY YARD

When a battleship is in action it is sometimes necessary to revolve the gun turrets very quickly in order to train the guns or locate them in the proper radial position. Owing to the weight of the guns and their inertia, the mechanism for revolving the turret must be very strong and powerful to withstand the sudden shocks incident to the rapid movements which are occasionally required. The turret rotating mechanism that is applied to battleships now being built in this country consists of two motors connected to a differential gearing from which power is transmitted to the turret through Hindley worm-gearing and a pinion engaging an annular rack attached to the turret base. When both motors are operating at what might be called the normal speed, the differential gearing and turret remain stationary, but by varying the speed of either motor the turret is caused to revolve, the direction of rotation being controlled by running one motor or the other faster than the normal speed. The Hindley worm-gearing is an important part of the turret controlling mechanism, at least from the shop man's viewpoint, because gearing of this type is rather difficult to make accurately, especially in the large sizes required for the purpose mentioned.

The accompanying illustrations, Figs. 1 and 2, show a simple method of producing these large gears, which is employed at the Brooklyn Navy Yard. An ordinary lathe equipped with a special attachment is used for machining both the worm and worm-wheel. Fig. 1 shows how the worm is threaded, and Fig. 2 illustrates the method of hobbing the worm-wheel teeth. The worm is made of steel and has a pitch diameter of 10 inches, whereas the wheel is made of phosphor-bronze, has a pitch diameter of nearly 36 inches, and a circular pitch of 3⅛ inches.

The worm blank, which is integral with its shaft, is first turned to the proper curvature in another lathe, as will be described later. When the worm is being threaded, the right-hand end of its shaft is supported by the tailstock center, and the left-hand end enters a special driving plate *G* (Fig. 1), which is bolted to the regular faceplate of the lathe. A shaft is keyed to this driver and carries a bevel gear *A*. This bevel gear meshes with a corresponding gear *B* attached to a shaft at right angles, which, through the spur gears *C* and *D* and worm-gearing contained in the special base *E*, transmits motion to the spindle *F*. In this way, the worm is caused to rotate in unison with spindle *F* and the tool-holding fixture *H* mounted on it.

The worm thread is formed by two separate operations and two sets of tools are used. The first set are roughing or stocking cutters, which simply form rough grooves, and these are followed by a set of finishing tools which give the threads the required shape. Fig. 1 shows the finishing cutters in the tool-holder and the roughing cutters are on the lathe bed at *J*. The cutting ends of the roughing tools vary in shape, some being square, whereas others are beveled more or less; in addition, there are right- and left-hand side tools on each side of the fixture. By having tools of different shape, some cut in one part of the groove and some in another, which facilitates the roughing operation. There are eighteen cutters in all, the number being equal to one-

half the number of teeth in the worm-wheel. The circular tool-holder is mounted on a cross-slide which is fed inward by handwheel K, the latter being connected with the cross-feed screw through worm-gearing, as shown.

After the thread grooves have been roughed out, the roughing cutters are replaced by eighteen finishing cutters. The tool-holder is so constructed that these tools can be accurately located each time they are placed in position. This holder consists of a circular casting H, having a raised inner ring fitted with set-screws against which the ends of the tools abut, and a circular ring for clamping the tools. The latter are located circumferentially by slots cut in the tool-holder, and radially by measuring the distance between the cutting ends and angle-plate L. In case radial adjustment is necessary, this is effected by the set-screws referred to. The tools are all numbered and there are corresponding numbers on the holder, so that each tool can always be located in the same position. The tops of the tools are, of course, in the same horizontal plane as the axis of the worm. When finishing, the tool-slide must be fed in very slowly, as each tool machines a large surface, thus making it necessary to take light cuts. The gears C and D are so proportioned that each tool, at the pitch circle, moves a distance equal to the circular pitch of the gearing, while the worm makes one revolution. Lubricant for the cutters is supplied by the tank seen above the worm. The collars on each side of the worm are integral with the shaft and engage thrust bearings when the worm-gearing is assembled.

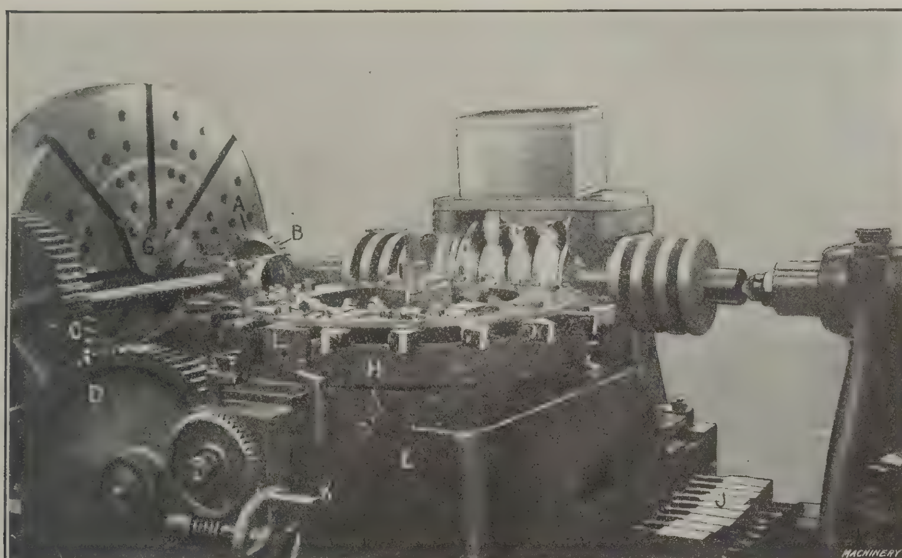


Fig. 1. Generating Thread of a Large Hindley Worm for the Battleship New York

When the worm-wheel is being hobbed (see Fig. 2), it is mounted on the same vertical spindle that drives the tool-holder, the latter being removed. The hob used for this operation has a long shaft which engages driving plate G, to which it is locked by a special key. The hob shaft also carries a bevel gear A for transmitting motion to spindle F through the shafting and gearing referred to. When hobbing the wheel it is necessary to run slowly and take light cuts, the same as when generating the worm thread, in order to secure smooth accurately finished teeth. The time required for hobbing one of these wheels is about five days, whereas the worm is threaded in about six days.

The hob used for the work, owing to its large size, was made with a machine-steel body, and the teeth are faced with tool-steel cutters K. These cutters are one-half inch thick and are held in position by cap-screws and dowel-pins. The inner end of each cutter is also fitted into a slot at the bottom of the gash, which gives additional support. When making the hob, the body was first turned and threaded just like a Hindley worm of corresponding size. Seven gashes were then sawed out to form the teeth, and the cutter-retaining grooves were milled. The annealed cutters or faces for the teeth were then bolted to the hob body, after being roughed to approximately the required form. The hob was then placed in the lathe and the tool-steel faces finished to the correct shape by hobbing with the worm-thread finishing tools, the operation being similar to that followed for making a worm. After hobbing, the sides of the cutters were filed to the proper degree of clearance. The clearance angle is about three degrees, although it varies somewhat owing to the change in the angle of the teeth due to the hob curvature. The final operation was that of hardening the cutters and attaching them to the hob body. By making the hob with a machine-steel body, the danger of distorting or cracking it by hardening was eliminated. There is also an advantage in having detachable cutters, in that they can easily be replaced if necessary.

The final operation on the worm-gearing is that of grinding the teeth to remove any uneven spots or ridges that may have been left by the machining operation. This grinding is done by running the worm and gear together and applying brick-dust and water, which abrades the threads of the worm and teeth of the wheel and produces smoother and better bearing surfaces.

The blank for the worm is turned in a lathe equipped with a special attachment which gives the required curvature. This attachment operates on the same principle as a regular taper turning attachment. It consists of a guiding templet having a curved slot, the radius of which corresponds to that of the worm. Engaging this slot there is a steel roller attached to a bar connecting with the lathe cross-slide, so that as the carriage feeds longitudinally, the turning tool follows an arc corresponding to that of the templet. This tool is centered with the blank longitudinally and is set in the same horizontal plane as the axis of the work. The phosphor-bronze blank for the wheel is turned to the proper curvature by means of a special attachment which consists of a tool mounted in a holder in such a way that it can be turned about a vertical axis, when finishing the curved periphery of the blank.

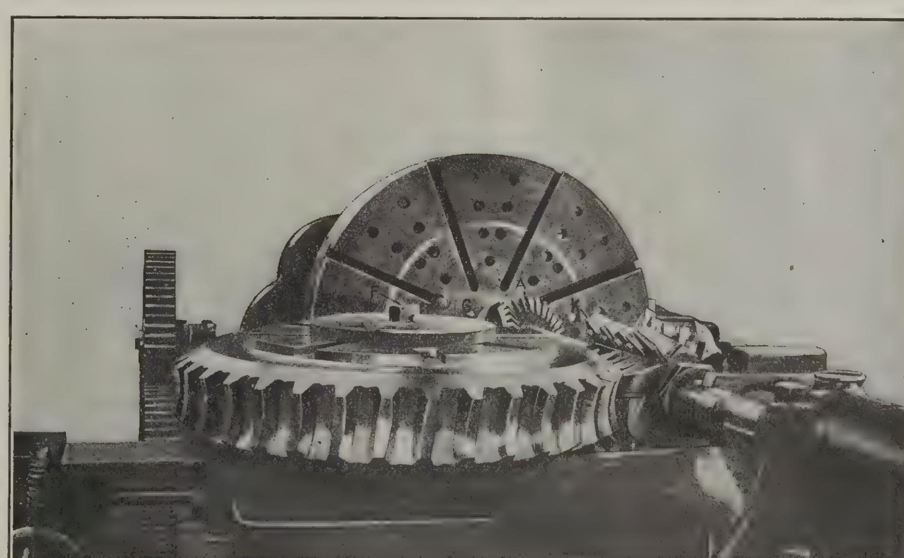


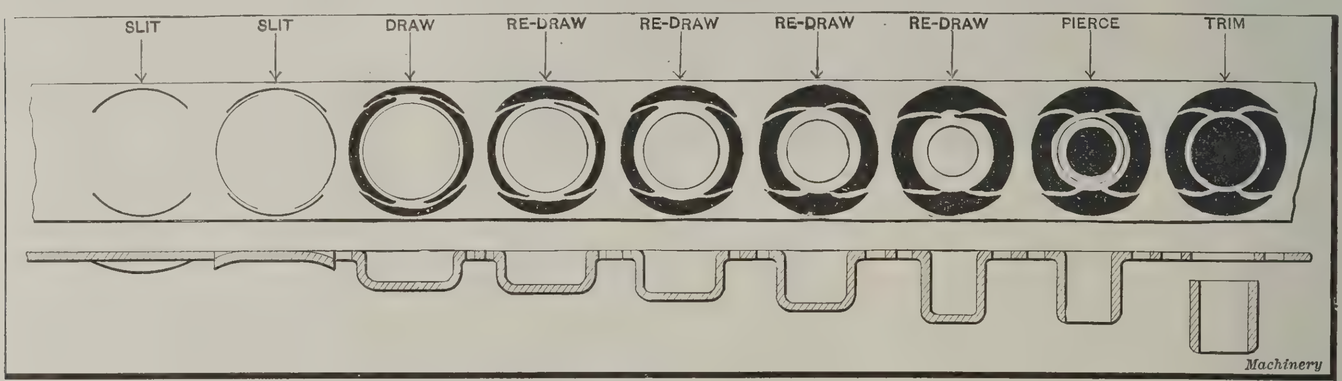
Fig. 2. Hobbing a Hindley Worm-wheel having a Pitch Diameter of approximately 36 Inches

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

PRODUCING DRAWN STEEL ROLLERS IN A GANG DIE

The illustration presented herewith shows the writer's idea of a layout for the progressive and automatic production of small chain rollers in quantities ranging from 18,000 to 22,000 parts per day per unit equipment. By using stock considerably thinner than the walls of the finished roller are to be, and working upon it progressively by means of gang or follow-up dies, as shown in the illustration, the roller can be completely finished in the power press. The plan view shows the entire evolution that the shell goes through to produce the result shown at the right-hand end of the sectional view. The stock used is dead soft, cold-rolled steel, which can be fed to the die by means of an automatic roll feed. At the first stroke of the press, the metal to form the shell blank is slit radially on two sides, as shown at the extreme left of the plan view. At the next stroke of the press, the metal is fed over one die space and is again slit. The next stroke performs the first drawing operation. The fourth operation is a redraw which is also the case in the fifth and sixth operations. The seventh operation is a finish-sizing process. In the eighth operation, the bottom of the drawn shell is punched out. The ninth and final operation consists of trimming the free end from the stock, as shown at the extreme right of the sectional view.



Evolution of a Drawn Steel Roller in a Gang Follow Die

At this point, the shells are annealed and then placed in a hopper. They are then fed to compression dies which apply end pressure to the tubes, and expand the shell walls to the required thickness. This operation will size and finish the rollers in exact duplication and to accurate dimensions. It will be seen from the layout that the work is carried along in the stock until the last operation, which cuts it free in the manner previously described. The writer estimates that the approximate cost of each unit die equipment, exclusive of a single acting power press, equipped with automatic feed, would be $300. A No. 19 single acting Bliss power press equipped with a No. 2 standard double roll Bliss automatic feed, is recommended as machine equipment. Stock ranging from 3/4 to 1 1/2 inch in width, and from 1/32 to 3/32 inch in thickness is best suited for producing such work.

New York City. J. V. WOODWORTH

THE TASK IDEA

The reader of technical literature today is likely to get the impression that the "task" system is a modern institution. This, however, is not so, for there exist today in England many concerns who have used this system for probably a hundred years or more. It is not quite the same system, however, for although the fixed task is there, no bonus is paid if it is performed in a briefer space of time than that set.

Fifty years ago, the writer's father worked under this system which was in vogue then and is still used in a large iron foundry employing about one thousand men. Pipes of all kinds are produced. Long experience has allowed the average time on a job to be accurately gaged, so that the output which constitutes a fair day's work is well known to everyone concerned. Disputes seldom arise and strikes are unknown. What is termed "80 inches" of standard socket pipe for gas or water is considered a day's work for a gang of men, but the number of men to a gang varies according to the size of the pipes. The unit "80 inches" means ten 8-inch pipes, eight 10-inch pipes, two 40-inch pipes, and so on. The gangs begin work at six o'clock in the morning and continue until the task per gang is finished and cast. Any bad castings have to be made good the following day.

The advantages of this system are manifold to the workmen, particularly in the smaller gangs where differences of opinion less frequently arise than in the larger gangs. When the whole gang is composed of fairly intelligent men, they can by steady work finish the day's task early, and enjoy long evenings for recreation and self-development. If a man wants an hour or two off, he only needs the consent of the other men in the gang. This has been agreed to by the management; all that is required is that the day's task is completed—there is no interference with the way it is done. By hard work a gang can finish at two o'clock in the afternoon, the furnaces and cupolas being kept going practically the whole day. Three or four o'clock in the afternoon are common hours for leaving. The wages earned are from 15 to 20 per cent greater than those of the ordinary day-workers who work until five o'clock.

The writer is not at all certain that present methods are an improvement on the old-fashioned way. Is it not a fact that the hours of labor at present are too long to permit of really efficient work during the whole of the day? Mind and body become weary, resulting in general inefficiency. But little time and, at any rate, but little inclination remains to devote the evenings to the study necessary to increase efficiency. Ten hours a day is too much for any man working at a monotonous occupation; eight is ample, and, in the opinion of the writer, would produce better results, if not in the immediate future, certainly eventually.

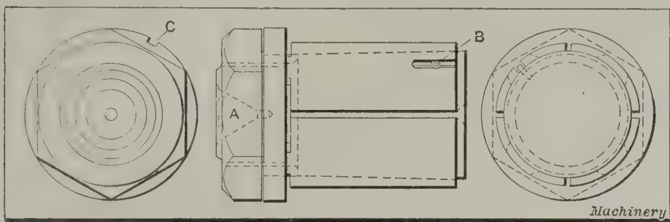
TIME LIMIT

EXPANDING CENTER FOR TURNING HOLLOW SHAFTING

A useful type of expanding center for use in turning hollow shafting, castings, or similar work, is shown in the illustration. It consists of a taper plug upon which a split shell is accurately fitted. In using this device, the lathe center fits into the hole *A*. The center is placed in the work and the split shell is then expanded through the action of the nut at the end of the plug. The pin *B* prevents relative rotation between the plug and shell, while the shell itself is held by a spanner fitting into the slot *C*. It will thus be evident that when the nut on the block is tightened, the shell is forced in on the taper and expands sufficiently to fit the work. When it is desired to disengage the block, the nut is slacked off. A sharp blow is struck on the end of the plug with a lead hammer. The center can then be as easily withdrawn as it was put into place.

These expanding centers have been found very useful on

many classes of work where the hole is too large to admit of the use of the regular lathe centers. They have been used in turning crankshaft parts, thrust, intermediate and tail-shafts for the steamship *Minnesotan*, the first of eight steamships now being built at the Maryland Steel Co.'s plant at



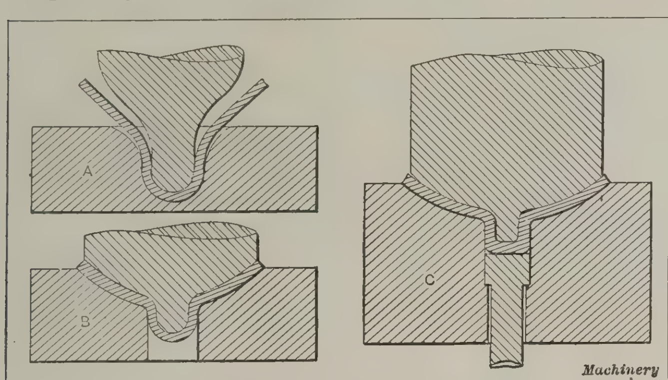
Expanding Center for Turning Hollow Shafting

Sparrows Point, for the American-Hawaiian Line. The work turned on this type of center is found to be as accurate and free from chatter as if the work were carried on the regular centers. LEWIS SYKES

Baltimore, Md.

DRAWING A SMALL SHELL FROM THICK BRASS

The shell shown in section in the dies at *C* in the illustration, is an unusually difficult job to draw from thick brass, the principal difficulty being due to the fact that the metal will not draw over anything approximating a sharp corner. The usual method of producing a shell of this kind—reducing it from larger cups by successive drawing operations—was tried without success. Finally the method shown in the illustration was hit upon, and it was found that satisfactory results could thus be obtained. This makes the operation akin to squeezing rather than drawing, the point being to protrude



The Three Dies used to produce the Shell

enough metal in the first and second operations to allow pressure from below to be applied in a third operation, shaping the stock and setting it to the required dimensions.

In the dies shown at *A* the object is to start the thick metal in a downward direction by means of the comparatively loose fitting punch and die shown. The edge of this die is very gradually rounded so that the metal will slide over easily. The second operation, which is performed in the dies at *B*, consists of shaping the shell around the depression already made, and the finished shape is the result of the operation performed in the dies at *C*.

The shell is started from a round blank, and two annealings are required to bring the metal to the finished shape. Subsequent piercing and cutting operations are afterward performed on the piece, but these do not differ from the general run of such operations.

Columbus, Ohio. OTTO R. WINTER

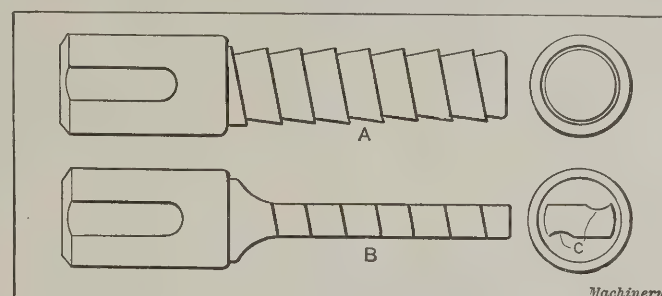
CHROME-VANADIUM STEEL FOR SCREW-DRIVERS

Screw-drivers made from properly heat-treated chrome-vanadium steel will be found superior to those made from other materials. Properly heat-treated chrome-vanadium steel possesses the hardness necessary to prevent the point from twisting off, and at the same time has enough toughness to prevent nicking or cracking; its torsional strength is exceptionally high. Actual tests have proved that when used for screw-drivers no material is superior to this steel. The heat-treatment should be as follows: Heat to from 1600 to 1650 degrees F., and quench in oil; then draw to from 700 to 800 degrees F.

Sandover, Md. W. A. SHERWIN

ROUGHING REAMER FOR CHROME-NICKEL STEEL GEAR BLANKS

Considerable trouble was met with in reaming tapered holes in certain chrome-nickel steel gear blanks. Several types of reamers were furnished by tool experts, but the results obtained were unsatisfactory. Finally, the type of roughing reamer shown in the accompanying illustration was devised. The blank for this roughing reamer was turned to the proper taper, but 0.005 inch smaller than the finishing reamer. A buttress thread of ½ inch lead was then cut on the reamer part, as shown at *A*, after which the blank was placed between



A Roughing Reamer used for reaming Holes in Chrome-nickel Steel

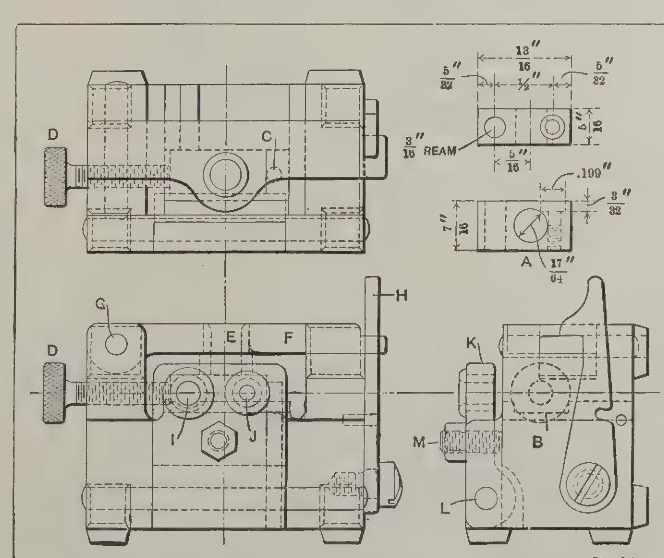
the centers in the milling machine and milled as shown at *B;* the cutting edges were then given the proper rake by milling two parallel grooves, as indicated at *C*. When removed from the milling machine, the reamer was finished by giving it the necessary relief on the cutting edges with a file.

This reamer was fed at a rate of 0.020 inch per revolution of the spindle, and after having reamed the hole with it, a finishing reamer of standard shape was used at slow speed, with a feed of 0.010 inch per revolution of the spindle. This reamer left a nicely finished hole.

Lafayette, Ind. W. H. ADDIS

DRILLING, REAMING, COUNTERBORING AND TAPPING JIG

A simple but very efficient jig for drilling, reaming, counterboring and tapping a part for a typewriter is illustrated herewith. The work shown at *A* in this illustration is a small



Jig for drilling, reaming, counterboring and tapping Piece A

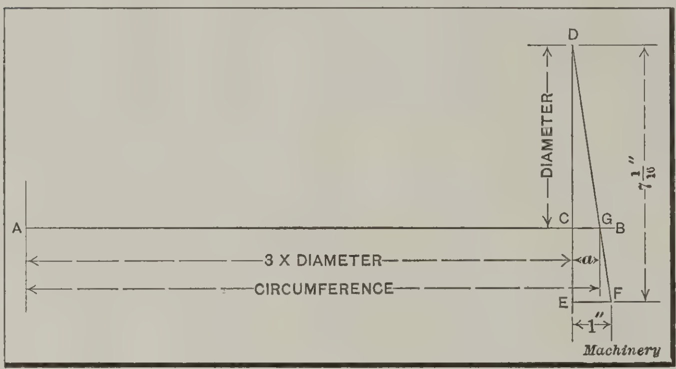
machine-steel block. This block is laid in a groove *B* in the body of the jig and is held against the locating pin *C* by means of the set-screw *D*. The work is held down by the head of the bushing *E* which is carried by the leaf *F*. This leaf swings

on a pin *G* and is clamped shut by the latch *H*. The largest hole is drilled through the bushing *E*, while the other two holes are drilled through the bushings *I* and *J*, which are carried in the second leaf *K* at the side of the jig. This second leaf swings on a pin *L*, but is not clamped shut. When closed, the adjusting screw *M* keeps the leaf in the correct position. After the three holes are drilled, the side leaf is lifted and one hole is reamed and the other counterbored and tapped. No guide bushing is used for the latter operation.

A. M. Rochester

LAYING OUT THE CIRCUMFERENCE OF A CIRCLE

The accompanying illustration shows a method by means of which the circumference of a circle can be laid out along a straight line, simply by using a scale. The method gives very accurate results. Lay out on line *AB* the distance *AC* equal to three times the diameter of the circle. At *C* erect



Method of Laying Out the Circumference of a Circle along a Straight Line

a perpendicular *CD* equal to the diameter of the circle; extend *DC* to *E* (if necessary), so that *DE* equals 7 1/16 inches. Draw *EF* perpendicular to *DE*, making it 1 inch long; draw *DF*, intersecting *AB* at *G*. (Should point *F* be located on the upper side of the line *AB*, extend *DF* until it intersects *AB* at *G*.) Line *AG* then represents the circumference of the circle.

Since the triangles *CDG* and *DEF* are similar, we have:

$$1 : 7\,1/16 = a : \text{diameter}.$$

Hence $a = (1 \div 7\,1/16) \times \text{diameter} = 0.1415929$, and $AG = 3.1415929 \times \text{diameter}$. Since the circumference of a circle is equal to $3.1415926 \times \text{diameter}$, this method is, theoretically, almost exact, the error being too small to be taken into account for any practical purposes.

W. L. Tryon

Schenectady, N. Y.

THE VALUE OF AN EFFICIENT TRUCKING SYSTEM

It is surprising to note how little attention is paid to the method of handling work in some factories. These are generally the establishments which complain most of the heavy item which overhead expense makes in their cost of production. The argument is advanced that trucking is non-productive labor, and consequently does not need so much attention. This statement, however, is far from accurate.

In a certain large factory engaged in the manufacture of sheet metal products, the method of transferring work from shop to shop was seriously neglected. It was the practice to allow the machine operators to move their own work from department to department. Sheets of metal were loaded on trucks to carry them from one machine to the other, the trucks being unloaded before each operation was started. It will be evident that this method was responsible for a serious loss of time, and when this fact was recognized the mistake was corrected by adding fifty new trucks to the shop's equipment. These trucks were placed at the disposal of the men and orders were issued that all material should be kept on the trucks. This meant that each machine had two trucks; one to take away finished work and the other loaded with raw material. It may seem that the presence of so many large trucks would take up too much floor space, but the results do not show that this was the case, as the room occupied by the trucks was formerly taken up by piles of material and finished product.

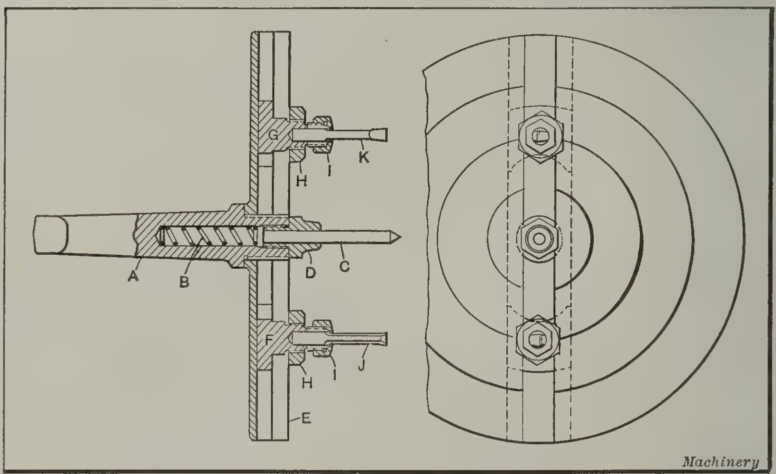
An important point in the development of the new trucking system was the maintenance of an aisle in each room, wide enough for two trucks to pass. The machines were arranged in progressive order on each side of the aisle, the men being required to keep the aisle-space clear. Instead of having the machine operators do their own trucking, a corps of truckers was employed under the direction of a floor manager, whose duty it was to keep the materials constantly moving from machine to machine as the various operations were completed. This floor manager ordered his raw materials from the yards and moved the work along through the departments as rapidly as possible. This kept each machine running continually and reduced the overhead cost to a great extent, owing to reduction in the amount of time which the equipment was idle.

New Britain, Conn. J. M. Henry

TOOL FOR CUTTING OUT RINGS OR DISKS FROM FIBER SHEETS

The tool shown in the accompanying illustration was designed for cutting out fiber rings or disks from the sheet, forming both the hole and the outside diameter in one operation; when desired, it can be used for cutting out the blanks only. The shank *A* of the tool is supplied with a Morse taper to suit a drilling machine spindle, and a hole is drilled in its lower end to receive the spiral spring *B* and plunger *C*, the lower end of the latter being cone-pointed. The top end of the plunger is provided with a head which acts as a stop for the plunger, coming against the threaded bush *D* screwed into the lower end of the shank *A*; this bush also acts as a guide for the plunger.

A disk *E* (which in this case is 5 inches in diameter) is screwed onto the lower end of the shank, and has a T-slot milled across its face to retain the tool-holders. The tool-holders *F* and *G* are made from a square bar, bored to receive a piece of round tool steel. The outsides of the tool-holders are turned, threaded and fitted with nuts *H*, which hold them in position in the disk *E*, when set to the required radius. The lower ends of the tool-holders are turned,



An Adjustable Tool for Cutting out Rings or Disks from Fiber Sheets

threaded, tapered and split, and are fitted with nuts *I* forming a split chuck for holding the cutting tools *J* and *K*. These tools *J* and *K* may be made in various lengths to suit the thickness of fiber to be cut.

The lower face of the disk *E* is provided with circles of various diameters and is marked so that the tool-holders may be readily set to cut any given diameter. The plunger *C* is so arranged that when pressed out by the spiral spring *B* to its extreme length, the point of the center projects about ⅛ inch in advance of the cutting edges of the tools. In using this tool, the fiber is marked with a center punch, the punch mark being located far enough from the edges of the sheet so that the cutters will not break out. The tool is placed in the spindle of a drilling machine and rotated at a good speed

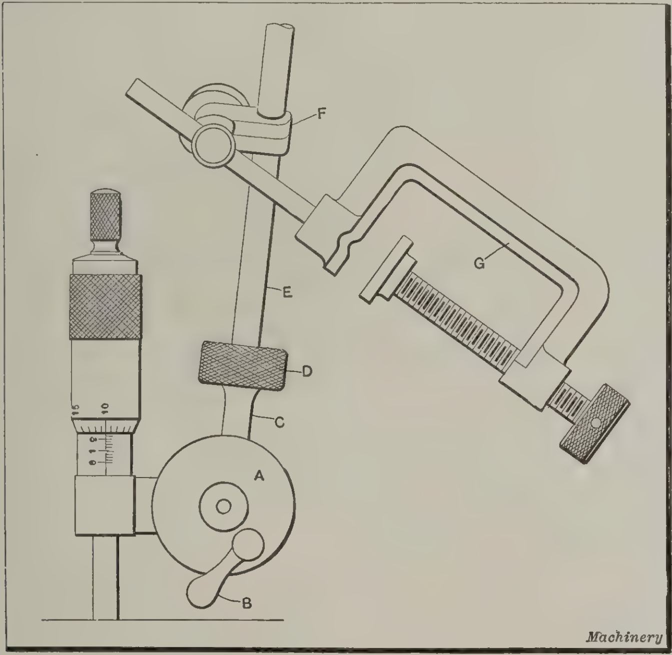
(say 1000 R. P. M.), the fiber being placed on the table of the machine with a thin board beneath it to protect the cutters when they pass the sheet. As the cutters are brought down toward the fiber, the center *C* which projects a little in advance of the cutters, comes into contact with the work first; this enables the fiber to be moved into the correct position, before the tools commence to cut, without stopping the machine.

When rings are required to be cut out, the inside cutter, or the one which is cutting out the hole is adjusted to cut the blank out of the ring before the other cutter separates the ring from the sheet; this insures the clean cutting out of the bore, and prevents the ring from being carried around by the cutter which is cutting the bore. The spiral spring behind the center, being stiff, holds the portion which is cut out first quite firmly in position, while the ring is being separated from the sheet. When cutting out blanks one of the cutters is removed. LAWRENCE W. WILLIAMS

Handsworth, Birmingham, England.

UNIVERSAL MICROMETER DEVICE

The writer has long felt the need of a micrometer device which would make it possible to remove surfaced work from the shaper, planer or milling machine and to replace it accurately. For this purpose, the tool illustrated in the accompanying engraving was devised. A standard 1-inch micrometer is used with the anvil part of the frame removed.



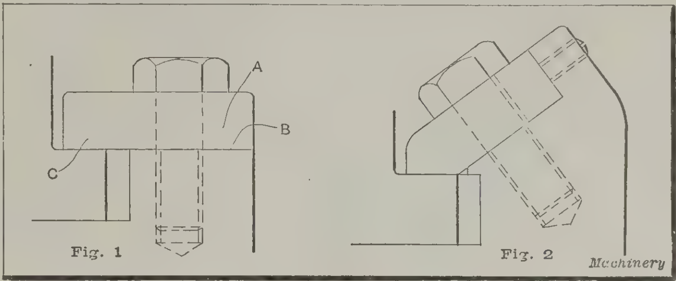
Universal Micrometer Head

The friction disk bearing *A* is mounted onto what remains of the frame, at right angles with the micrometer spindle. This bearing can be locked by handle *B*. Stud *C* is inserted in the disk bearing *A*; this stud is threaded to fit nut *D*. The support *E* is provided with a collar at one end that fits into nut *D*, this arrangement making it possible to use different types of supports. The purpose of nut *F* and clamp *G* is apparent from the illustration. The device can be clamped to any stationary part of the machine, and as it is universal in its adjustment and the micrometer spindle has a range of one inch, it is a very valuable tool for the machinist and toolmaker. WM. H. ADDIS

La Fayette, Ind.

DESIGN OF SQUARE GUIDE FOR SLIDES

Undoubtedly the square slide is to be preferred to the V-guide when friction and wearing qualities are considered, but the objection to its wider adoption is the difficulty of adjustment of the strip *A* in Fig. 1. On some slides where the wear is small this defect is not of much consequence, but on slides such as used for shaper rams, where the wear is great, the design presents a great drawback. In addition, the cost of fitting and adjusting the slide on a new machine, if a good fit is required, is objectionable. The only way of adjusting the strip is by carefully removing metal from the surface *B* until the required fit is reached. This lack of adjustability is also a bad feature when the machine has become worn through use. Because of the trouble involved in adjusting the strip, the machine is frequently allowed to run until it is in very bad shape.

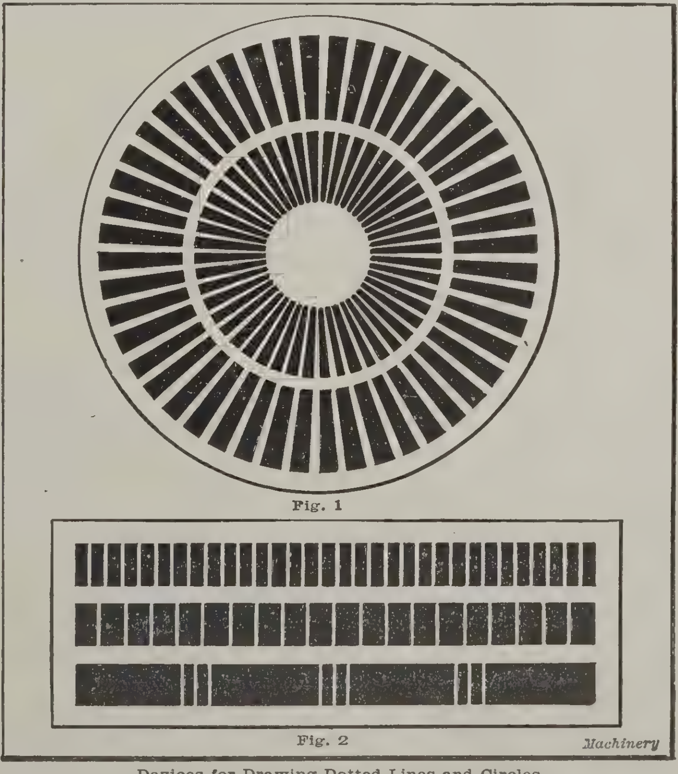


Figs. 1 and 2. Conventional and Improved Designs of Square Guide for Slides

The arrangement shown in Fig. 2 was intended to overcome the weak points of the design shown in Fig. 1, while still retaining all the good points. The construction can be quite massive, and as the bolt heads are practically over the heads of the thrust, there is little chance for looseness of the fit. The adjustment is very simple, and the ease of fitting is apparent. A. H.

DEVICE FOR DRAWING DOTTED LINES

The accompanying illustration shows the principles of a device for drawing dotted lines. It is well known that it requires considerably more time to trace dotted lines than to draw full lines and circles. The devices illustrated are made from thin sheets of amber or celluloid. The parts shown in black are cut out so that the pen will touch the paper at these points. The length of the dots and dashes can be regulated by the spacing of these sections. When drawing a dotted line, the T-square or triangle is simply placed over the "dotter" (Fig. 2) and the line is drawn as if it were a full line, without lifting the pen. When drawing dotted circles by means of the device in Fig. 1, the "dotter" must lie perfectly flat on the drawing. Care must be taken in lifting the "dotter" from the drawing so that the ink will not blot.



Devices for Drawing Dotted Lines and Circles

McKees Rocks, Pa. AUGUST H. ANGER

[It would seem difficult with a device of this kind to prevent the ink from flowing along the edges of the celluloid

and also that it would be almost impossible to lift the disk from the paper without causing ink blots. The idea was tried in this office, however, and found to work fairly well.—EDITOR].

FILING MACHINE BRACKET

The accompanying halftone shows the application of a special holding-down bracket used on a filing machine made by the Simplex Mfg. Co., in order to increase the range of work that can be handled on the machine. The arm is shown in detail in the line engraving Fig. 2. It is supported from the column of the machine and held in position by a clamp hub, and is as universal in its adjustment as the holding-down clamps furnished with the machine. Two offset fingers are used for clamping purposes. The use of this bracket makes it possible to keep the table clear for any class of work. After the fingers are set to accommodate the thickness of the work at hand, no further adjustment is required. One of the two ordinary clamps is also shown on the table in Fig. 1, merely to illustrate its appearance and application.

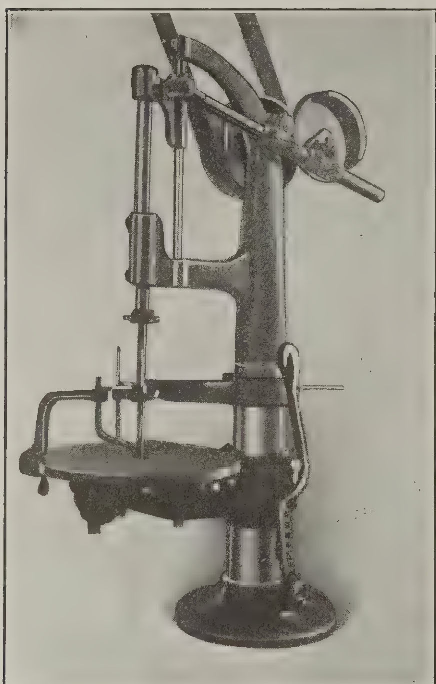


Fig. 1. Bracket applied to Filing Machine

The advantages of the bracket are particularly in evidence in cases where it is required, for example, to file a set of cams for a Brown & Sharpe automatic screw machine. The whole table of the filing machine would be unobstructed and any part of the cam could be filed without adjusting the holding-down clamps. On all kinds of dies and punches it is also especially useful for filing a circular portion. It is often desirable to be able to swing the work through a large arc, which this special bracket permits. D. SIGN

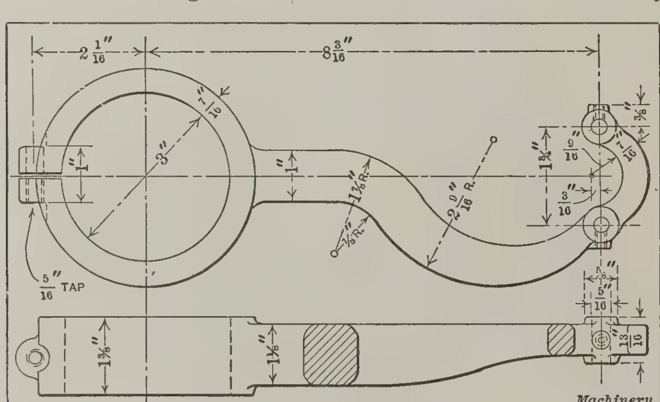


Fig. 2. Dimensions of Bracket

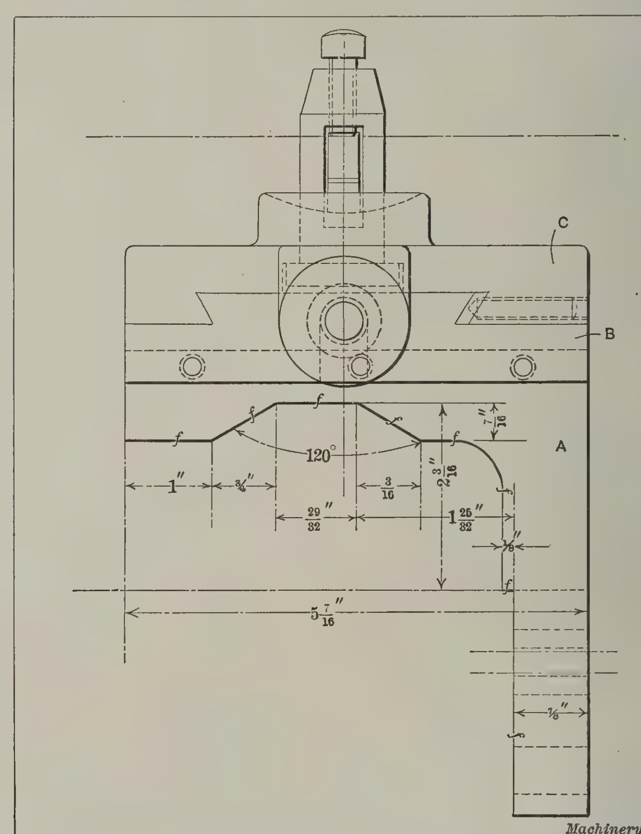
USING GASOLINE ON TRACING CLOTH

It is probably the most common practice in drafting-rooms to use powdered chalk or some similar preparation to absorb the greasy element on the surface of tracing cloth. While the results obtained are satisfactory so far as the object in view is concerned, the gritty preparation rubbed over the cloth will dull the finely sharpened edges of the ruling pen in a comparatively short time. For this reason it is preferable to rub the tracing cloth with a soft cloth slightly dampened with gasoline. When this practice is followed the ruling pen will be found to remain sharp much longer than when the tracing cloth is rubbed with chalk. Gasoline is also useful as an eraser for lead pencil marks and for cleaning a soiled tracing before removing it from the drawing-board.

Manchester, N. H. CLARENCE KENT

TOOL FOR FINISHING THREADS ON A THREAD MILLING MACHINE

The accompanying engraving shows a device used for finishing threads on a Pratt & Whitney thread milling machine. By means of this device objectionable milling cutter tooth marks can be removed whenever they become very apparent on the work, as, for example, when maximum feeds are used with such materials as cast iron, bronze and soft steel. The device consists of a bracket *A*, fitted to the carriage of the machine and bolted to the seat used for carrying the follow-rest on regular long work. The bracket bears on the top of the cutter-slide which is planed to an angle of 120 degrees. Mounted on this bracket is a slide *B*, parallel to the work.



Device for Finishing Threads on a Thread Milling Machine

This slide has provision for adjusting the finishing tool to the threads already roughed out by the milling cutter. This adjustment is accomplished by means of two fillister-head screws, one at each end of the slide. Attached to this slide is the top slide *C* in which the shaving or finishing tool is clamped. This latter is made from 3/8 by 3/8 inch stock, and is held in a regular toolpost. The top slide is operated by a small handle located immediately above the handwheel which operates the cutter-slide. This handle is provided with a graduated dial reading to 0.001 inch.

When this device is used, the milling cutter is fed into the work and the work roughed out to within from 0.002 to 0.004 inch of the finish size. The finishing tool is then brought into action, removing the remaining stock and leaving a smoother finish than could be obtained by milling alone with a heavy feed. J. E. SHEUMAN

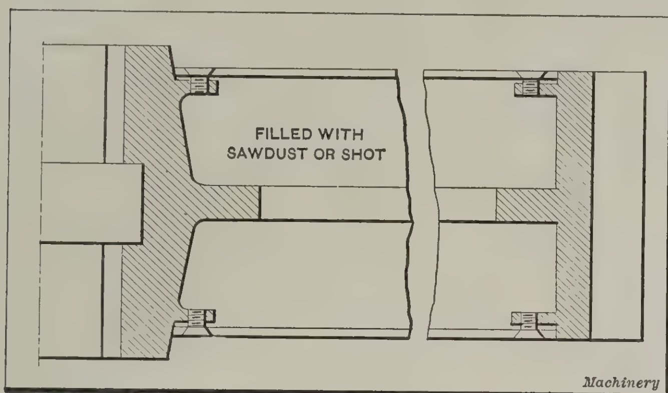
Waynesboro, Pa.

ANOTHER CURE FOR NOISY GEARING

In the May issue of MACHINERY, a cure for noisy gearing is mentioned which appears to combine the advantages of low cost and efficiency. The following method which is used

on a large scale in some engineering works in St. Petersburg, Russia, is even more efficient, but it is also far more expensive.

In using this method gears of less than 18 inches in diameter are fitted with two sheets of tin which enclose the space between the hub and the rim of the gear. This space is then filled with sawdust or with No. 4 shot, the idea being to eliminate vibration by this means. In some cases, it has been found advantageous to use a mixture of shot and sawdust. The sheets of tin are fastened to the rim and hub with a number of small screws, as shown in the illustration. When



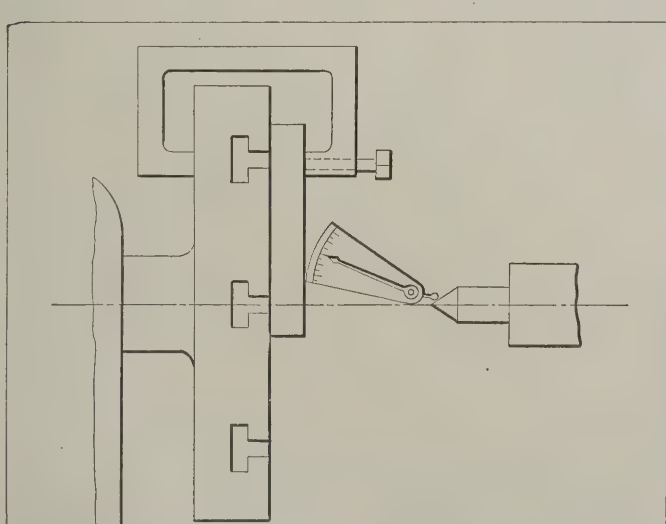
Method of Quieting Noisy Gears

the diameter of the gears exceeds 18 inches, wooden rings are used in place of the tin, the method of attachment being similar in either case. A felt packing is used to prevent the sawdust from leaking out. This arrangement has the further advantage of closing the space between the spokes of a wheel, thus making it impossible for a workman to get his arms or tools caught by the rotating wheel.

Wolverhampton, England. A. Wind

TESTING THE ALIGNMENT OF LATHE CENTERS

The writer once desired to know the alignment of the dead center of a lathe in which he had a piece of work mounted. This work was of an awkward shape, and after clamping it to the faceplate it was found necessary to bring the dead center forward to a hole which had been drilled, to assist in holding the work. When the lathe was started, a slight vibration of the center hole showed the center to be out of line with the lathe spindle. To bring the dead center into alignment,



Method of Testing the Alignment of Lathe Centers

a test indicator, graduated to read in thousandths, was clamped to the faceplate, in such a position as to enable the indicator point to come into contact with the end of the center. This is clearly shown in the illustration. When the lathe spindle is revolved under these conditions, the amount of error in the alignment of the dead center is accurately shown. This error can then be easily remedied.

This is a useful method of lining up centers before starting to turn a straight piece of work. It is far superior to the practice of taking trial cuts and making the necessary measurements and adjustments between cuts, in order to ascertain whether the piece will be straight when finished. Almost every tool-room has some kind of test indicator which is capable of being used for this purpose. F. E. C.

A STEADYREST NOVELTY

In the July issue of Machinery, E. W. Tate has a tilt at the steadyrest proposed by H. Terhune in a previous issue. He enumerates several rather visionary faults, and sets out to abolish them with a design which appears to me to perpetuate rather than remedy the very points he criticises in H. Terhune's design. And it was rather unfortunate, after complaining of the cost of the first design, when he confessed that the application of his own is limited on that account.

This controversy and the editor's trenchant footnote anent the neglect usually accorded these accessories has prompted me to advance a description of a type of steadyrest which is, as far as I know, quite novel, and which is both compact and cheap. This steadyrest can be made in two styles, as shown in Figs. 1 and 2, according to whether the screw is required to work the jaws both ways or not. The construction in

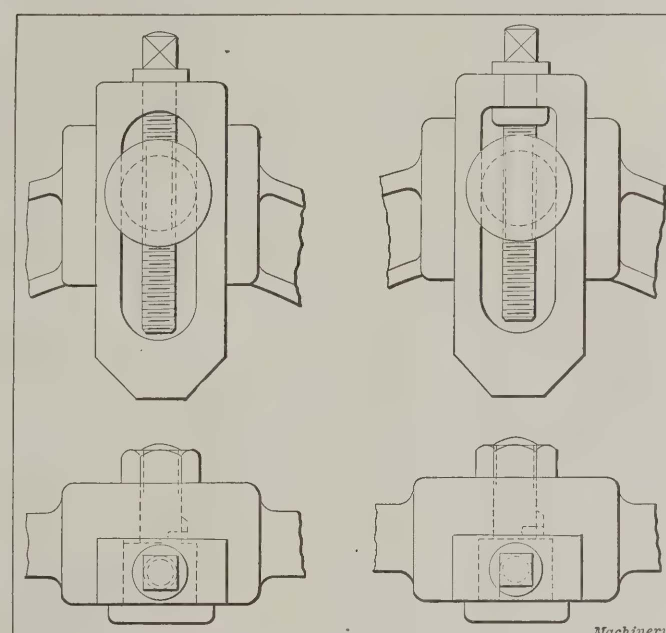


Fig. 1. Steadyrest to work Jaws in One Direction   Fig. 2. Steadyrest to work Jaws in Two Directions

each case is practically identical, the difference being that the type shown in Fig. 2 has the screw turned with a second collar, and the hole for the screw in the top of the jaw is milled out to the front. There are no unsightly screws projecting when the jaws are fully out, as in the case of many of the types now in use. The machining of the jaw guides can be done by an ordinary milling cutter going straight through, instead of end-milling them, which is now necessary with the blind end guides. A. H.

PUNCH AND DIE FOR FORMING ELECTRIC TERMINALS

The punch and die shown in Fig. 2 were designed for forming electric terminals of the type shown in Fig. 1. The arrangement has been so worked out that two terminals are formed and two others sheared off by each stroke of the press. The stock used is copper tubing, ¼ inch in diameter with a wall about 1/32 inch thick.

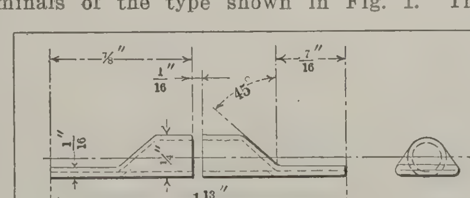


Fig. 1. Two Electric Terminals after being cut apart

Reference to the cross-sectional view of the punch and die

shown in Fig. 2 will enable the operation to be readily understood. In this illustration *A* is the punch which forms the work in the die *B*. The shear *C* is bolted to *A* and backed up by a shank to enable it to withstand the blow. The right-hand face of the die *B* acts as the lower shearing plate. *D* is a square block of tool steel which is used to straighten out the formed tube before the punch *A* descends for the next stroke upon the unformed section of the work. The use of this block has been found necessary to bring the flat portions of the double terminal into proper alignment. When the shear *C* is in the act of descending, distortion of the formed tube would be inevitable were it not for the action of block *D*.

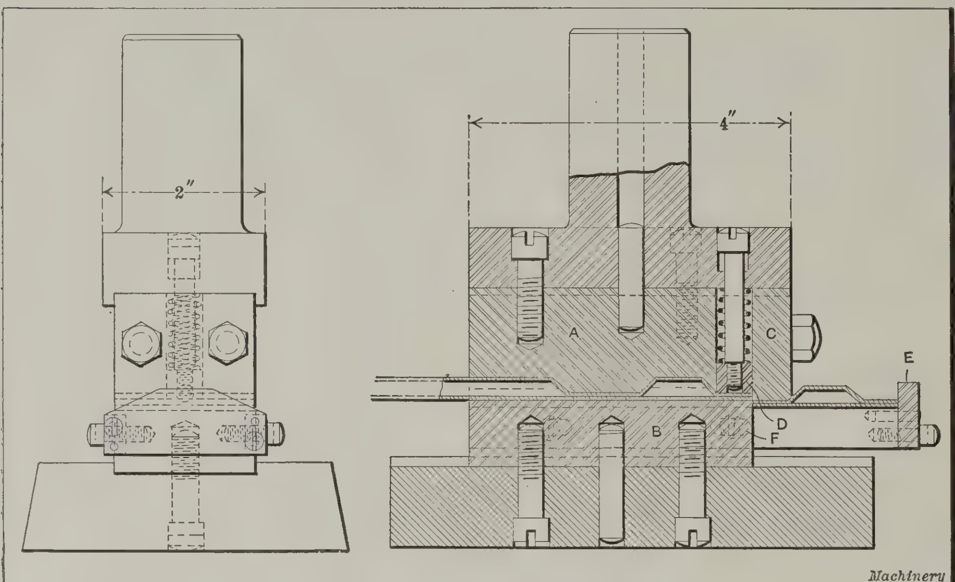


Fig. 2. Punch and Die for Forming Electric Terminals

The work is fed through the die until it comes up against the stop *E* which can be adjusted by means of screws *F* that are located in a suitable elongated hole. With the work in position against the stop *E*, the punch descends, shearing off the end of the stock and forming a double terminal between the punch and die. The work is now advanced to bring it into contact with the stop *E* and the punch is again tripped. This shears off the pair of terminals which were formed in the preceding operation, and at the same time a second pair is formed in the die.

After the terminals are sheared off, they are put into another die and the hole in each end is pierced. They are then run over a saw which cuts them exactly in half, as shown in Fig. 1. Two terminals are thus produced from each piece which is sheared off by *C*.

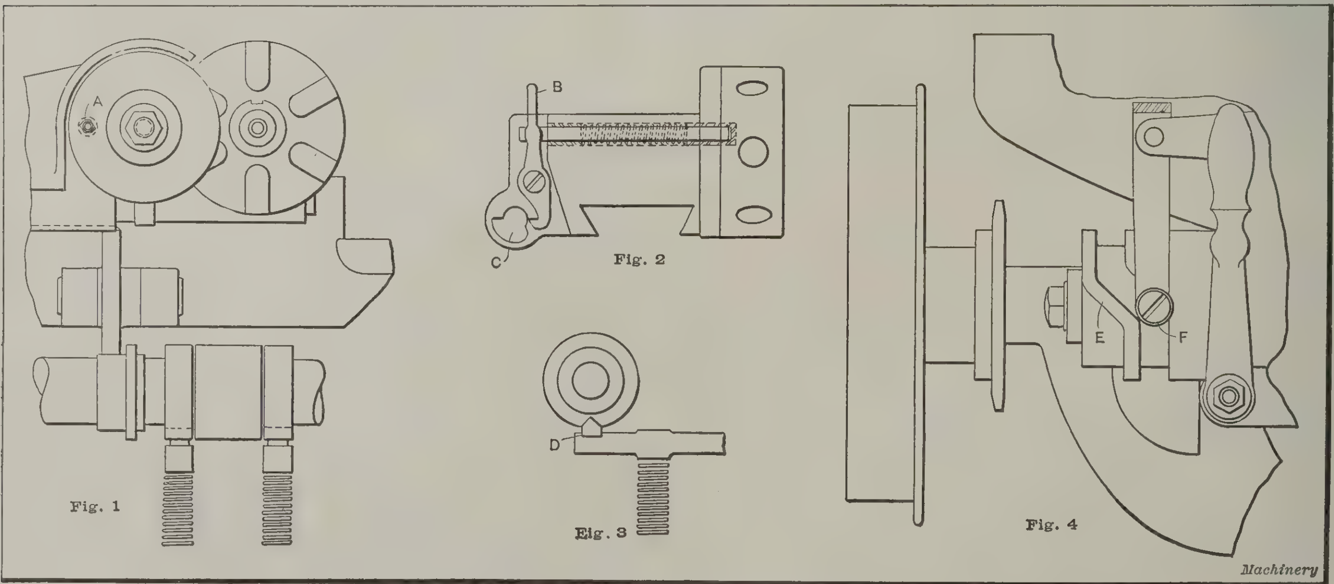
Chester, Pa. CHARLES R. ENGEL

TAKING OUT BACK-SHAFT OF A B. & S. AUTOMATIC SCREW MACHINE

In every screw machine department equipped with Brown & Sharpe automatic machines, it is necessary to take out the back-shaft of at least one or two machines a week. The back-shaft is located in the rear of the machine and carries the various operating gears and clutches, the entire machine being operated therefrom. The reason for removing the back-shaft has nothing whatever to do with the design of the machine, since it is taken out for the sole purpose of removing the gummed oil, etc. In the following, the writer will describe the only practical and correct method of removing the back-shaft, which is a very important item in the training of any screw machine operator.

If a back-shaft is taken out and replaced in such a manner that every gear does not mesh with the same teeth as it did before the shaft was removed, then the machine will be "out of time," and the entire job will have to be set up again. If all the rules stated in the following are not observed when replacing a back-shaft, the machine, although it appears to be running all right, will be running under conditions which will probably cause breakage.

Some screw machine men, when about to remove a back-shaft, mark the gears with a center-punch which is not very satisfactory after the shaft has been removed several times. Fig. 1 shows the first thing to be done when about to remove a back-shaft. The roll on the turret operating disk, the clamp nut of which is shown at *A*, should set in line with the center of the turret. The machine should be operated by hand until this effect is brought about. Fig. 2 shows a view of the turret looking from the spindle; the cam *C* should be set as shown with regard to its radial drop. This cam is used for operating lever *B*, which unlocks the turret.

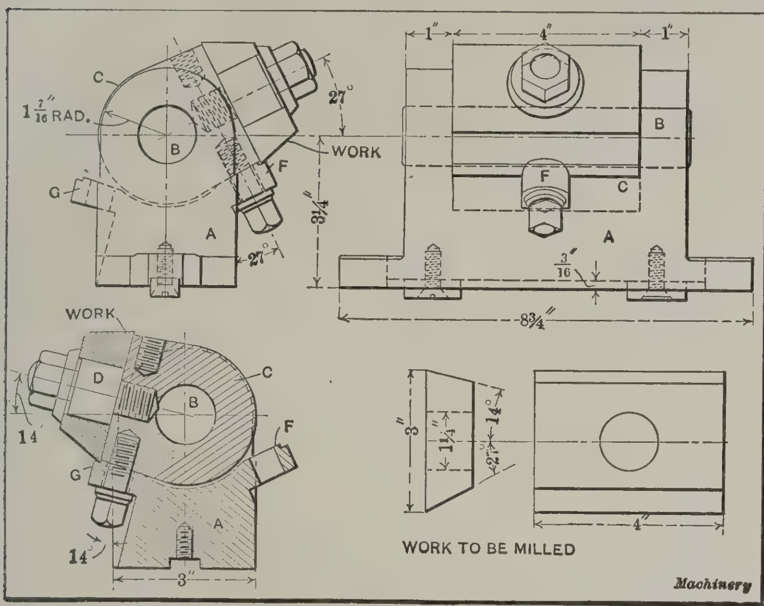


Figs. 1 to 4. Method of Taking Out the Back-shaft of a Brown & Sharpe Automatic Screw Machine

Fig. 3 shows how the clutches on the back-shaft should be set—with the notch down and engaged with the lever *D*. In Fig. 4 is shown a front view of the machine, in which the starting lever will be recognized. The cam for opening the chuck and operating the feeding of the stock is shown at *E*; *F* is the roller which rides on this cam and is shown in the position in which it should be set. When all these conditions have been observed it is safe to take out the back-shaft. NEVIN BACON

MILLING FIXTURE

The milling fixture shown in the accompanying illustration was designed for holding the cast-iron piece shown in the lower right-hand corner of the engraving. This piece has its sides milled off at different angles as indicated. The fixture consists of a base casting *A*, the flanges of which are bored out to admit shaft *B*. This shaft passes through the center casting or work-holder *C* and allows it to turn freely from stop *F* to stop *G*. In the upper left-hand corner of the engraving is shown the position of the work in the fixture when milling the 27-degree side on the work. The center block *C* is held in position while milling by a screw passed through the lug *F*. The sectional view indicates the position of the work in the fixture when milling the 14-degree side. The work itself is held to the center block *C* by a stud *D* provided with a nut and collar.



A Milling Fixture for Holding Work while milling Beveled Sides

Cincinnati, Ohio HENRY FRANZ

MEASURING SCREW MACHINE CHIPS

A common practice among screw machine workers is to measure the thickness of the chips to determine the feeds of the tools. The writer wishes to point out that this practice is misleading because of the tendency of the metal to compress in one direction and swell and stretch in the other, when separated from the bar by the cutter. In order to obtain data on the difference between the feed of the cutter and the thickness of the chips, some tests were made on a Brown & Sharpe automatic screw machine. A cam, the exact size and travel of which was known, was placed on the machine, and the machine was geared to rotate the cam at a given speed. The exact speed of the spindle was also determined, and in this way the exact feed of the cutter was known.

These tests showed that a form tool, ¼ inch wide, having a feed of 0.001 inch per revolution, cut a chip which measured 0.0025 inch when cutting brass, while a form tool ⅝ inch wide, with a feed of 0.0015 inch per revolution, cut a continuous chip 0.005 inch thick. A cut-off tool ⅛ inch wide, cutting brass and fed 0.001 inch per revolution, produced chips from 0.0015 to 0.002 inch thick. The proportions between the feed and the chip for the turret tools were slightly greater than for the cross-slide tools; that is, the chip expanded slightly more. The tests for steel indicated a smaller expansion than for brass.

Many times a cam designer is criticized by the operators for providing excessive feeds when this is not really the case, the apparent error being due to the erroneous method used by the operators in measuring the feed. The error that would result in the design of cams if the draftsman worked to data obtained by measuring the chips is, however, apparent.

NEVIN BACON

ERASING INK MARKS FROM TRACINGS

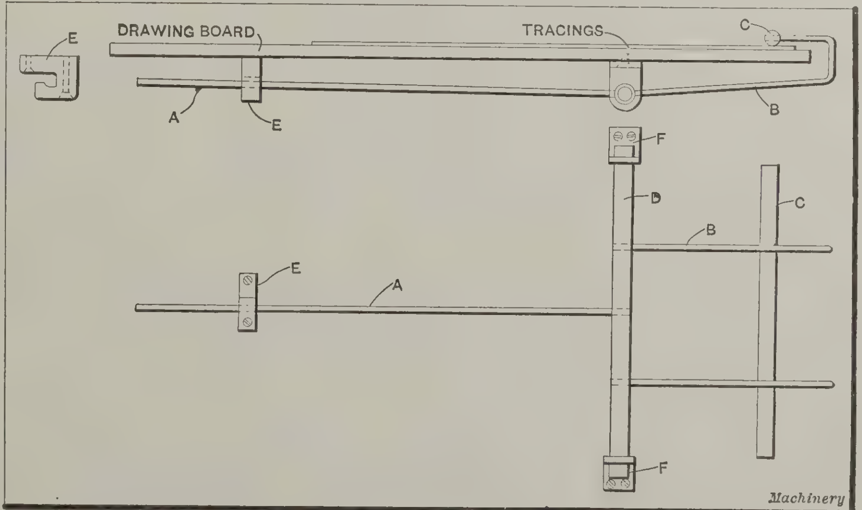
The writer wishes to add a few remarks to the discussion concerning the erasure of ink marks from tracings which appeared in the issue of MACHINERY for September. It will be found that the use of an ordinary pencil eraser on tracings will give better results than an ink eraser. The ink eraser will burn the tracing, as Mr. Allison states, if care is not taken in using it; this difficulty will not be experienced with a pencil eraser. Although a pencil eraser does not give as quick results, it will leave a much better finish on the tracing, and the use of soapstone will be unnecessary. If, however, a heavy line is to be erased, it will be found advisable to start with an ink eraser and then finish with a pencil eraser. A rather large detail can be changed on a drawing in this way, without leaving any noticeable mark. All that is required is a little patience. A. H. MYERS

York, Pa.

DRAWING-BOARD CLAMP FOR TRACINGS

When a great many tracings are used on the drawing-board at the same time, as, for example, when an assembly drawing is made, considerable trouble is experienced on account of the tracings sliding off the board. The accompanying illustration shows a special clamp made to take care of this difficulty. The tracings are placed beneath a maple stick *C*, which is located at the top of the drawing-table near the right-hand side. The clamping rod *A* is swung into the bracket *E*, and the drawings are held tightly in place. As each drawing is used it is thrown over the back of the table, the clamp still holding it in place. When a drawing is to be removed, rod *A* is taken out of the bracket, thus removing the pressure of the clamp rod which is immediately raised from the drawing-board on account of the rod *A* being the heavier part of the device. Any number of drawings can then be removed without the draftsman leaving his chair, thus saving considerable time.

Rods *A* and *B* are made of ⅜-inch cold-rolled steel and are driven into a 1-inch pipe *D*, and riveted. The maple rod *C* is 1½ inch in diameter, rods *B* being driven into it. Bracket *E* is also made of maple and is fastened to the table with two screws. Brackets *F* are made of cold-rolled steel and screwed to the board. As will be realized from the foregoing description, the whole outfit can be simply and easily made.

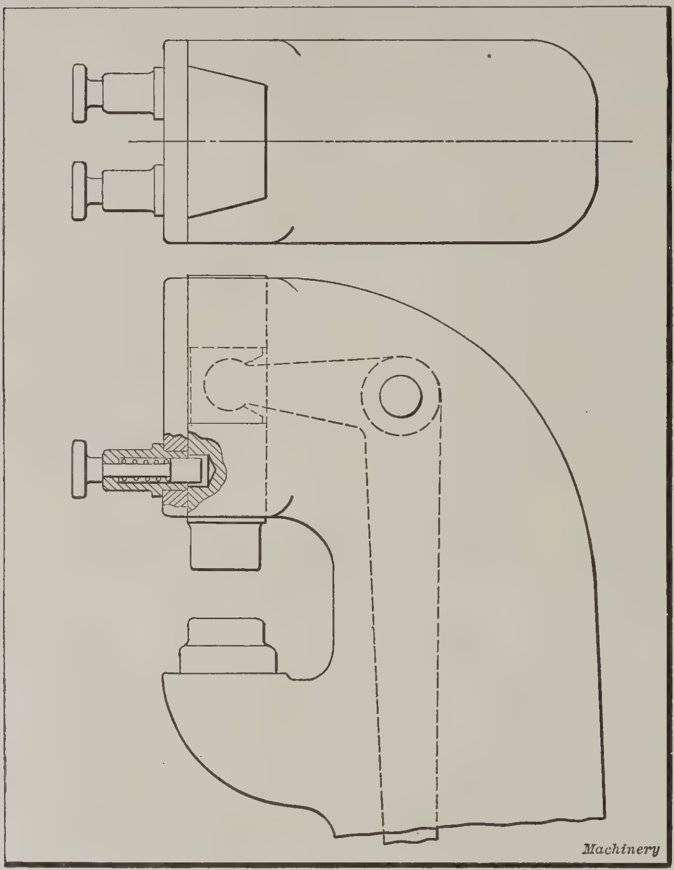


Arrangement for Clamping Tracings used for Reference to the Drawing Board

F. A.

SAFETY DEVICE FOR FOOT PRESS

In a certain shop where presses were operated by foot power, the girl operators constantly got their fingers trapped between the work and the punch. Whenever this happened, if blood was drawn, about one-half of the girls were inevitably rendered useless for some time; some even fainted at the sight. Hence, it became necessary to devise a safeguard. The simple scheme shown in the illustration was adopted.



A Safety Device for a Foot Press

Two spring plungers were used which remained in the holes in the ram until they were drawn out. As both hands were required for pulling out the plungers, it was no longer possible for the girls to have their fingers in the danger zone when the ram was depressed. As presses of this type are very common in shops doing a variety of light work, the scheme described may prove of service to others.

J. Sysmore

COMBINATION FOLDING AND CURLING DIE

The accompanying illustration Fig. 3 shows a combination folding and curling die used for making the rectangular box shown in Fig. 1, which is produced from 80- to 90-pound tin.

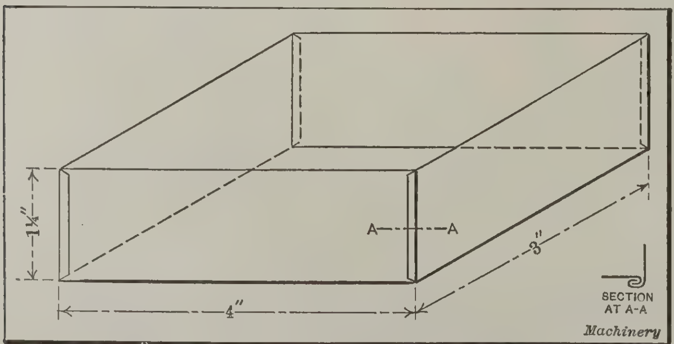


Fig. 1. The Box to be made and Section of Seam

At *A-A* is shown the section of the joint produced at the corners of the box. These corners are curled over nicely while passing through the die. The blank indicated by the lines *B* in Fig. 3 is located against the stop-pins *S* and is folded around a rectangular punch. As this punch descends the stock at the corners is slightly drawn and then follows through the narrow slit in the first section *E* of the die to the conical groove in the second section *F* where it is curled. The curled part is then flattened out in the lower section *G* of the die. The box is completed in one stroke of the die, the joints being made powder-tight. No additional trimming is required. The die can be made of machine steel with the exception of the curling blocks *D*, also shown in Fig. 2, which should be made of tool steel, hardened, and then inserted into the middle section of the die. Four curling blocks are required, two "rights" and two "lefts," of course. The blanks were cut in a previous operation, as it was more convenient than to use a large and cumbersome progressive action die.

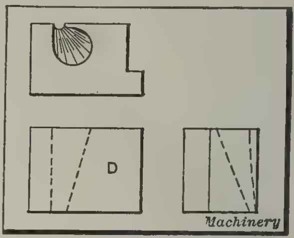


Fig. 2. The Curling Die

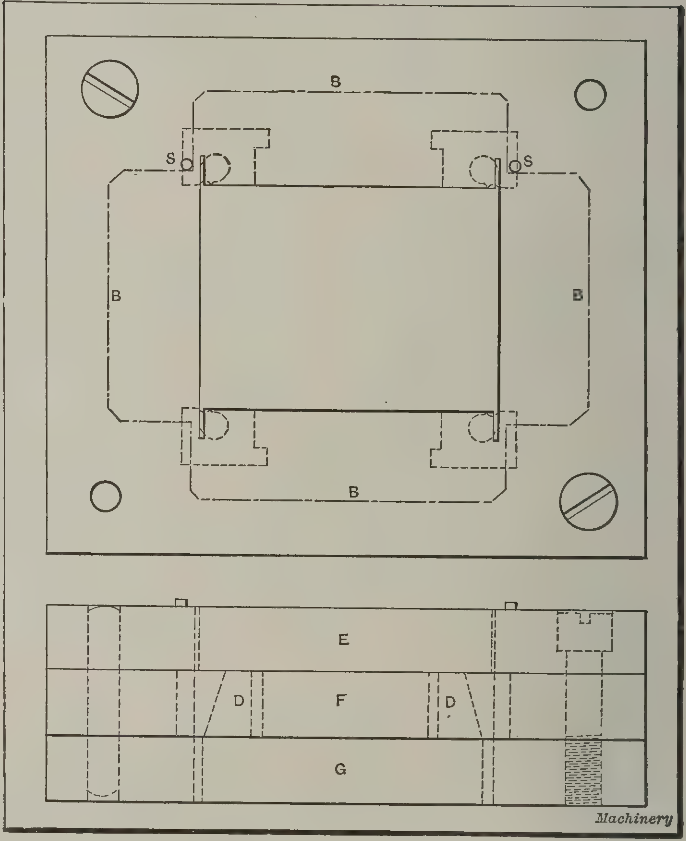


Fig. 3. General Design of Die

Columbus, Ohio. Otto R. Winter

CORRECT METHOD OF HANGING BLUEPRINTS AFTER WASHING

The writer has noticed that in most cases when blueprints have been washed, they are hung up so that they are as nearly level at the lower edge as possible. This method is not a good one, because when a print is hung so that the lower edge is practically level, the water will gravitate to this edge and hang there in globules, and the print will not be perfectly dry at this edge for hours; and in almost every case the edge is discolored.

The best way to hang blueprints for drying is to place them so that the lower edge is at an oblique angle with the horizontal; then the water will gravitate to the lowest corner. There will be no accumulation of water at other points, and the drying will be far more rapid than in the case when the sheet is hung level. This is a very small detail of drafting-room work, but it is of considerable consequence, both as regards time and the appearance of the blueprints.

St. Louis, Mo. C. H. Casebolt

* * *

A gib key should not be used to fasten a coupling on a shaft. If a key is used, it should be a headless key, or, still better, a feather.

ADVANTAGES OF N. M. T. B. A. MECHANICAL SECTION*

In order to state clearly how the National Machine Tool Builders' Association could be benefited by the formation of a mechanical section, it will be necessary to review briefly the history of the industry with relation to the forces that have been active in bringing it from obscure job shop methods, both as regards manufacturing aand selling, to the proud position of one of the largest manufacturing industries in the land. Judging from the number and character of machine tools of foreign make purchased prior to 1875, and still in use in some railway division shops, the machine tool industry of those days must certainly have been in its infancy. There are men still active or recently passed away who have been in touch with the industry during all the years since then, and who are responsible for the marvelous changes that have taken place. The story of their lives is the story of the development of the industry. Few of these men were distinguished as salesmen. Financiering and accounting in the modern sense were unknown to them, but they were able mechanics—master workmen of their day, possessed of almost egotistical pride in personal accomplishments in their line. Guarding jealously the product of their own brain, they for the most part respected the rights of competitors, whether registered in the patent office or not.

These men had their faults, it is true, growing out of conditions then existing. They traveled little, they never met their competitors face to face, and knew nothing of them except through their dealer, who visited the shops occasionally to place stock orders for the requirements of the next six months or year. It is, therefore, little wonder that a competitor was regarded as an enemy, incompetent and unscrupulous. These were the golden days for the dealer. Factory sales organizations were unknown, and selling costs were at a minimum. The manufacturer knew nothing of shop costs, and sale prices were made to harmonize with the sale prices of competitors, with the result that profits to those engaged in the industry were small in almost any line requiring high-grade effort.

Out of these conditions, bad as they were with relation to the commercial end of the business, came a mighty strength, for as early as 1893 all the nations of Europe had discovered that this country was producing metal working machinery superior to that which could be found elsewhere. Was it superior sales organizations that gave us almost exclusive control of this great market for the next ten years and established a reputation for American tools that still lingers in spite of later developments abroad?

As proof of this statement, it may be well to cite an incident touching this point. The author was present at an interview in the factory office between one of these peerless pioneer mechanics and a European purchasing agent, who was regarded as a joke, and whose proposal to sell quantities of the manufacturer's product abroad was almost turned down. This mechanical man simply could not understand why any one would wish to come all the way from Europe to purchase the product of his little shop. He was inclined to regard his visitor with suspicion.

Since that day the tremendous increase in the demand for metal working machinery both at home and abroad has been working a transformation in the management and ownership of the business. That this transformation is natural, logical, and inevitable, the author shall not attempt to dispute; but it carries with it dangers that must be guarded against. We must occasionally get back to first principles and not lose sight of the reason why Europeans first came to extensively purchase the product of our shops, with practically no solicitation. The familiar title, the old man or the boss, the master workman of yore, who worked at the drawing-board, bench, or desk, is now transformed to the title of "president" or "general manager", and his knowledge of shop conditions is gathered from a condensed record of costs prepared by an expert in his line, all of which is well and necessary, but which marks a distinct change in the relative importance of the commercial and mechanical departments.

Since the organization of the Machine Tool Builders' Association there has been a noticeable improvement in many directions, and all honor to those leaders who have been its promoters and ardent supporters. Competitors now meet on a basis of real friendship; but something has been lost in the passing of the old professional spirit and pride with reference to mechanical things that will ultimately work great injury. This mechanical spirit that once dominated all, is now dominated by the commercial end. And while the author does not expect that the mechanical end can ever be reinstated in its old position of supreme importance, when coping with a sales organization that reaches around the world, we must not lose sight of the fact that in order to be successful in the markets of the world we must be able to offer at all times the best and the most advanced design to be found anywhere. If this can, in a measure, be brought about, great benefit may come to the Machine Tool Builders' Association by the formation of a mechanical section.

It is more difficult in these days when all-around skilled help is at a premium, for the superintendent and foreman to get away from their work, than for any other set of men connected with the plant. However, this does not apply with the same force to men connected with the designing end of the business. Our trade papers are alert to secure and publish anything of general interest to shop men and designers, and nearly all connected with the industry depend largely on these papers for their information, but, of course, there are lacking the benefits that would come from the personal touch.

It would seem that the annual convention could be extended over five or six days, with the last two or three days given up entirely to subjects that would be of general interest and benefit to the builders and designers of machine tools; or in place of the longer session, a three days' session with meetings held by the different departments in separate rooms, would, perhaps, be preferable.

Another subject for discussion is the advisability of holding in New York, by the National Machine Tool Builders' Association, at stated intervals of five or more years, an exhibition of metal working machinery, restricting each exhibitor to one machine of a type, and permitting no machine to be exhibited that did not show noteworthy improvement over the machine shown by the same exhibitor at the previous exhibition. While this thing may not be practical, the author is convinced that if it could be worked successfully, it would not only be a stimulus in the design of new machines, but would be of great value to the sales end of the business, as it would be sure to be attended by buyers of machinery from all parts of the world.

The whole thought is this: We must first have machines, and then salesmen to introduce them, if we are to maintain ourselves in the foreign markets, as well as in the home markets, for our experience during the past year shows clearly whither we are tending as regards protection. Let us develop the highest grade of commercial spirit, and use if possible this same instrumentality to better our product, to the end that in a measure the professional mechanical spirit of yore be re-established, so that our foreign competitor, should he ever find his passage through the customs house unobstructed, will be greeted everywhere with the sign of the uplifted hand.

* Abstract of paper by E. J. Kearney, of the Kearney & Trecker Co., Milwaukee, Wis., read before the convention of the National Machine Tool Builders' Association, in New York City, October 17, 1912.

* * *

In a paper read before the Iron and Steel Institute, Great Britain, Mr. C. Chappell gave some interesting information relating to the influence of carbon on the corrodibility of iron. He stated that in rolled and annealed steels the corrodibility rises with the carbon content to a maximum at the saturation point (0.89 per cent carbon), and falls with a further increase of carbon. In hardened and tempered steel a continuous rise in corrodibility takes place with an increase of carbon up to a carbon content of 0.96 per cent. Quenching increases the corrodibility to a maximum, while annealing tends to reduce it to a minimum.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE MUELLER 18-INCH HEAVY-DUTY ENGINE LATHE

The Mueller Machine Tool Co., Cincinnati, O., has recently added to its line the 18-inch heavy-duty engine lathe illustrated in Fig. 1. This machine swings 18½ inches over the ways, 13¼ inches over the carriage, and takes work up to 2 feet 4½ inches between the centers.

The headstock is of massive construction and is ribbed and cross-ribbed to secure the maximum rigidity. The cone pulley has three steps of 9 1/4 inches, 11 3/16 inches and 13 5/32 inches diameter, and double belting 3 1/2 inches wide is used for driving, thus providing an abundance of power for the heaviest classes of service. The cone pulley is locked to or released from the face gear by a spring pull-pin.

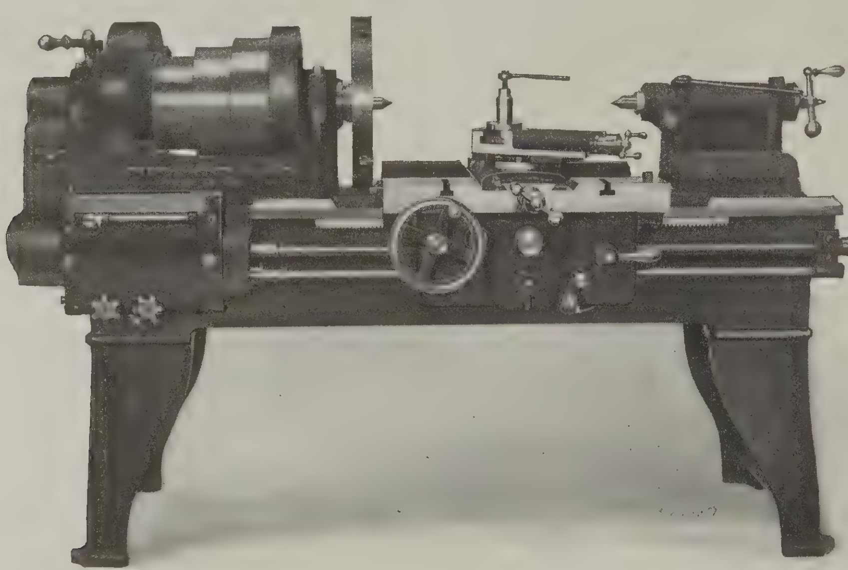


Fig. 1. The Mueller 18-inch Heavy-duty Engine Lathe

The tailstock is arranged with two plug clamps for locking the tailstock spindle without throwing it out of line. Both the headstock and tailstock are set off center, so that large diameters can be turned without having the bottom slide on the carriage overhang its bearings. The tailstock is clamped to the bed by means of two ¾-inch bolts; the tail spindle has a movement of 8¼ inches, and a bearing 2½ inches in diameter.

The work spindle is made of high-carbon crucible steel; it has a 1 9/16-inch hole through its entire length, and is fitted for a No. 4 Morse taper. The spindle boxes are of phosphor-bronze, bored and hand scraped to an accurate fit. The bearings are oiled through sight-feed oilers and felt pads which dip into a reservoir. The oil supplied to the bearings by this method is freed from all foreign matter, thus insuring perfect lubrication. The thrust collar is of hardened steel and the end motion is taken up by a nut at the end of the spindle. Nine spindle speeds are provided, ranging in geometrical progression from 13 to 300. The double back-gears on this machine are of the slip-gear type. A lever which is conveniently located at the front of the machine provides means for changing from low to high speed or *vice versa.* The back-gear ratios are 3½ to 1, and 10½ to 1.

This lathe will cut 45 thread pitches ranging from 2 to 60 per inch, including 11½ inch pipe thread. All changes are obtained within the quick change gear box. The ends of the shafts of the gear box and the reversing gears on the head are arranged to receive change-gears for special and metric thread cutting. All threads can be cut without the removal of a gear, and there is a chasing dial on the carriage for "catching" the threads. The turning feeds are positively geared, and are four times the thread feeds. They can be started, stopped or reversed in the apron or head, for either a cross or lateral feed motion, but only when the lead-screw nut is disengaged.

The carriage has exceptionally long bearings on the V's for its entire length. It has an adjustable taper gib the full length of its bearing against the rear side of the bed, thus eliminating the possibility of any twisting of the carriage while extra heavy cuts are being taken. A long shear wiper and oiler is fastened to each end of the carriage bearing on the shear; this arrangement automatically wipes the shear free from all dirt and chips, and oils it as the carriage moves along. The upper slide of the compound rest is bolted to the swivel base with four screws, which insures absolute rigidity.

The apron is of the rectangular box type, in which all the bearings for the gears and screws are cast integral with the apron itself. All gears are provided with bearings on both sides and the studs are of hardened and ground steel. The feeds are so arranged that only one feed can be in operation at a time. The lead-screw is 1 9/16 inch in diameter, and has a four pitch thread; it is only rotated when the lathe is engaged in screw cutting. The lead- and feed-screws for this lathe are cut from a master screw, thus insuring the greatest possible accuracy.

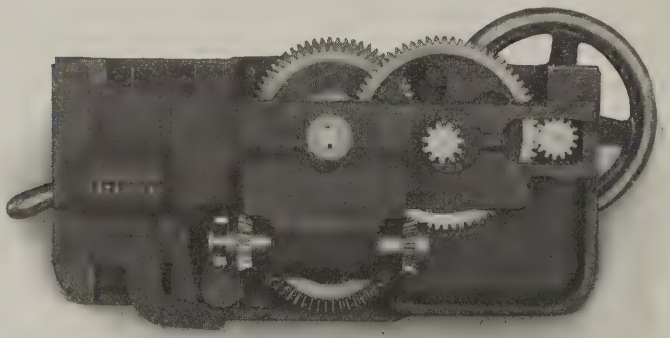


Fig. 2. Rear View of the Lathe Apron

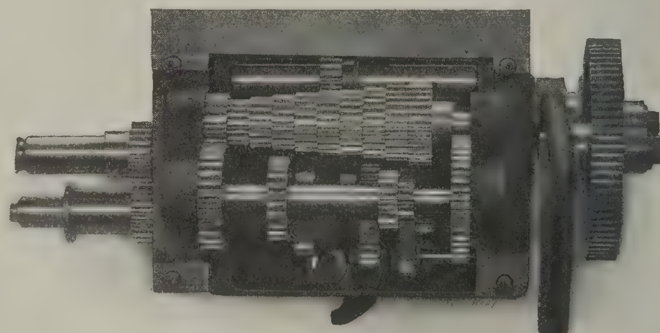


Fig. 3. Gear-box of the Mueller Lathe

The bed is designed with an unusual vertical depth and is firmly braced through its entire length with heavy cross girths, capable of absorbing the vibration of the heaviest cut. The rear bearing is flat. The countershaft has double friction pulleys, 14 inches in diameter. It is fitted with heavy bearings and hangers which insure rigidity and long life.

All gears in the quick change gear box are of steel and have chamfered teeth. Steel gears are also liberally distributed throughout the machine in all places where severe strains are encountered. The greatest care is taken in cutting all of

these gears in order to secure the maximum accuracy in the teeth and consequently smooth and noiseless operation. All gearing on the lathe is completely enclosed. The regular equipment consists of two faceplates for large and small stock, steady-rest, follow-rest, countershaft, and the necessary wrenches. The lathe can also be equipped with direct-connected motor drive and with a longer bed, when so required.

MILWAUKEE UPRIGHT DRILLING MACHINES

Two upright drilling machines built by the Richards Machine Co., 1129 Davis St., Milwaukee, Wis., are illustrated in Figs. 1 and 2. Fig. 1 shows the 20-inch machine equipped with back-gears, power feed and a combined wheel-and-lever feed. This machine can also be obtained without the back-gears and power feed, and with either a combined wheel-and-lever feed or a plain lever feed, as desired.

The chief feature of this machine is the method used in disengaging the power feed, when it is desired to use the wheel or lever feed. This device consists of an arm carrying the bevel gear, worm and worm shaft, which is operated by an eccentric for disengaging the bevel driving gears. In the illustration the lever for operating this eccentric is shown in the position it occupies when the power feed is being used. To disengage the power feed, this small lever is simply pulled towards the front of the machine.

There are eight changes of spindle speed and twenty-four changes of feed. The back-gears for the slow speed of the spindle are enclosed in the upper cone pulleys. Power for the automatic feed is obtained from the upper cone spindle, and

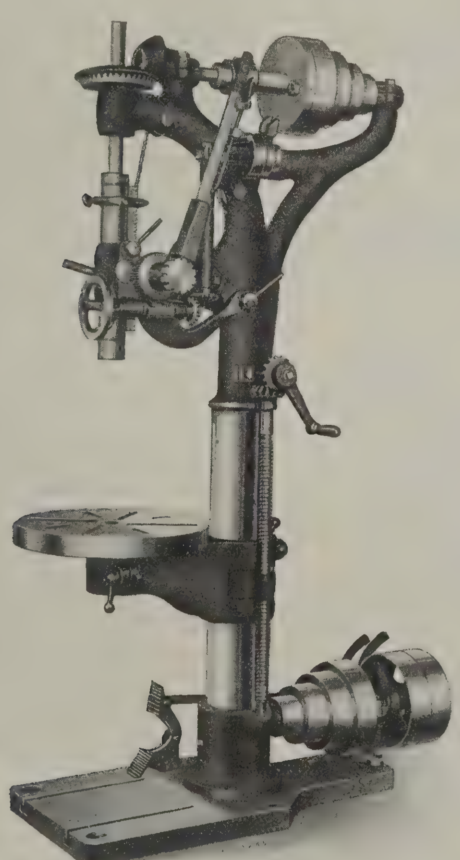


Fig. 1. Upright Drilling Machine built by Richards Machine Co.

is transmitted to the drill spindle by belt and the worm and bevel gearing shown.

The principal dimensions are as follows: Movement of drill spindle, 9 inches; greatest distance from end of spindle to base, 41 inches; greatest distance from end of spindle to table, 25 inches; height over-all, 69 inches; diameter of table, 17 inches; hole in spindle, No. 3 Morse taper. The machine will drill to the center of a 20-inch circle.

The upright drilling machine shown in Fig. 2 is provided with a sliding head, is back-geared, has positive feed and a number of interesting features not found in the other machine. Among these might be mentioned the gear-box for giving a positive feed to the spindle, and the device for effecting the feed changes. This device consists of two levers located directly below the gear-box, which operate a sliding gear for changing the rate of feed. These levers are properly located by a notched plate which they engage. By moving the lower lever up or down, three changes of feed are obtained, and by

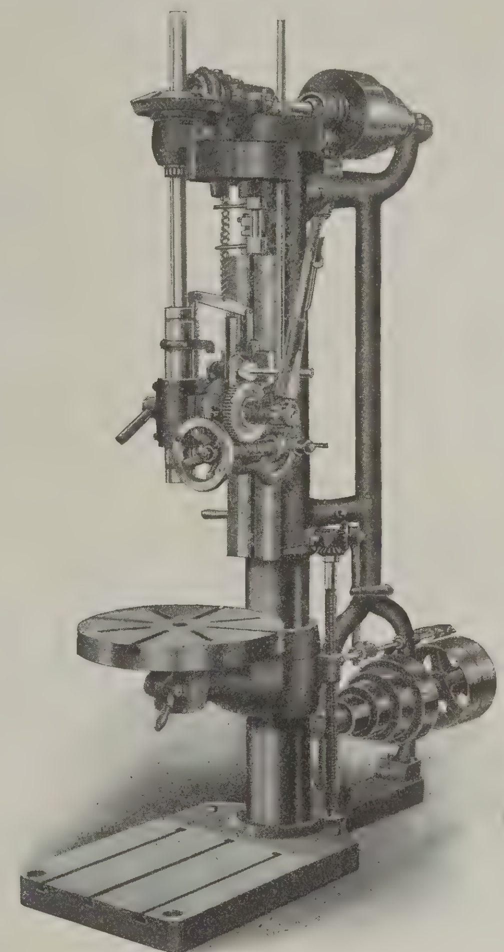


Fig. 2. Upright Drilling Machine of Sliding-head Type

shifting the upper lever into the "slow" or "fast" notch, six changes of feed are secured. With the top lever in the "slow" notch and the lower lever placed successively in the three notches, the feeds are: 0.003, 0.007 and 0.011 inch per revolution of the spindle. With the upper lever in the "fast" notch and the lower lever shifted to the three positions, the feeds are: 0.023, 0.060 and 0.095 inch per revolution of the spindle.

The back-gears are enclosed in the upper cone pulleys and are thus protected from dust and dirt. The principal dimensions of the machine shown in Fig. 2 are as follows: Movement of drill spindle, 10⅜ inches; movement of sliding head, 20 inches; greatest distance from spindle to base, 50 inches; least distance from spindle to base, 19 inches; greatest distance from table to spindle, 37 inches; diameter of table, 20 inches; height over-all, 84 inches; hole in spindle, No. 4 Morse taper; drilling capacity, to the center of a 24¾-inch circle. The weights of the machines shown in Figs. 1 and 2 are 600 and 1500 pounds, respectively.

CINCINNATI PRECISION LATHE WITH SCREW-CUTTING ATTACHMENT

The latest design of friction-driven bench lathe built by the Cincinnati Precision Lathe Co., Cincinnati, Ohio, is shown by the front and rear views, Figs. 1 and 2. This lathe has an improved friction drive and a slide-rest screw-cutting attachment. The difference between the friction-driving mechanism of this lathe and those formerly built is in the control and the construction of the driven disk. The latter,

instead of being a solid piece, is formed of two members which are separated by a series of coiled springs, thus forming a spring tension or "cushion" disk. These two parts are shown in detail in Fig. 3. In addition to springs, there are a number of steel guiding studs near the circumference of the disk and a large projecting hub in the center, all of which engage holes in the upper member. The guiding studs and hub are accurately fitted and there is also a bearing fit between the flange on the lower disk and the periphery of the upper disk, which insures a uniform tension at all points on the horizontal friction surface.

A further advantage claimed for this disk is that there is a very slight tendency of the horizontal friction plate to incline with relation to the driving shaft when the friction driving wheel is located outside of the center. This movement, while very slight, is just sufficient to release that part of the friction filler material which would otherwise bear against the outer and more rapidly moving surfaces on the driven disk. In this way the sliding action between the two surfaces, which is common to a rigid-disk friction drive, is obviated and the loss of friction material reduced. As the driving disk is applied on both sides of the driven disk center for obtaining forward and reverse speeds, the face or periphery of the driving disk wears uniformly or parallel to the friction driving shaft. As the driving disk approaches the center of the driven member, the spring tension increases slightly because the wheel comes directly under an increasing number of springs as it approaches the central and higher speed positions. In case a heavier spring tension is desired, the lower driving shaft can be raised by means of eccentric bushings provided.

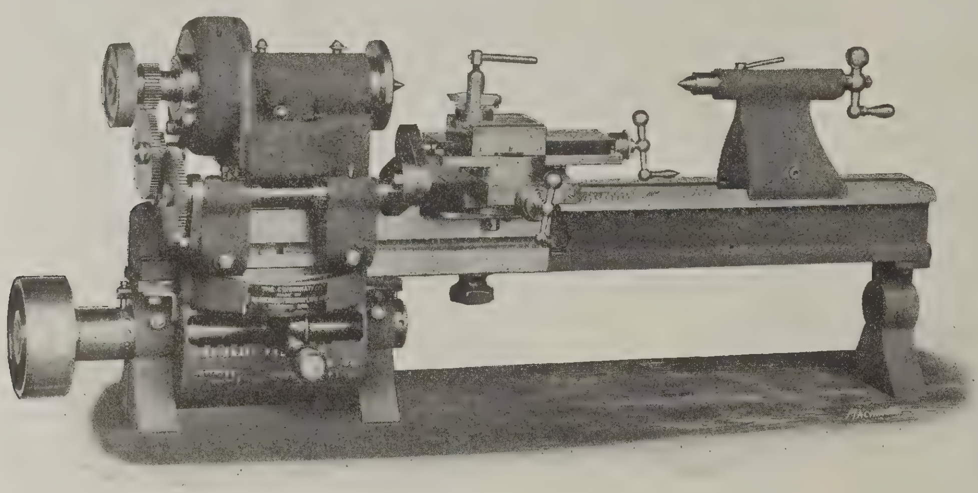


Fig. 1. Cincinnati Friction-driven Precision Lathe with Slide-rest Screw-cutting Attachment

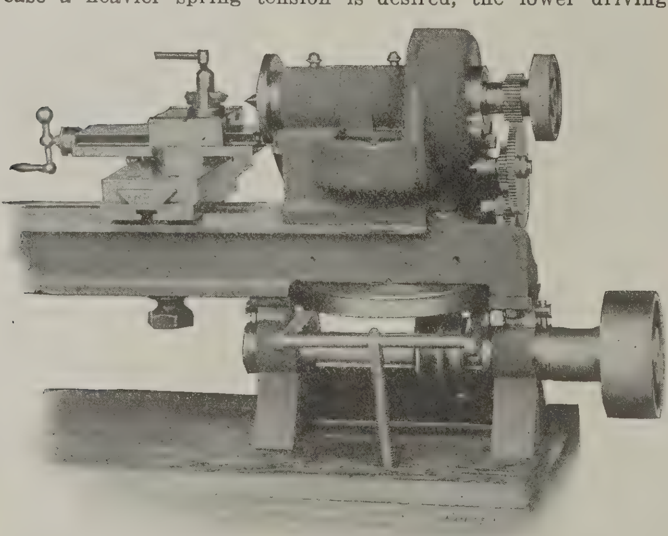


Fig. 2. Rear View of Headstock and Friction Drive, showing Foot-pedal Release

With the horizontal friction disk as the driven member, if the lathe should be overloaded and the frictions caused to slip, the driving disk would continue to revolve and the wear would be uniform instead of forming flat spots. It is claimed that the location of the driving pulley at the base and the use of the cushioned disk reduces vibration to a minimum. The friction hand-control lever for varying the speeds has a circular inner end which engages a recess or slot in the hub of the driving disk. The latter slides easily on the friction driving shaft and a longitudinal key inserted in the shaft, when the friction members are disengaged. The lower side of the control hand lever is so shaped as to readily drop into notches in the front gear cover, for retaining the friction driving wheel in any desired speed location on the driven disk.

Fig. 3. The Two Parts of the Spring-tension or Cushion Friction Disk

The rear view of the lathe head and friction drive shown in Fig. 2 illustrates the foot pedal release that is applied to this lathe. This releasing mechanism consists of two arms or levers, on the ends of which are bushed fiber rollers so arranged that when pressure is applied to the foot pedal the friction disk surface is raised, thereby disengaging the friction driving member. At the same time, the rollers act as a brake and stop the machine almost instantly. The forward or reverse speed changes can be quickly made, and, as the spindle can be stopped and started very quickly, threads can be cut close to a shoulder with safety. The spring seen between the bench and lever cross-arm is for holding the lifting levers away from the disk when the lathe is in motion. The foot pedal is pushed under a retaining step on the floor when the lathe is to remain stationary.

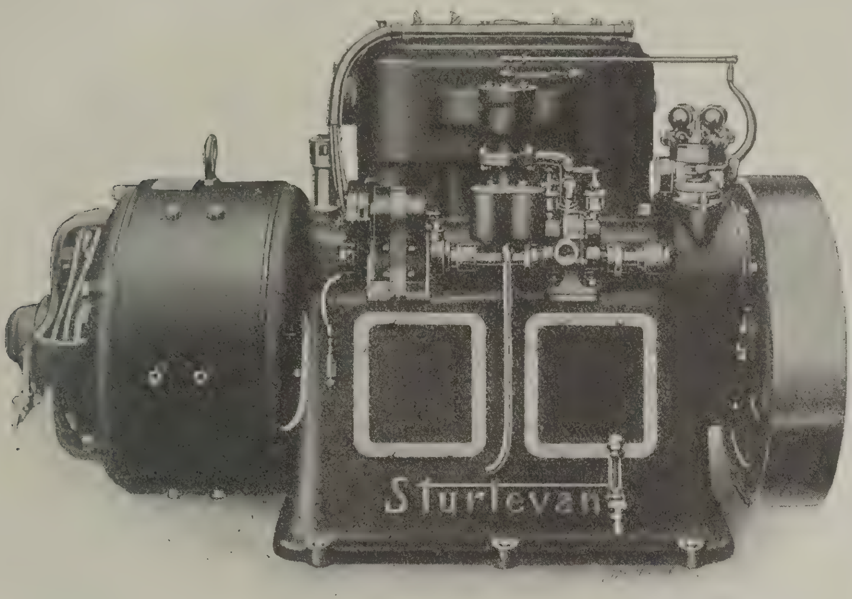
STURTEVANT GASOLINE-ELECTRIC GENERATING SETS

The B. F. Sturtevant Co., Hyde Park, Mass., is now building gasoline-electric generating sets designed to supply the demand for units that will be easy and inexpensive to operate, in places where electric power is not available. These sets are intended to be used in direct connection with lighting and power circuits and not through a storage battery, although they can be so arranged if desired. The design, workmanship and efficient governor control are said to insure constant voltage through wide variations of load, so that the use of a storage battery to equalize fluctuations of voltage is not necessary.

These generating sets are built in three sizes of five, ten and fifteen kilowatts capacity, capable of lighting 200, 400 or 600 twenty-candlepower tungsten lamps, respectively. The five-kilowatt size is illustrated herewith. These sets consist of a Sturtevant gasoline engine directly connected to a Sturtevant direct-current electric generator. The engine is of the four-cycle, water-cooled, vertical type, having either four or six cylinders, according to the size of the unit. The bore of the cylinders used in the ten and fifteen kilowatt sizes is 4 inches, and the stroke 6 inches, whereas the five-kilowatt engine has a 3¼-inch bore and a 5-inch stroke. The cylinders

of the two larger sizes are cast in pairs and have T-shaped heads with inlet valves on one side and exhaust valves on the other. The cylinders of the five-kilowatt engine are cast *en bloc* with inlet and exhaust valves on the same side. In both cases the water jackets are integral.

The cylinders are accurately bored and ground to size, and provision is made for the easy removal of the valves for inspection or regrinding. The pistons have four rings and the piston pins are of large diameter and are made of hardened steel. Both the piston and pin are accurately ground and finished. The connecting-rods are exceptionally long, of I-section and are drop-forged from high-grade steel. The inlet and exhaust valves are of nickel steel. The valves for the ten and fifteen kilowatt units are operated by two camshafts, whereas one camshaft is used on the five-kilowatt size. The cams are integral with their shafts and are hardened and ground to the proper shape. The engine bases of the ten and fifteen kilowatt sets are made of two castings, split horizontally on the center line with the crankshaft bearings. A single casting is used for the base of the five-kilowatt unit and the generator is attached directly to the engine base, as the illustration shows. A separate sub-base for the engine and generator is provided on the larger sizes.



Sturtevant Five-kilowatt Gasoline-electric Generating Set

The crankshaft is made of 3½ per cent nickel steel which is of exceptionally high tensile strength and has undergone careful heat-treatment. All pins and journals are accurately ground. The most improved system of forced lubrication is used, the oil being furnished to all bearings under a pressure of 20 pounds, by means of a gear pump located in the engine base. The oil enters the main bearings and flows through the crankshaft (which is drilled for that purpose) to the crankpins, whence it passes up the connecting-rods to the piston pins. The oil spray thrown off by the centrifugal action of the crankshaft covers the piston and cylinder walls. When the oil falls back into the base it passes through a filter before being used again.

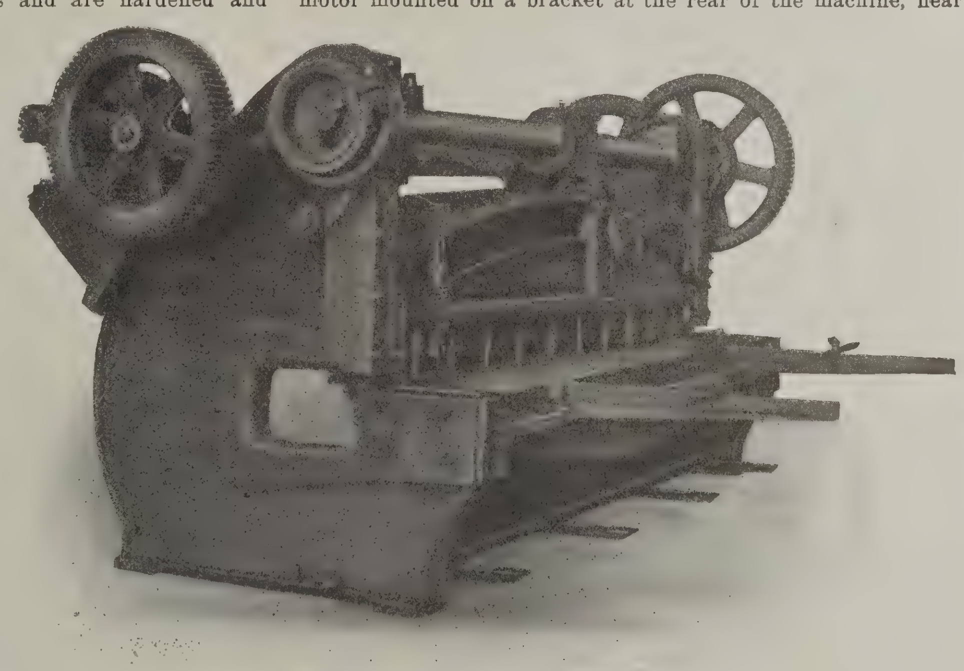
The engine is controlled by a throttling governor of the centrifugal type, operated through bevel gears from the end of the crankshaft. The motion of the governor is transmitted to a throttle valve placed in the inlet manifold. This governor is said to regulate the speed of the engine so accurately between no load and full load, that the voltage variations due to sudden changes in the load are imperceptible and no storage battery is necessary to maintain a constant voltage. The engine is equipped with a high-tension Bosch magneto, which is mounted on the base and is operated from the camshaft. The same type of generator that has been used in connection with Sturtevant steam engines of the U. S. Navy and merchant marine, is used for these gasoline power units. The generator is designed to require a minimum amount of attention. Both the engine and generator are capable of operating under an overload of 25 per cent for two hours.

NIAGARA MOTOR-DRIVEN PLATE SHEAR

A plate gap-shear recently designed and built by the Niagara Machine & Tool Works, Buffalo, N. Y., is shown herewith. This machine has the convenient means for adjusting the bed, crosshead and gibs, common to all large shears built by this company. The motion is controlled by a positive clutch which can be operated by a foot treadle, and the machine stops automatically when the crosshead reaches the highest position. The "hold-down" is raised and lowered by two cams, keyed to opposite ends of the crankshaft. The latter is forged from high-carbon steel.

The arrangement for adjusting the back gage attached to the cutter-bar is a new feature. This gage can be quickly adjusted by the operator, when he stands in front of the machine, by means of the handwheel seen in the center of the shear. The motion is transmitted to the gage by shafting, bevel gears and feed-screws at the rear. The gage always remains in a position parallel to the knives.

This shear is driven by a direct-connected, 15-horsepower motor mounted on a bracket at the rear of the machine, near the gearing seen to the extreme left in the illustration. It has a cutting length of 126 inches and will cut soft steel up to ¼ inch thick. The weight of the shear is about 22,000 pounds.



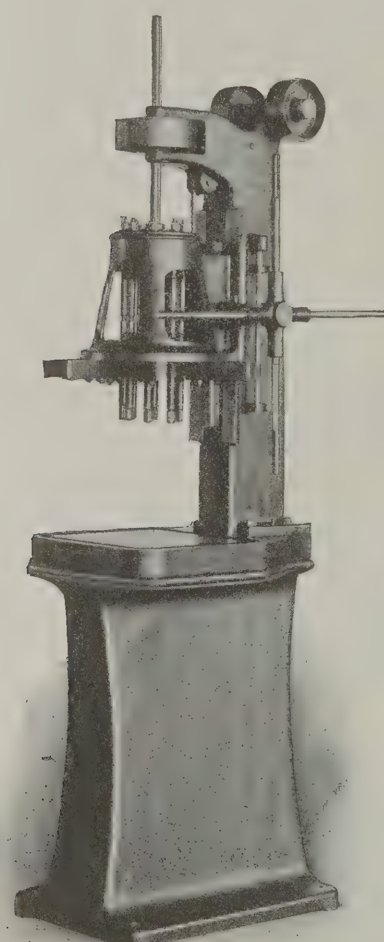
Niagara Motor-driven Plate Shear

THE NATCO NO. 9 MULTIPLE DRILLER

The National Automatic Tool Co., Richmond, Ind., has added to its line of multiple drillers, a smaller machine which in-

cludes a number of new features in its design. This machine is known as the Natco No. 9, Type D, and has been designed with a view of replacing multiple spindle drill fixtures which are not only entirely special, but which require a large drilling machine to drive them. This machine can be arranged for either bench or floor use, as it is made with a separate base upon which the machine is mounted for service as a floor drill. The illustration shows the machine set up in this manner, while for use on a bench, it would, of course, be taken from the base.

The method of indépendently changing the spindle speeds in use on the other multiple drillers made by this company is not used on the present machine, as the maximum size of drills for which it is intended is ¼ inch. The head feeds down to the work by means of a capstan operating a rack and pinion; the head has a bearing 11½ inches in width and a maximum travel of 12 inches. It is counterbalanced by means of a chain and weight, and is provided with adjustable stops for drilling holes to a specified depth. Adjustable gibs provide means to take up any wear that may develop, and the machine has a maximum capacity for a circle 8⅜ inches in diameter.



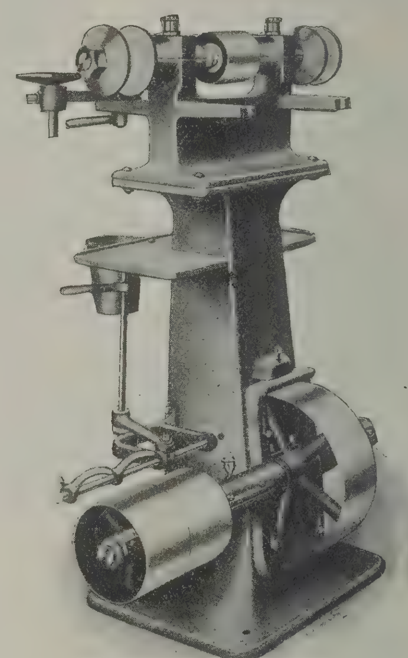
The National Automatic Tool Co.'s No. 9 Multiple Drilling Machine

The same rail and joint construction is used on this machine as on the larger sizes of multiple drillers built by this company. The rails are made of steel and have a bearing of 4 inches for the spindle. They are provided with ball thrust bearings, means of adjusting for wear and ample oiling facilities. Two sizes of rails are used which are known as the No. 1 and No. 2 size. The largest drill for the No. 1 size is 3/16 inch, with minimum centers 21/32 inch; for the No. 2 rail, the largest drill used is 1/4 inch, with minimum centers 25/32. If closer centers are desired, special rails can be furnished. The rails are easily changed from one layout to another. The base has a working surface 14½ inches square, and the surface over the oil groove is 17¼ by 18¼ inches. The maximum distance from the end of the spindle to the base is 15 inches, and the minimum distance 3 inches.

This machine can also be equipped with cluster boxes in which all of the spindles are permanently located. With a cluster box equipment, it is possible to drill a larger number of holes than with the rails, the number depending upon the material to be drilled and the size of the holes. The use of these cluster boxes saves the time occupied in changing rails from one layout to another and any number of cluster boxes can be used on a given machine, as all boxes are made interchangeable. The advantages of the cluster boxes for strictly interchangeable manufacturing are apparent. The illustration shows the machine equipped for belt drive, but individual motor drive can be furnished if so desired.

ST. LOUIS GRINDER

The grinder shown in the illustration is an improved design now being built by the St. Louis Machine Tool Co., 1209 Gratiot St., St. Louis, Mo. The countershaft of this grinder is carried by a frame that is attached to the column by accurately milled square gibs. With this construction, the countershaft is kept in accurate alignment and the tension of the belt can easily be varied by simply raising or lowering the frame, a suitable adjusting screw being provided for that purpose. By driving the spindle from below, the wheels run smoothly, as the pull of the belt is downward against the rigid body of the machine.

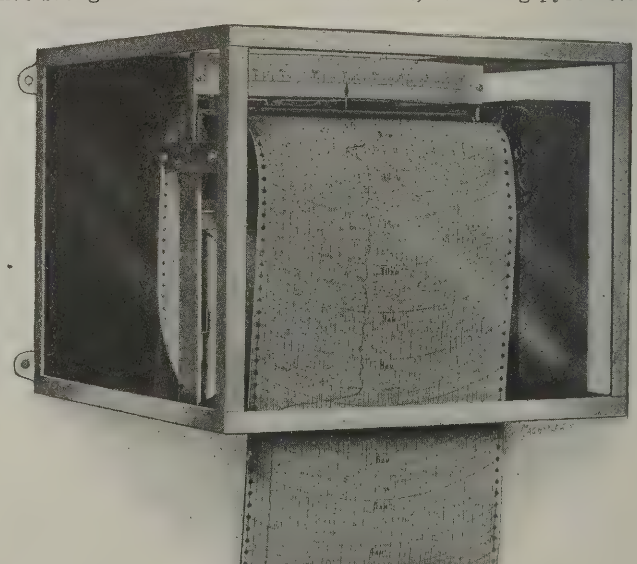


Rear View of St Louis Grinder showing Method of Attaching Countershaft

The spindle of this grinder is made of 0.40 per cent carbon steel. The boxes are dust-proof and the rests are of an improved design requiring a shorter bracket than the straight type. As the illustration shows, the machine is also equipped with back-rests for attaching wheel guaras or fixtures. The wheel guard is a simple and effective design consisting of a steel channel rolled to a segment of a circle and reinforced by a heavy cast-iron bracket riveted to the inside flange. This bracket is attached to the back-rest by a bolt which slides in the slot, thus allowing the guard to be adjusted backward as the wheel wears. The lips of the guard can be kept close to the wheel where they are not in the operator's way. These grinders are made in six sizes.

CONTINUOUS-CHART RECORDING PYROMETER

The Brown Instrument Co., of Philadelphia, Pa., and its associate company, the Keystone Electrical Instrument Co., have brought out a new continuous-chart, recording pyrometer.



Continuous-chart Recording Instrument for Indicating Temperatures, Volts, Amperes, etc.

This instrument is designed more particularly for use as a pyrometer, but can also be employed for indicating volts, amperes, revolutions per minute, mechanical operations, etc.,

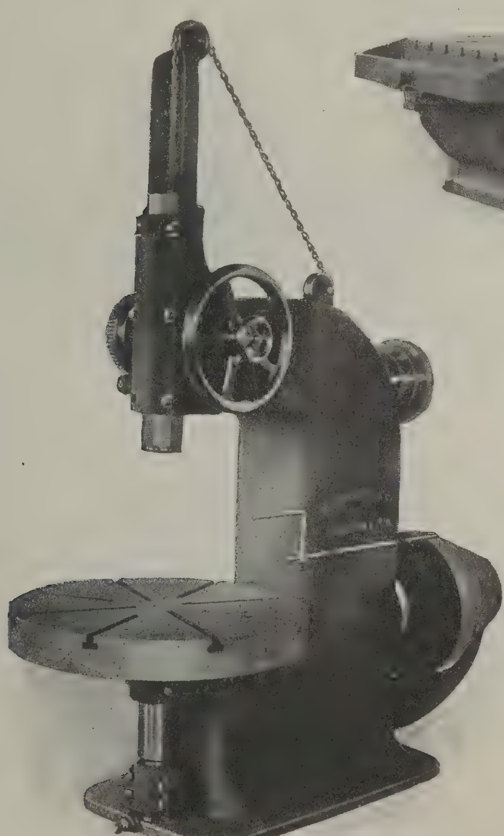
where a small current of electricity is required to operate a recording instrument.

The construction of this instrument is simple, and the works are enclosed in a plate-glass case. It is of the frictionless type, the pen forming a line by making single dots of ink on the paper at short intervals of ten seconds or a minute, as desired. These dots practically form a continuous line. The instrument carries a roll of recording paper which will last six months. This paper travels a little over an inch an hour, so that it is not necessary to change the charts daily and a continuous record can be secured.

BICKFORD VERTICAL CHUCKING MACHINE

The vertical chucking machine shown in the accompanying engraving has been designed to supply the demand for a low-priced tool for boring car wheels, gears, pulleys, and similar work. The tool-slide of this machine is octagonal in shape and is counterbalanced. The spindle feed is operated through a large friction worm-gear on the left side of the head, which runs in oil. This worm-gear is driven through a geared feed-shaft connecting with the main driving shaft by the four-step feed cones seen at the rear, which gives four changes of feed. A large handwheel is provided for hand adjustment and a quick-return movement, and the friction feed is engaged by means of a small handwheel in the center of the large wheel.

The table is driven through heavy bevel gears and it has a large spindle fitted with adjustable boxes. The weight of the table and work is taken by a hardened and ground steel step which is submerged in oil and is adjustable. The frame of the machine is very rigid. The driving shaft is mounted in three long bearings and the outer end is supported by a heavy arm attached to the frame. This machine can be equipped with detachable chuck jaws or a special chuck table. The swing is 37 inches, and the total movement of the spindle, 29⅛ inches. It is built by H. Bickford & Co., Lakeport, N. H.



Bickford Vertical Chucking Machine

INGERSOLL MILLING MACHINE

The Ingersoll Milling Machine Co., Rockford, Ill., recently installed the large five-head, six-spindle horizontal milling machine shown in Fig. 1, in one of the largest tractor plants in this country. This machine is used for milling forty and sixty horsepower tractor engine frames, as indicated in Fig. 2. These frames are finished complete on this machine and five cutters operate simultaneously. The largest of these cutters has a diameter of 36 inches.

The bed and table of the machine are of the conventional planer-type construction, and the wings upon which the housings are mounted are cast integral with the bed. The housings and cross-rail are also made in one piece, and because of this feature, the machine is known as the "fixed rail" type. The casting forming the housings and cross-rail, is very large and heavy, as the illustration indicates. The face or bearing for the saddles is 21 inches wide and the housings are 36 inches deep. The distance from the top of the table to the under side of the rail is 42 inches.

As previously mentioned, the machine has five heads, three of which are horizontal and two vertical. One of the horizontal heads is mounted on the left-hand housing, and on the right-hand side there is a main head carrying an auxiliary head and also an extra spindle which passes through the main spindle. The horizontal heads on both sides are counterbalanced and can be moved simultaneously or independently.

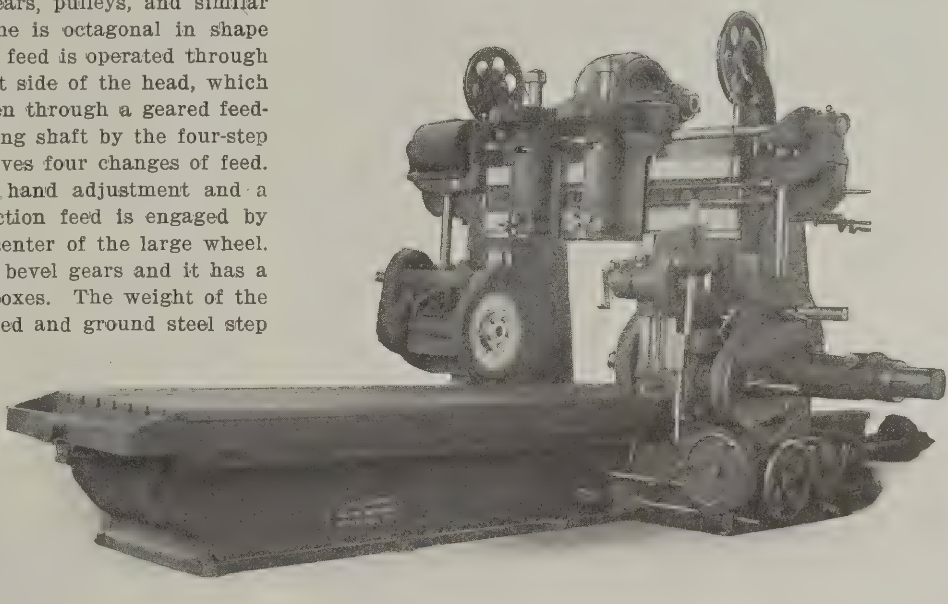


Fig. 1. Ingersoll Five-head, Six-spindle Milling Machine

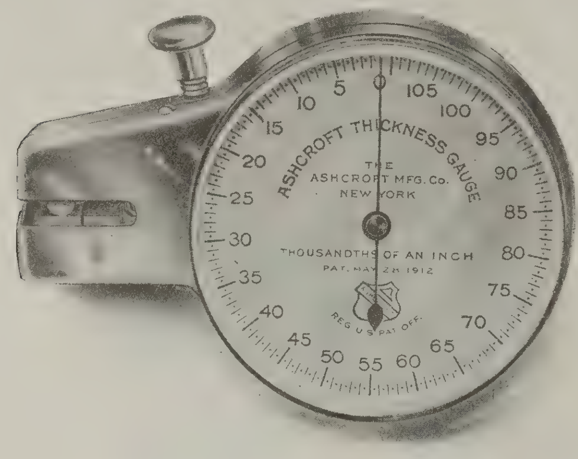
The right-hand horizontal head is the most massive, as the illustration shows. Its main spindle is of the faceplate-drive type and is arranged to carry cutters varying from 24 to 36 inches in diameter. The spindle which passes through this main spindle, is used for driving small cutters. It is 4½ inches in diameter and has an in-and-out adjustment of 18 inches. The auxiliary head or saddle is in front of the main spindle and also has a 4½-inch spindle which runs in a sleeve or quill 6⅛ inches in diameter. The spindle has an in-and-out hand adjustment of 6 inches, and the saddle itself has a vertical adjustment of 18 inches on the main saddle.

Fig. 2. Ingersoll Machine Milling Tractor Engine Frames

The left-hand horizontal head is also of the faceplate-drive type, cutters of large diameter being bolted directly to the spindle driving gear. The vertical spindles are 4½ inches in diameter. The drive is a 40 H. P. direct-connected motor.

ASHCROFT THICKNESS GAGE FOR SHEET MATERIALS

The Ashcroft thickness gage shown in the illustration is a convenient and accurate instrument for quickly measuring the thickness of sheet metal, sheet rubber, leather, paper, boxboard or any sheet material not exceeding 0.110 inch in thickness. It is of a convenient size to be held in the hands, and the material to be measured is inserted between the jaws which are opened by pressing a push-button with the finger.



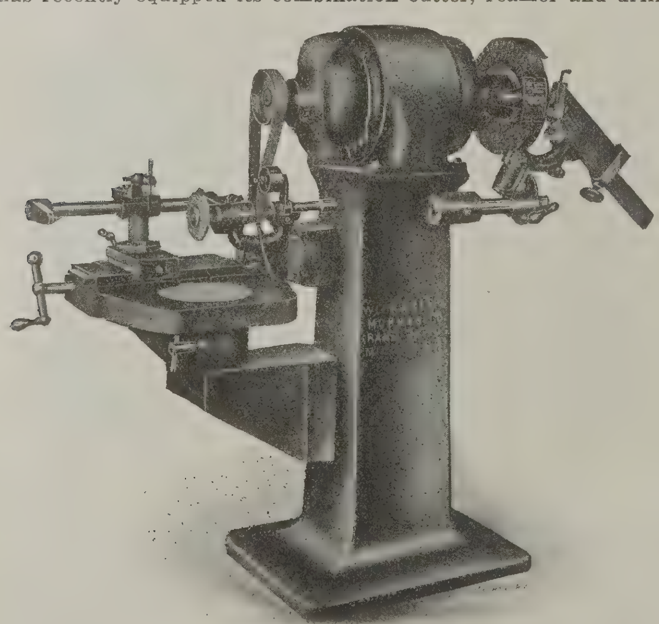
Ashcroft Thickness Gage for Sheet Materials

When pressure on the push-button is released, the jaws automatically close and the thickness of the material is indicated on the dial.

The white enamelled dial is easy to read, as the graduations stand out distinctly. The dashes represent thousandths, the dots one-half thousandths, and the points equidistant between the dots and dashes, one-quarter thousandths of an inch. The gage has no sliding parts, the movement being mounted on steel pivots. Friction and wear are thus reduced to a minimum. This gage can be carried in the vest pocket, if desired, and, with proper care, will last for years. It has been placed on the market by the Ashcroft Mfg. Co., 85 Liberty St., New York. The price of the instrument is $10.

WILMARTH & MORMAN MOTOR-DRIVEN CUTTER, REAMER AND DRILL GRINDER

Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has recently equipped its combination cutter, reamer and drill



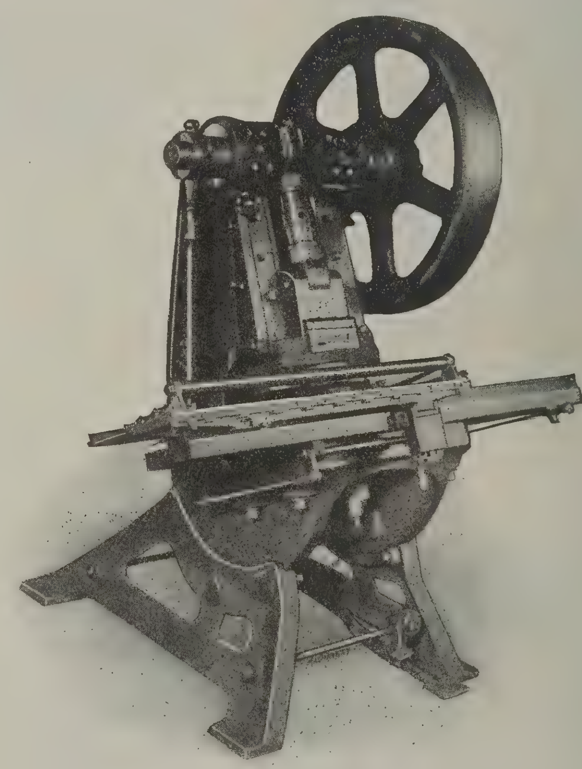
Wilmarth & Morman Motor-driven Combination Cutter, Reamer and Drill Grinder

grinder with a direct connected motor drive. The motor on this machine is one horsepower, and is made by the General Electric Co. to meet the special requirements of the present class of work. The controller for the motor is mounted on the column of the machine, and the power switch is located directly beneath the controller. The table and its slide are mounted on a knee, as shown in the illustration, so that it is possible to swivel the table around to enable grinding to be done on either side of a plain wheel, or to provide for the use of a cup-wheel.

The machine will grind face and side milling cutters up to 12 inches in diameter, straight or taper reamers up to 17 inches in length with flutes not over 11½ inches, angle milling cutters of any angle up to 8 inches, plain milling cutters of any type up to 8 inches, gear cutters up to 5½ inches, hobs up to 5½ inches, forming cutters of any length up to 5½ inches in diameter, and flutes of taps up to 11½ inches in length. The machine will take cylindrical or taper work up to 7¼ inches in diameter and 11½ inches in length. It has a maximum distance between centers of 17 inches, and a capacity for internal grinding up to 4 inches in depth by 10½ inch swing. The drill grinding attachment is the regular new Yankee non-calipering type, which provides for simply dropping the drill in the holder and grinding it. The capacity for drill grinding runs from No. 60 to ⅝ inch, from 3/32 to 1¼ inch, or from ⅛ inch to 2¼ inches.

STAGGER FEED SPACING TABLE FOR BLISS PRESSES

The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has recently developed and patented a stagger-feed spacing table for use in connection with inclinable single-crank and three-



Bliss Inclinable Press equipped with Stagger-feed Spacing Table

crank, double-action presses. This attachment is adapted for rapid, accurate feeding of decorated stock for bottle caps, covers, and similar work.

The table is moved by the operator after each stroke of the press and is locked by a cam-actuated stop which engages a rack on the table. The table is a light aluminum casting mounted on rollers. This construction allows the operator to cut an entire row of blanks without stopping the press. A handle bar is provided which is used to move the table and also, through eccentric pivots, to control the grippers. The sheet is first placed between the guides on the table and rests on a pair of preliminary stops which locate it for cutting the first row. A twist of the handle bar then closes the grippers, the preliminary stops are lifted clear by a knob at the right and the first row is cut. Subsequent rows are gaged by al-

lowing the sheet to drop against a straightedge at the back. All the operator has to do is to open the grippers, allow the sheet to fall, and close the grippers again.

A pair of scrap cutting dies is used to trim the sheet so that new gage points are made as each row is cut. The scrap is cut into small pieces, and scrap cutters are usually mounted on the same block as the die, to facilitate setting. The table is designed to handle standard sheets 20 inches wide by 28 inches long, and adjustment is provided to take sheets up to 30 inches long. The spacing rack for gaging is clamped over a T-slot and can be removed readily and different spacing racks attached. The speed of the press can range from 120 to 150 strokes per minute, depending on the size and character of the work.

THE CINCINNATI 36-INCH FROG AND SWITCH PLANER

The Cincinnati Planer Co., Cincinnati, O., has recently added to its line the 36-inch frog and switch planer illustrated in Figs. 1, 2 and 3. This machine has been constructed along lines which give it ample strength and rigidity for the heaviest classes of work. The bed is of the modern deep pattern, braced throughout by box girders, and is made with four

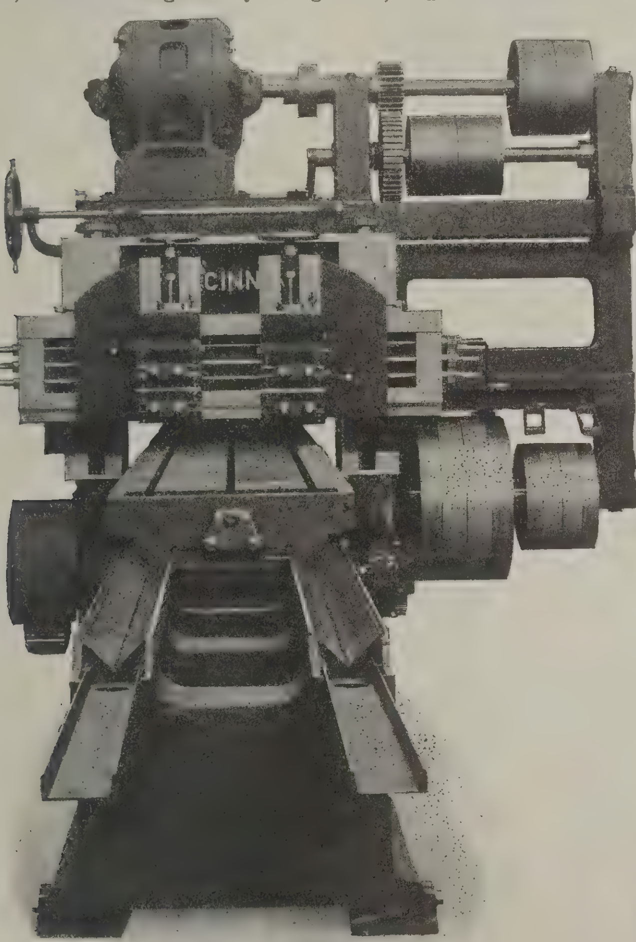


Fig. 1. Front View of Cincinnati 36-inch Frog and Switch Planer

walls between the housings where the greatest strain is developed. The vees are extra wide and are oiled by a forced lubrication system which maintains a film of oil between the table and bed at all times. The table is 32 inches in width, and has an inside bearing on the bed for its entire length, thus overcoming the pressure of heavy side cuts. Adjustable side gibs are provided on each side to prevent the table from lifting. The housings, which are of box form, have a 10-inch face and extend down to the floor. They are secured to the bed by bolts and dowel pins, and a tongue and groove 1½ inch deep by 5 inches wide. The cross-rail is 20 inches wide and has a deep ribbed box brace on the back to provide increased stiffness. In addition to the usual outside set of clamps, it is secured to the housings by an extra set of clamps on the inside; this design provides a very rigid form of construction. If desired, the cross-rail can be fastened to the housings by large dowel pins at various fixed heights. The rail screw has two long nuts in the saddle, thus reducing the strain on the threads when taking heavy side cuts and also insuring long life for both the screw and nut. The heads have automatic cross and vertical feeds, and are made right and

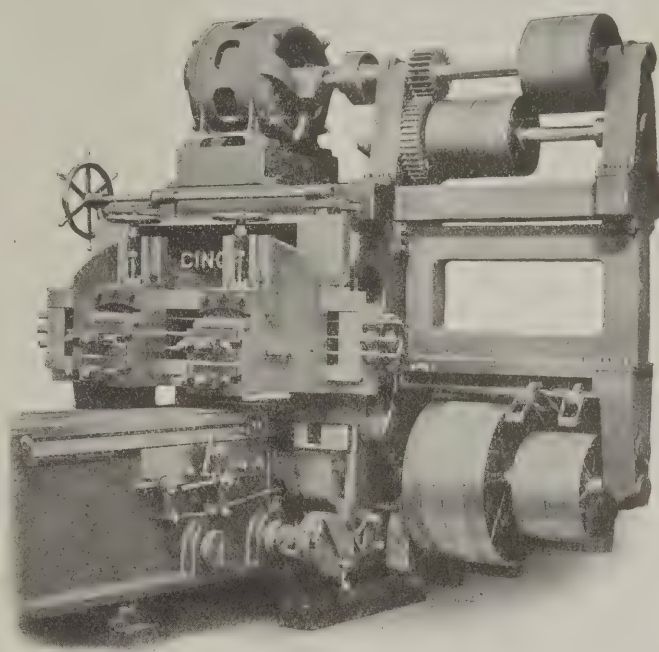


Fig. 2. Operating Side of Cincinnati Planer

left to bring them close together. The saddle and harp are made in one piece, without a swivel, and have a bearing of 25 inches on the rail. The countershaft is mounted on top of the housings and is driven by a 50 H. P. motor as shown, thus making the machine self-contained. A heavy cast-iron frame is fitted between the upper and lower bearings, and is

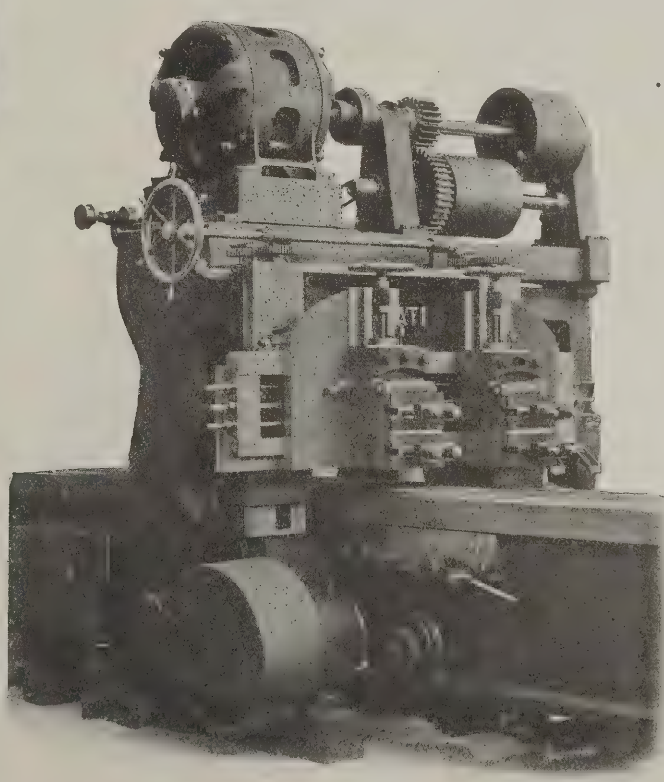


Fig. 3. Another View of Frog and Switch Planer

also fastened to the housings so that there can be no spring in the shafts or bearings when the machine is working on the heaviest cuts. The driving pulleys are 34 inches in diameter and are made of aluminum alloy, thus providing for a quick reverse on short strokes. The four-belt drive used on this planer provides ample power for the heaviest classes of work, and the shifting mechanism is provided with a safety locking de-

vice which prevents the table from starting, except at the will of the operator. Levers are so arranged that the machine can be operated from either side. The driving shafts are of unusually large diameter; they are made of special crucible steel. They are accurately ground and run in long bearings which are fitted solidly into the bed. The driving pulleys are so constructed that they only require oiling once in sixty days. The rack and gearing are made of solid crucible steel, to enable them to withstand heavy strains incident to frog and switch work; the bull wheel and rack are 12 inches in width and 1½ diametral pitch.

BLAKE & JOHNSON GANG SLITTING MACHINE

The Blake & Johnson Co., Waterbury, Conn., has brought out an improved gang slitter for cutting steel or other metals into strips. This machine, which is illustrated in Figs. 1 and 2, is so designed that the cutters can be changed in a minimum of time. The upper arbor is hinged on an intermediate shaft and is adjustable to or from the lower arbor, on an arc rather than a straight line. As the driven gear on the upper arbor revolves about the center of the driving gear, both gears remain in mesh regardless of the upper arbor's position. With this arrangement, it makes no difference whether the cutters have a diameter of 5¼ inches, as when new, or are reduced to the minimum diameter of 4½ inches, because the adjustment for changes in diameter can be made without introducing lost motion in the driving gears. The upper arbor is driven by a bronze gear on the intermediate shaft, which is in mesh with the steel gear on the lower arbor.

In order to change the gangs of cutters for slitting different widths, it is only necessary to remove two cap-screws at the foot of the outboard housing, slide the housing clear of the arbor ends, release a lock-pin and adjusting screw and swing the upper arbor up and away from the lower one (see Fig. 2). The ease with which cutters can be changed will be appreciated where different widths of stock are required.

The machine is driven by a sensitive clutch pulley, the clutch of which can be operated either from the front or rear of the machine, or from a considerable distance by means of a suitable rope connection. The clutch pulley is 16 inches in diameter and has a 4-inch face, and the power is transmitted through back-gears having a ratio of 4.2 to 1. All the bearings of the machine are bronze-bushed and the arbors are made of crucible steel. This slitter has a capacity for stock up to 6 inches wide and is especially adapted for slitting steel

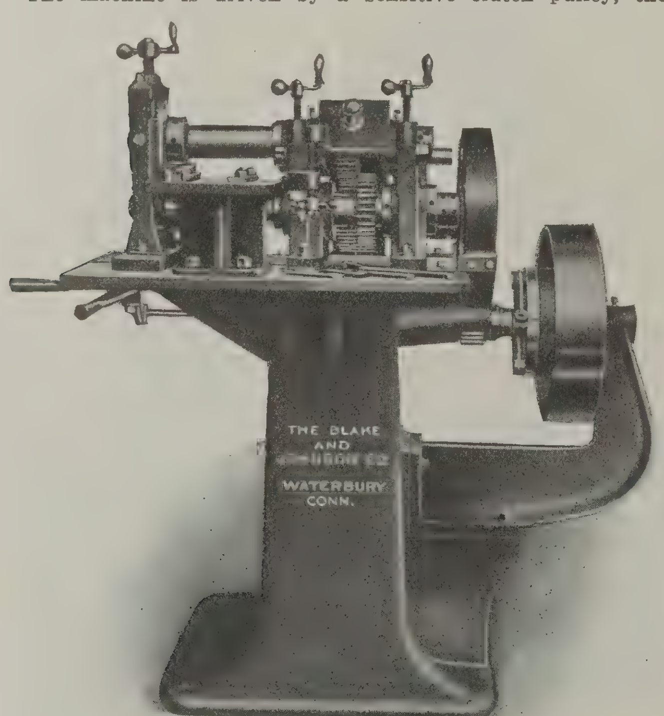


Fig. 1. Blake & Johnson Gang Slitting Machine

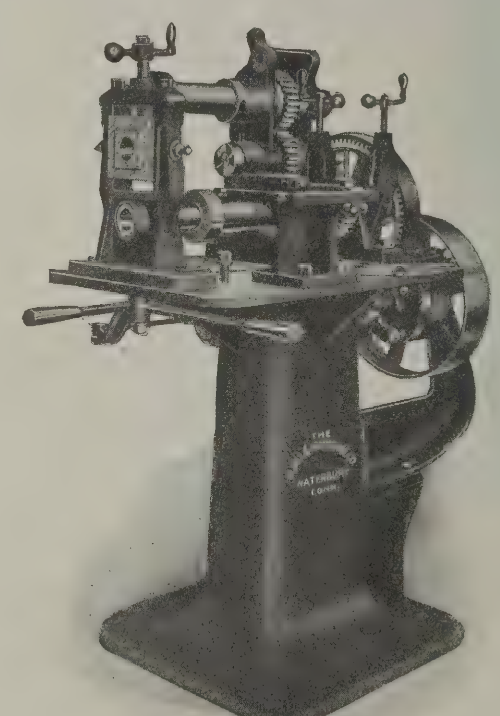
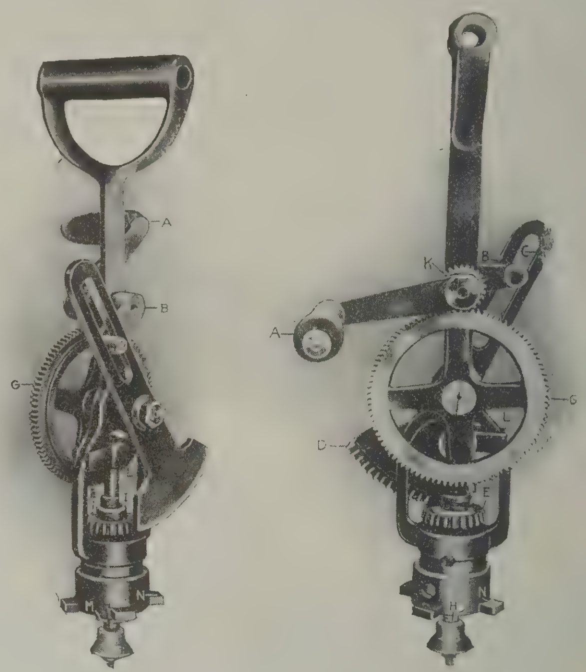


Fig. 2. Slitter with Housing moved back for changing Cutters

AUTOMATIC VALVE GRINDER

The valve grinder illustrated herewith is intended for grinding the valves of gasoline engines. This grinder gives a continuous cycle of operations, so that the valve is evenly ground and accurately seated. The valve is rotated in opposite directions in its seat and is progressively advanced periodically in one direction. First the valve is reciprocated on its seat a



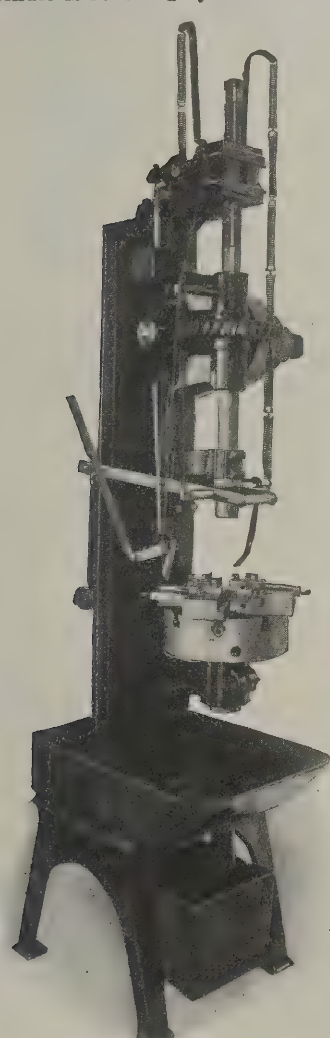
Specialty Machine Co.'s Hand-operated Valve Grinder

given number of times; it is then lifted, and when released by a suitable cam is automatically placed in a different angular position on the seat, after which it is automatically moved forward through a given angle and again reciprocated. The operation of this grinder is as follows: When the handle *A* is turned, crank *B*, which engages slot *C*, imparts an oscillating motion to segment *D*, which reciprocates the small pinion *E*. This pinion, through clutch *I*, transmits motion to the driving spindle *H*. At the same time, gear *G* is driven by a small pinion *K*. Located on the inside of gear *G* there is a cam which periodically comes under a roller mounted on carrier *L* and lifts clutch *I* from engagement. The clutch remains disengaged until pinion *E* is rotated through a given

arc, when the cam drops the clutch back into engagement. This movement effected by the cam also lifts the valve from its seat. Spring *M* engages the clutch at the proper time and insures a constant grinding pressure. The compression of this spring varies in accordance with the size of valves which are to be ground. The weight of the tool and downward pressure of the operator is carried by shoulder *N* which rests on the valve opening of the engine. This automatic valve grinder is being manufactured by the Specialty Machine Co., 95 Liberty St., New York.

BICKFORD UPRIGHT TAP-THREADING MACHINE

The Bickford Machine Co., Greenfield, Mass., has placed on the market a new machine for threading taps. This machine is an upright design, as the accompanying engraving shows. The taps are threaded by a die-head located below the spindle and supported by a foot projecting from the vertical column. The spindle rotates the tap blank being threaded, and, at the same time, is fed downward by a lead- or master-screw. The spindle is revolved by means of coarse-pitch worm-gearing having a ratio of about ten to one. The worm is carried by a horizontal shaft located near the top of the machine. This shaft is driven by a three-inch belt connecting with the cone pulley seen to the right of the worm-gear, and the latter transmits the motion to the spindle.



Bickford Tap-threading Machine

The lead-screw is in the form of a threaded shell. It is located on the upper end of the spindle and is engaged by half-nuts operating in a slide which forms part of the main column. The lower end of the spindle carries a holder for driving the tap blank, and the latter, when threaded, drops through the base of the machine. The spindle also carries (but does not revolve) a horizontal bar to which is attached, from above, pull-strings which return the spindle upward to its normal position when the half-nuts are released from the lead-screw. This disengagement of the half-nuts is effected by a trip which can be set to act just after the threaded tap drops from the holder.

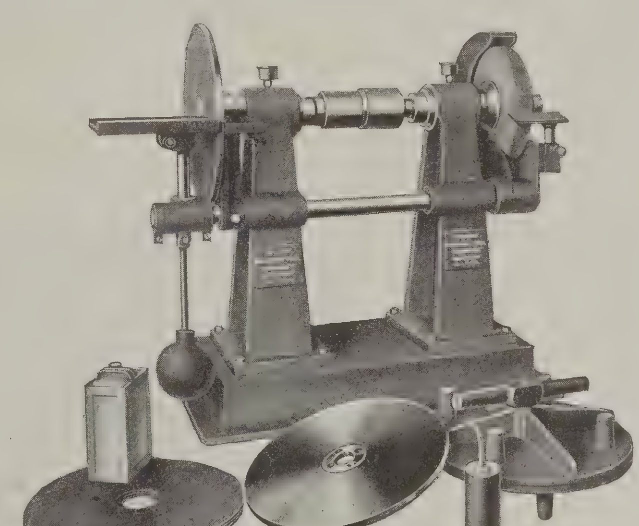
In operating the machine, the square shank of the tap blank is inserted in the holder at the lower end of the spindle, while the machine is running. The tap is held in position with one hand and the spindle is pulled down with the other (until the tap enters the die) by means of the short cross-handle seen in front of the spindle. The tap blank is then released and the lever on the left (which has a chain attached to its short arm) is pulled over, which engages the half-nuts with the lead-screw, thus causing the spindle to feed downward.

Lead-screws and half-nuts of different pitches are easily applied to the machine, and, if desired, they can be furnished with an increased lead to compensate for shrinkage in hardening the taps. A generous stream of oil is supplied to the work by a pump at the rear, which is driven from the countershaft. The lower bearing for the spindle can be removed easily, and, when this is detached, a much longer spindle travel is obtained. This feature adapts the machine to the threading of stay-bolt or other taps having long threads. The machine has a capacity for taps varying from one-half to two inches in diameter, and the same set of chasers can be used on any size tap having the same pitch of thread.

The company recommends the installation of two machines so that when threading large taps which require two cuts, the machines can be used in conjunction with each other. The threading die employed is a solid adjustable type having milled chasers. This die is efficient and produces accurate work. The total height of this machine is 8 feet 4 inches, and the weight about 1200 pounds.

SELLEW COMBINATION DISK GRINDER

The disk grinder shown in the accompanying engraving is built by the Sellew Machine Tool Co., Pawtucket, R. I. This is a combination grinder, one end having a 14- by 2-inch carborundum wheel for general work, and the other, a 20-inch disk wheel. The grinding wheel is enclosed by a substantial safety guard, carrying an adjustable support with rests so arranged as to enable the operator to work either on the front or side of the wheel. This equipment can be removed quickly for attaching buffing wheels, drums, etc. The spindle has a safety cap nut on its threaded end. The twenty-inch disk has a swinging table on the outer or finer side, which can be tilted for angular work and clamped in its tilted position. On the inner or coarse side of the disk, there is a stationary rest which can be used for supporting the work while taking roughing cuts or, if necessary, it can be swung down out of the way altogether. If desirable, both ends of the machine can be equipped either with disks and swinging tables or with grinding wheels.



Sellew Combination Disk Grinder

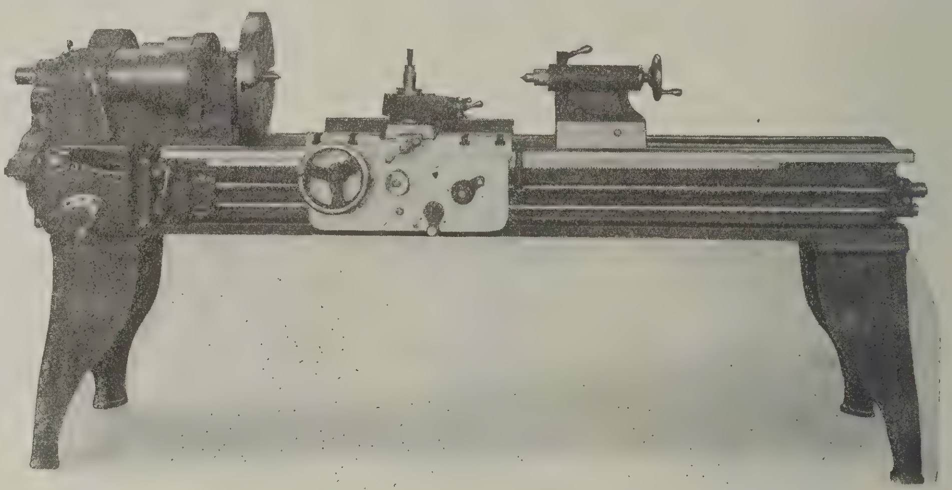
The spindle of this grinder was made exceptionally long in proportion to the diameter of the disk, to eliminate excessive wear of the journals and vibration. The length of the spindle over-all is 40 inches and the journals measure 2 by 7¼ inches. The journals are self-oiling and have ball bearings to take endwise thrusts. These bearings are protected by felt dust-guards. The spindle driving pulley is somewhat larger in diameter than the loose pulley, in order to relieve the tension of the belt when it is shifted to the loose pulley. The weight of the machine, complete with the necessary equipment, is 1600 pounds.

CONOVER-OVERKAMP QUICK CHANGE GEAR LATHES

The Conover-Overkamp Machine & Tool Co., Dayton, Ohio, is now manufacturing the quick change gear lathe shown herewith. This design is made in 14- and 16-inch sizes and with either a large three-step cone and friction double back-

gears, as shown in the illustration, or with a five-step cone and single back-gears. These machines can also be equipped either with a quick change gear box, as illustrated, an all-geared feed-box, or a standard belt feed-box and change-gears. Each of these boxes is an independent unit and they are interchangeable. This feature makes it possible to attach any one of these three units to the lathe at any time; that is, either a quick change gear box, a geared feed-box or a belt feed-box.

All gears in the boxes are steel and the bearings are bronze-bushed and can easily be renewed, in case of wear, without affecting the center distances or alignments. The boxes are fastened to the bed by four bolts and can easily be attached or removed. The change gear box, the geared feed-box, and the belt feed-box, are simple designs and there are no overhanging parts at the end of the lathe. The quick change gear box contains a driven shaft carrying a tumbler gear which can be engaged with any one of the eight cone gears. In constant mesh with the cone gears, there is an intermediate shaft provided with four gears, and a set of sliding gears can be engaged with any one of the intermediate gears by means of the lower lever seen at the front of the box. With this arrangement, thirty-two changes are obtained with but two operating levers and without removing or changing a single gear. A stud is provided on the reverse quadrant for compounding or for the introduction of special gears, so that special or metric threads can be cut with the standard lead-screw. The geared feed-box has four changes and is operated by one lever. The changes are obtained through sliding gears and positive clutches. The belt feed-box is equipped with a belt tightener.



Quick Change Gear Lathe built by Conover-Overkamp Machine & Tool Co.

These lathes can be furnished with standard legs, cabinet legs and also with short legs and oil pans. A taper attachment can be added at any time, as all carriages are planed and drilled for this purpose before the lathe is shipped.

NEW MACHINERY AND TOOLS NOTES

Precision Boring Head: Precision Tool Co., Lansing, Mich. A new precision boring tool for use in fine miller work and similar classes of service. This tool is equipped with an adjusting screw to adjust it for any size of radius work, the screw being provided with a micrometer attachment for securing any radius that is required.

Spiral Cutter Grinder: Sloan & Chace Mfg. Co., Newark, N. J. A spiral cutter grinder, semi-automatic in its action, which has an emery wheel four inches in diameter. The machine will grind an eight tooth 45 degree angle cutter in three minutes. The wheel spindle is fitted with S. K. F. ball bearings and the work is held between centers.

Mandrel Press: G. T. Eames Co., Kalamazoo, Mich. A mandrel press provided with a leverage system which multiplies the applied force by three hundred. This press is equipped with a square ram and is operated by a rack and pinion; it has a lock-nut that enables the ram to be clamped in any position while adjusting the work. These presses are made in a variety of lines and sizes.

A Group of Special Lathes: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. A special manufacturing lathe, designed with the jack shaft under the bed so that the machines can be grouped together and arranged for any desired speed. The driving pulley is loosely mounted on the spindle and is engaged by means of a friction clutch; the lathe headstock is cored out to permit the passage of the driving belt.

Metal Cutting Machine: Racine Tool & Machine Co., Racine Junction, Wis. A new type of metal cutting machine equipped with a three speed attachment designed to give speeds of 60, 90 and 125 R. P. M. respectively, when cutting unannealed tool steel, annealed high-speed steel and mild steel. The general construction of the machine follows the lines which are now generally recognized as standard for equipments of this type.

High-Speed Hacksaw Machine: E. C. Atkins & Co., Indianapolis, Ind. A high-speed hacksaw machine known as the No. 7 "Kwik Kut," equipped with a swivel vise and independent motor which has a speed range of 550-1100 R. P. M., and drives by means of a Morse chain running over hardened steel gears. The machine is provided with the most modern type of lubrication system and method of raising the saw on the idle or return stroke.

Electric Drilling Machine: Van Dorn & Dutton Co., Cleveland, O. An electrically operated drilling and reaming machine which has a drilling capacity of one-half inch in steel and one inch in wood, and a reaming capacity of 7/16 inch. The machine is 14 inches high from the top of the handle to the bottom of the chuck, and weighs 17 pounds. It is designed to operate at a speed of 700 R. P. M. and can be furnished for connection with either 110 or 220 volt lines.

Multiple Drilling Machine: Taylor & Fenn Co., Hartford, Conn. A machine equipped with a multiple head that is built with from two to fourteen spindles. The position of these spindles is not adjustable, so that special heads are required for each class of multiple drilling that is to be done. The spindles are gear-driven, and as the gear ratio is arranged to provide the proper speed for various sizes of drills, it is necessary to specify the size of drills that are to be used.

Double Arbor Buffing and Polishing Machine: Excelsior Tool & Machine Co., East St. Louis, Ill. A special design of buffing and polishing machine which has two independent spindles, giving a combination of handiness of operation, simplicity, and large capacity. The entire machine is enclosed by dust-proof covers and has a solid bracket for attaching the dust hood. The machine is designed to run at a speed of 300 R. P. M., although this figure may be varied slightly to meet the requirements of individual classes of work.

Revolution Counter: American Ever Ready Co., 304 Hudson St., N. Y. City. A new type of revolution counter that is shaped somewhat like a revolver and of about the same size. The starting and stopping of the counting mechanism of this device are not dependent upon the amount of pressure applied in holding the counter against the revolving spindle. The counting mechanism is started and stopped by operating a trigger, and the recorder indicates in the forward direction regardless of the direction of rotation of the shaft.

Belt Surface Grinder: Peerless Surface Machine Co., Newark, N. J. A line of belt surface grinders of both vertical and horizontal types, and of different sizes for a variety of classes of work. These machines are provided with an endless belt upon which the abrasive material is mounted, and a work table that can be swung to any desired angle. The bearings in which the spindles of the belt pulleys run are provided with boxes of the sliding type, which enables any stretch in the belt to be taken up. A dust collector is arranged to catch the metal dust which is removed from the work.

Plain Radial Drilling Machines: Dreses Machine Tool Co., Cincinnati, O. These machines are of the 3- and 3½-foot size, and are similar in construction to the 5-, 6-, and 7-foot sizes illustrated in November, 1911. They are designed for the use of high-speed drills, are convenient to operate and substantially built. The outer column swings on a fixed inner column extending to the top, and there is a third bearing in the middle which greatly increases the strength and rigidity. The arm is of box, parabolic shape and the lower rib is double-webbed, thus giving great resistance to bending and torsional strains. The head has long and wide bearings on the face of the arm, and, in addition, a third bearing at the rear. This third bearing gives extra support to the head, prevents bending the rear shaft, reduces the wear of the bevel gears and bearings and distributes the torsional strain over the entire arm. The spindle has twenty-one speeds, runs in phosphor-bronze bearings and is driven by two keys. The driving gear of the spindle rests and revolves on a ball bearing, which is said

to effect a power saving of 15 per cent. The feed is all-geared and there are eight changes which can be varied while drilling, by a handle located on the head. There is an automatic stop and depth gage; a quick-return having four handles, either of which can be used for engaging or disengaging the feed; and a tapping, starting and stopping mechanism of the frictional type, operated by a conveniently located lever.

* * *

BORING MORTAR CARRIAGES

At the Builders' Iron Foundry, Providence, R. I., some interesting work is going through in connection with the making of disappearing carriages for mortars for the U. S. Government. These mortars are of the 12-inch size, model 1896—M—III, and will be used for coast defense. One of the trunnion castings is shown in Fig. 1. This casting weighs 5620 pounds,

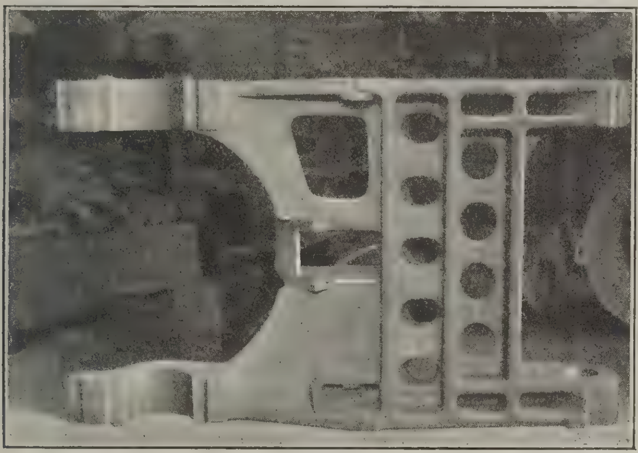


Fig. 1. Disappearing Mortar Carriage Casting being bored in Fig. 2

and the boring operations on it well illustrate the general character of the work.

This work consists in the boring of the large trunnion holes at one end, the fulcrum pin holes at the opposite end, and miscellaneous smaller holes between the two ends to receive the intermediate and elevating shafts. In doing this work a universal boring machine is used, as shown in Fig. 2. In order to facilitate the handling of the work upon this machine a special table was made to assist in supporting the work while being operated on. This will be observed in place on the machine beneath the casting. Before the casting is bored, however, the trunnion ends are milled and fitted with the bearing caps. This being done, the casting is mounted on a fixture and the fixture supported on the machine in position for boring the trunnion holes, which are finished to a size slightly over 13 inches. It is important that this dimension be very accurate. It will be observed that the casting is too large to be supported wholly on the table of the machine, and it is necessary to support the outer end upon jacks which may be seen in Fig. 2. This part of the work being done, the casting is reversed, and, by supporting a test-bar in bearings which have been provided in the trunnion end of the fixture, a convenient means is afforded for taking measurements when boring the fulcrum pin holes. This is the operation shown being done in Fig. 2. After both ends have been bored, the several smaller bearing holes for the intermediate and elevating shafts are bored at intermediate positions between the ends of the casting.

The work is under the direction of a government inspector, and the limits allowed are extremely close in regard to diameters of holes, distances between holes, and parallelism.

* * *

TO DISTINGUISH BRASSES BY COLOR

The composition of the brasses (copper and zinc alloys) may be readily determined, approximately, by the color. The method gives a brass founder a simple and rapid means for ascertaining what his brass contains. The following shows the color of the various percentages of copper and zinc:

When the brass contains 5 per cent of zinc, it has a red color scarcely differing from that of pure copper. When 10 per cent of zinc is present, the mixture has a true bronze color. With 15 per cent of zinc, the brass has a light orange shade. When the amount of zinc reaches 20 per cent the color of the mixture is greenish-yellow and is known as "green brass." With 25 per cent zinc, the color is practically that of the 20 per cent mixture so that this, too, is a "green brass." Brass with 30 per cent zinc has the true, yellow brass color. The same is found with 35 per cent of zinc, but at about this point the yellow color begins to disappear, for at 40 per cent zinc a reddish yellow color is found. Brass, therefore, that has a reddish-yellow shade will always contain more than 35 per cent zinc. The "dead line" seems to be about 38 per cent zinc, for at this percentage, the transition from the real yellow to the reddish-yellow begins.

When the zinc is increased to 45 per cent, the color of the brass is a rich golden shade and, strictly speaking, it may be called "orange." The mixture containing 50 per cent zinc has also a golden shade, but even richer than 45 per cent zinc alloy. At 55 per cent zinc, the color resembles that of 14-karat gold. When 60 per cent of zinc is reached, the brass has a yellowish white shade, and as the quantity increases, the color becomes white and finally gray.

It becomes possible, then, to make an approximate determination of the composition of a brass by the color. If it is very soft and red or orange color, then the amount of zinc is from 10 per cent to 15 per cent. If greenish-yellow, the quantity of zinc ranges from 20 per cent to 25 per cent. The true brass color is found when the zinc amounts to from 30 per cent to about 38 per cent. If, however, it is found that the brass is hard and has an orange yellow color, then the zinc must be present in an amount greater than 38 per cent. To cite an instance of this kind, a concern may be purchasing yellow-brass ingot. If, upon cutting or filing it, the color is found to be orange, then the zinc in it is excessive and may run from 40 per cent to 50 per cent.

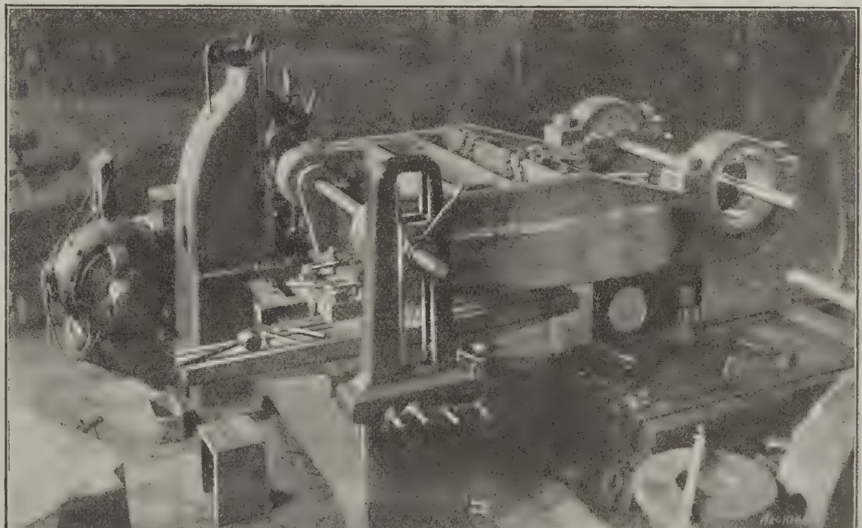


Fig. 2. Boring a Disappearing Mortar Carriage Casting on a Universal Boring Machine

In comparing the color of the brasses, a highly polished surface is not as suitable as a dead one for the reason that false reflections are apt to deceive the observer. A surface that has been filed or ground is preferable, and in order to avoid tarnishing the metal should be freshly cut when a comparison is to be made.—*Brass World.*

* * *

The following method for preventing short-paid postage on letters to foreign countries has been adopted by a large firm having a considerable amount of foreign correspondence: Different-colored envelopes are used by the stenographers when addressing letters to foreign countries. The stamping clerk first of all segregates the letters according to the color of the envelopes and then stamps them as required. Mistakes become very rare under this system, and the simplicity of the system recommends it for use.

THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The eleventh annual convention of the National Machine Tool Builders' Association was held at the Hotel Astor, Wednesday, Thursday and Friday, October 16 to 18. The meeting was called to order at the morning session on October 16 by the president, E. P. Bullard, Jr., who referred to the work of the association in a brief address. The remainder of the session was given over to the reports of committees. The membership committee reported applications for membership from the following firms:

Beaman & Smith Co., Providence, R. I.
Blake & Johnson Co., Waterbury, Conn.
Turner Machine Co., Danbury, Conn.
Union Twist Drill Co., Athol, Mass.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Zeh & Hahnemann Co., Newark, N. J.

These firms were elected to membership, making the total number of members 188. Reports were also submitted by the committee on standardization, foreign relations, patents, and investigation of cutting tools. A resolution was passed, after some discussion, making a change in the membership fee—graduating it according to the capital and surplus of the respective members.

During the afternoon session, October 16, and the morning session, October 17, the following papers were read:

"Export Trade," by W. A. Viall, of the Brown & Sharpe Mfg. Co., Providence, R. I. (See abstract in this number.)

"The Use of an Association Catalogue in the Development of Foreign Markets," by Stanley H. Bullard, of the Bullard Machine Tool Co., Bridgeport, Conn.

"How United States Patents might be made of Greater Value to Patentees," by Samuel W. Banning of Banning & Banning, patent attorneys, Chicago, Ill.

"Tariff Legislation and its Influence on the Machine Tool Trade," by C. Wood Walter, of the Cincinnati Milling Machine Co., Cincinnati, Ohio.

"How could the Association be benefited by the Formation of a Mechanical Section?" by E. J. Kearney of the Kearney & Trecker Co., Milwaukee, Wis. (See abstract in this number.)

The sessions on the afternoon of October 17 and the morning of October 18 were devoted to committee meetings on lathes, sensitive drilling machines, boring machines, gear cutting machines, grinding machines, hand screw machines, planing machines, radial drilling machines, milling machines, shaping machines, vertical drilling machines, and turret lathes.

It was decided to hold the next spring meeting in New York City. The following officers were elected for the coming year: president, E. P. Bullard, Jr., of the Bullard Machine Tool Co., Bridgeport, Conn.; vice-president, A. T. Barnes, of the W. F. & John Barnes Co., Rockford, Ill.; second vice-president, R. K. LeBlond, of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio; treasurer, A. E. Newton, of the Reed-Prentice Co., Worcester, Mass.; and secretary, C. L. Taylor, of the Taylor & Fenn Co., Hartford, Conn.

The Association Catalogue

The paper by Mr. S. H. Bullard aroused considerable interest on account of the novelty of the idea presented, and was followed by an animated discussion. The idea proposed is, briefly, that the association should publish a catalogue for distribution mainly in foreign countries, in which the product of every member should be represented, this catalogue to be printed in English, German, French and Spanish. Apparently most of the members present favored the idea. A committee was appointed to further work out the details, and this committee reported at the last session, October 18, the report being to the effect that a permanent committee should be appointed and that the details of the issuing of a catalogue as proposed should be taken up by letter ballot with the members. At the same meeting a special committee was decided upon to report to the association at its next meeting on the question relating to the formation of a mechanical section raised by Mr. Kearney's paper on the subject.

Patents and Patent Legislation

The paper on patents and patent legislation, by Mr. S. W. Banning, contained a review of the Oldfield bill now before Congress, which is designed to eliminate certain alleged abuses which have grown up during the old patent law. The speaker referred to the main features of the bill (see MACHINERY, July, 1912, "Proposed Changes in Patent Laws"), and particularly gave attention to the compulsory license clause against which he presented an argument. The section of the bill referring to restrictions with respect to the resale or use of patented machines after the title to such machines has passed from the manufacturer, was also referred to, as well as the conditions where contributory infringement is claimed on account of the use of accessories with the patented machine which are not secured from the seller of such machine. The stand taken by the speaker was that when the restriction is one that relates exclusively to the patented invention, it should be amenable to the remedy provided for enforcement of the inventor's rights in an infringement suit; but when the restriction is one that relates to supplies of a general nature, the question is one outside the realm of patent infringement and one that should simply be decided as a question of breach of contract, the validity of the contract to be decided in ordinary court proceedings. It was pointed out that under present practice the patent may be used as a weapon to enforce control of the use and sale of articles that are not even accessories to the machine patented and which are wholly unrelated to its use. As an example, the patentee of an adding machine may sell it with the restriction that its use is conditional upon the purchase from the same source of all typewriters required by the user, and under penalty of suit for infringement of the adding machine patent. In this way, the present law would permit the patentee to extend his monopoly to cover a device upon which he has no patent and which bears no relation to the invention actually protected. Reference was also made to some questions not included in the Oldfield bill.

Under the present practice the inventor is required to append to his specification one or more claims which point out and limit the invention, and which are intended by their language to distinguish it from all prior inventions. The invention is considered as a concrete embodiment of certain mechanical parts or elements, and the claim is restricted to this physical combination. The real invention, however, may go a great deal deeper than this, and in the case of basic inventions it is the underlying principles and not the mechanical embodiment which is of value and importance; but under present practice, inventions of this kind are the more difficult to adequately protect. Minor improvements are easily claimed in mechanical language, even when they are merely new mechanical embodiments of old basic ideas.

The speaker advocated that the inventors should be allowed to claim the functional co-relation of the parts in such a way as to cover every physical embodiment of the same fundamental principle. In this respect, the German practice is quite the reverse of the American practice. In Germany, the claim is directed to the basic functions of the elements involved, and this the speaker considered ought to be the case also under our patent laws. Under the present practice, the unnecessary strictness in claiming the invention, and the oftentimes ill-advised liberality of the courts in construing the claims, renders it extremely difficult to determine the rights of the patentee.

* * *

AMERICAN MACHINIST'S THEATER PARTY

The *American Machinist* followed its custom of some years standing by entertaining a theater party of several hundred machine tool builders, mechanical engineers and representative men in metal manufacturing lines, during the meeting of the National Machine Tool Builders Association in New York. The party saw the French comedy "Oh, Oh, Delphine!" played at the Knickerbocker Theater, Thursday evening, October 17, and was highly entertained by the spicy witticisms and catchy songs of this brilliant hit of the season.

* * *

The *Boletin de l'Industrie Minerale* states that aluminum wire is being extensively used in Europe for electric transmission lines, on account of the saving in first cost. The initial cost of an aluminum line is about 25 per cent less than an equivalent copper line, all items considered.

MACHINERY'S 1912 OUTING

MACHINERY'S tenth annual outing for machine tool builders, dealers and others connected with the machine tool industry, including many superintendents of manufacturing plants, took place on October 19.

MACHINERY'S steamer left the foot of East Twenty-fourth St. at 11 A. M., stopping first at the Brooklyn Navy Yard, the most important naval station in the United States, where Uncle Sam's new super-dreadnought, the 27,000-ton battleship *New York* is now under construction. The keel was laid in September, 1911, and she will be launched before this item is read. The Commandant and his aide had been suddenly ordered to Washington the night before, and through some oversight the arrangements made for the entertainment of the party were not carried out; but opportunity was afforded to inspect the yard and go aboard the battleships *Utah*, *Florida* and *Connecticut*.

Luncheon was served while at the Navy Yard, and immediately afterwards the steamer started up the East River and around Manhattan Island, passing through the Harlem River and shooting some fourteen bridges that span it, returning to the foot of East Twenty-fourth St. on time. The steamer was the largest that ever passed through the Harlem River, and it was a close call getting through High Bridge.

An unexpected feature of the outing which was highly enjoyed by the friends of Mr. Charles E. Hildreth, for some years secretary of the National Machine Tool Builders Association, was the presentation to him of a cake well covered with candles, in honor of his birthday, which happened to fall on October 19. A song especially written for the occasion was sung with gusto, and Mr. Hildreth responded feelingly.

MACHINERY'S outing was started ten years ago with a tally-ho ride given to twenty-one manufacturers and others present at the convention in New York at that time, and the attendance has now increased so that between five and six hundred representative men in the machinery industry meet each year to renew and extend their acquaintance and to spend a few social hours on that occasion.

* * *

PRICE SHEETS FOR SALESMEN

Loose-sheet price books have come into common use by machinery salesmen in the past few years. The page most used is of thin paper printed on one side only, cut to the standard, 4 inches wide and 7½ inches long, with three holes punched on three-inch centers, and with round corners. A sample page was shown in the April, 1912 number of MACHINERY on page 593, engineering edition. A well-known western machinery dealer is establishing among machine tool manufacturers for the use of their salesmen similar sheets printed on both sides and made of light weight tag stock, that is, white filled linen, which, of course, is much stronger and more durable than the thin paper commonly used. These sheets carry illustrations of machines on one side and the specifications on the other. The texture of the stock being coarse, it is advisable to illustrate with wood cuts or coarse screen half-tones, the illustrations being used simply to identify the machines and not to show details of construction clearly.

* * *

Thin steel saws for slotting heads of machine screws and bolts are tools which require frequent renewal. The work is very destructive and, ordinarily, the tools do not last long. However, one of these slitting saws, made of "Ark" high-speed steel, recently slotted 477,000 stove bolts before giving out.

NEW YORK ELECTRICAL EXPOSITION

The sixth annual electrical exposition, held in the Grand Central Palace, New York City, October 9 to 19, included a variety of interesting applications of electricity. The majority of the exhibits were of a nature to interest non-technical visitors, as they consisted of electrical devices used for household and office purposes. The exposition was opened with a luncheon in honor of Thomas A. Edison, commemorating the completion of thirty years of Edison service in New York City, given by the New York Edison Co., October 9. Mr. John W. Lieb, Jr., general manager of the New York Edison Co., related how the industry has grown since the opening of the historic Pearl St. plant, September 4, 1882. Electrical plants thoughout the country are capitalized at $2,500,000,000, having an annual capacity of 12,000,000,000 K. W., and gross earnings of $4,000,000,000.

The exhibit of the New York Edison Co. showed the wonderful development in the application of electricity which has taken place in the past decade. This fact will be readily brought out by touching upon the statistics presented by this company's commercial engineering department. Without entering into detail, an idea of this development may be gained from the fact that in 1899 the total horsepower of the motors connected to the Edison Co.'s system in New York City was 34,457, while in 1911 this figure had increased to 312,863. This is but one of the increases in consumption of electric power which have taken place, and it will be evident that to keep pace with such an increase of power consumption corresponding increases in generating equipment were necessary. The developments which have been made along this line are clearly set forth by models of the old Edison station on Pearl St., N. Y. City, which was built in 1882, and the Waterside stations which are carrying the load at the present time. These models are constructed on a scale of one inch to two feet, and show the complete plants, together with the arrangement of the equipment. The old "Jumbo" generators of the first Edison station in New York, which were built by Armington & Simms, Providence, R. I., and placed in operation September 4, 1882, were run under the following conditions: rated capacity, 126 K. W.; capacity in 16-candlepower lamps, 1000; square feet of floor space occupied, 122.5; R. P. M., 350; weight of generating set in pounds per K. W., 488; K. W. per square foot of floor space occupied, 1.03. The present type of Curtiss turbine generators were built by the General Electric Co., Schenectady, N. Y., to operate under the following conditions: rated capacity, 20,000 K. W.; capacity in 16 candlepower lamps, 1,000,000; square feet of floor space occupied, 297; R. P. M., 750; weight in pounds per K. W., 42; K. W. per square foot of floor space covered, 67.34.

Another particularly interesting exhibit is that of the Electrical Testing Laboratories of New York City. Among the apparatus shown, there was a series of twenty-seven electric meters which cover a range of design from the old-fashioned electrolytic type, which was the first used in New York City, up to the most modern type of instrument. In this connection it may be of interest to mention that the method of measuring current with the old electrolytic type consisted of shunting a part of the current through a cell; the amount of current passed was then measured by the weight of metal deposited from the solution. The Electrical Testing Laboratories have one of the original balances which were used to weigh the metal deposited in this way.

One of the interesting features of the exposition was the exhibit of the American Museum of Safety. A large number of wax models of different parts of the human body affected by a variety of vocational diseases were shown. This is a subject which has not received much attention in this country, but which has been studied in detail in Germany. Dr. Wm. H. Tolman, director of the American Museum of Safety, has recently been in Germany making a study of the results of investigations of this subject which have been made there, and the models exhibited were brought back by him from Germany. It is the intention of the American Museum of Safety to issue circulars at a later date showing the causes of such vocational diseases and the means of prevention.

DOGS AND DRIVERS

A review article was published in the October number, engineering edition, illustrating a large number of dogs and drivers for lathe and milling machine work held on centers. Unfortunately, a description of the meritorious safety lathe dog illustrated in two styles in Figs. 1 and 2, which is made by J. H. Williams & Co., Brooklyn, was omitted. In this lathe dog, the square-head set-screw so dangerous to the workman's hands and arms, is displaced by square socket set-screws always lying flush with the surface of the screw hub or below it. Inasmuch as the set-screws do not project above the surface, they cannot catch the workman's sleeve or other parts of his clothing and thus cause injuries.

Figs. 1 and 2. J. H. Williams & Co.'s Safety Lathe Dogs

This lathe dog is essentially the same in design as the form used in the works of the National Tube Co., and illustrated in the April, 1911, number of MACHINERY. A feature of the design of the drop forged dog is the reinforcement at each side of the screw hub made to strengthen it at a critical point and to eliminate the part of the boss which would project if the lines were the same as on the square-head set-screw type. These safety dogs are made in the same sizes as the regular square-head set-screw type dogs.

Another dog worthy of notice which is especially adapted for milling taper work, spiral taper reamers and other taper parts held on centers, is the Hill compensating dog made by the Ready Tool Co., of Bridgeport, Conn., and shown in Fig. 3. Features of this dog are a forked driver mounted on the spindle or faceplate and a dog having a tail with a ball-shaped part engaging the fork of the driver. The point of application of the forked driver on the ball is in approximately the same plane as the end of the piece being indexed. The object of this is to eliminate the irregularity of action in indexing tapered work that inevitably follows the use of the ordinary bent tail dog when engaged with an ordinary driver, and arises from the sliding of the taper tail of the dog in and out of the slot and the necessary looseness of engagement of the tail in the slot.

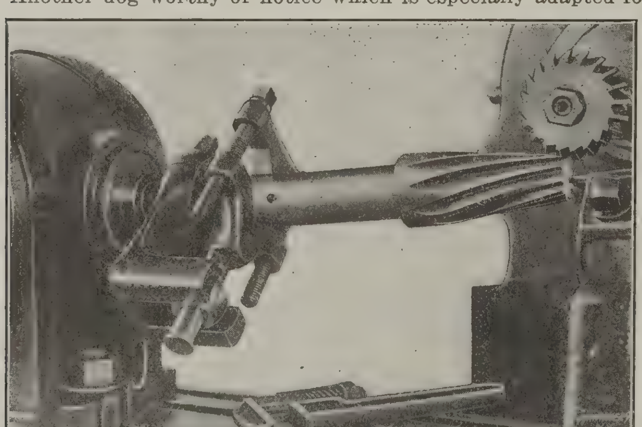


Fig. 3. Ready Tool Co.'s Milling Machine Dog

PERSONALS

Frank Koester, consulting engineer, has moved his office from 115 Broadway to larger quarters at 50 Church St. (Hudson Terminal Building), New York.

F. Mandon, manager of Fenwick, Freres & Co., Paris, France, is making a short visit to American machine tool building centers in the interests of his company.

E. G. Buckwell, secretary and manager of sales of the Cleveland Twist Drill Co., Cleveland, Ohio, sailed on the *Carmania* October 5, for a two-months' business trip abroad.

V. Brockbank, a British contributor to MACHINERY, has come to America and joined the National Twist Drill & Tool Co., Detroit, Mich., in the capacity of assistant superintendent.

E. J. Lees of the Lees-Bradner Co., Cleveland, Ohio, maker of gear hobbing machines, sailed for Europe October 1, on the *Mauretania*, for a five or six weeks' business trip in England and France in the interests of his company.

D. O. Barrett, superintendent for the past year-and-a-half of the Manitoba Engines Ltd., Brandon, Manitoba, and an occasional contributor to MACHINERY, has resigned to take charge of the experimental work of the Heer Engine Co., Portsmouth, Ohio.

H. W. Kreuzburg, president of the Champion Tool Works Co., Cincinnati, Ohio, who sailed for Europe May 25, returned early in October, having made an extended tour of British and Continental manufacturing centers in the interests of his company.

Ralph E. Flanders, advertising manager of the Fellows Gear Shaper Co., Springfield, Vt., has resigned to become manager of the Fay automatic lathe department of the Jones & Lamson Machine Co., Springfield, Vt., and also manager of the company's advertising.

Howard G. Carter will have charge of the equipment of the new $300,000 high school building in Hamilton, O. The school will have a completely equipped technical department including a machine shop, forge shop, foundry, pattern shop, stockroom, bench room and drafting-room.

Louis M. Pawlett has recently left the Locomobile Company of America, where he held the position of executive engineer, to enter upon a consulting practice in motor transportation engineering. For this purpose, Mr. Pawlett has opened offices in the new building of the U. S. Rubber Co., 1786 Broadway, N. Y.

John S. Myers, known to readers of MACHINERY as an occasional contributor of articles on machine design and other subjects, has resigned his position with the American Engineering Co. (successor to the Williamson Bros. Co. and the American Ship Windlass Co.) to go with the Southwark Foundry & Machine Co., Philadelphia, Pa.

J. McA. Duncan has been appointed district manager of the Westinghouse Electric & Mfg. Co. for the Pittsburg district, in place of Mr. W. F. Fowler, resigned. Mr. Duncan has been employed by the Westinghouse Electric & Mfg. Co. about twenty-five years, and is one of the group of eight men taken over from the Union Switch Signal Co., then located in Garrison Alley, Pittsburg, to form the electric company, which was first established at the same place.

* * *

OBITUARIES

William H. Corbin, vice-president of the Joseph Dixon Crucible Co., Jersey City, N. J., died at his country home in Sullivan Co., N. Y., September 25, aged sixty-one years.

Stephen Holman, founder of the Holyoke Machine Co. of Worcester and Holyoke, Mass., died at his home in Swampscott, October 13, aged ninety-two years. Aside from his machine building industries, Mr. Holman was also for many years in the cotton industry, and was a leader in the National Association of Cotton Manufacturers. He was a graduate of Williams College.

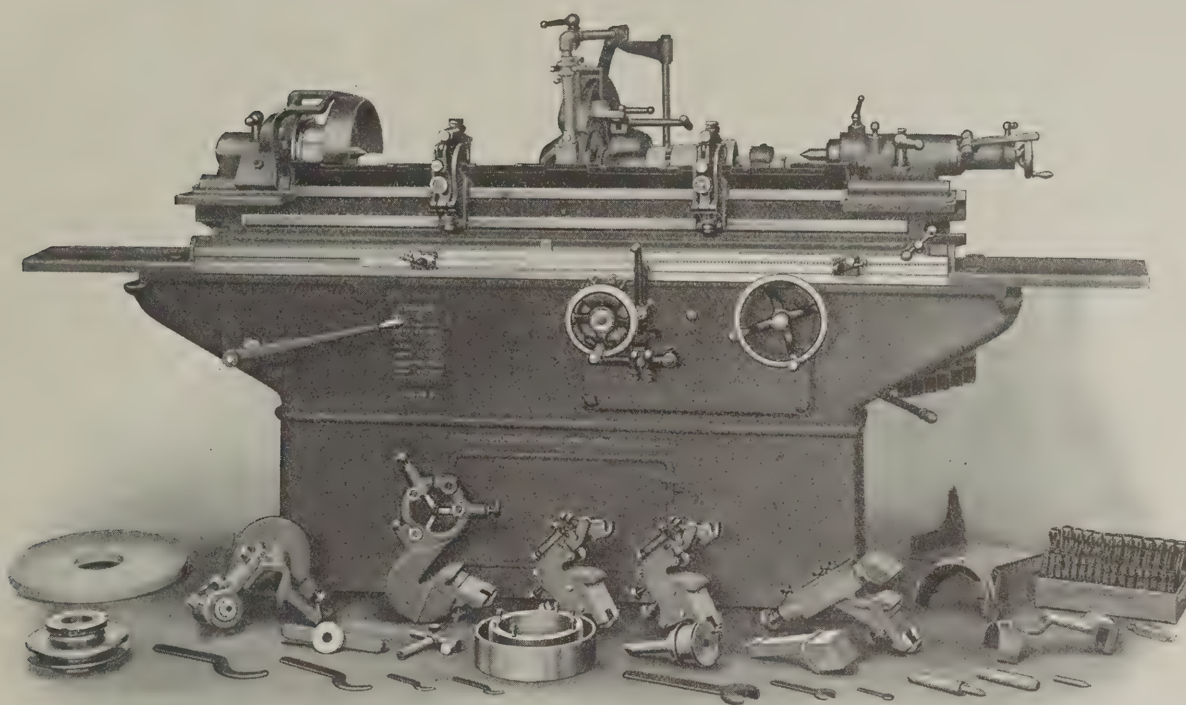
Horace Inman, president of the Inman Mfg. Co., Amsterdam, N. Y., died October 16, aged seventy-three years. Mr. Inman was widely known because of his invention of automatic and semi-automatic paper box machinery. He was one of the three mechanics who received a diploma at the World's Columbian Exposition at Chicago, the other two being Ambrose Swasey and Edwin Reynolds.

* * *

The replacing of forty-four consolidation engines by twenty-five Mallet compound locomotives on the Hinton Division of the Chesapeake and Ohio Railroad, has resulted, it is stated, in a saving of 37.55 per cent of the cost of handling the freight traffic on this division. As the Mallet locomotives are more costly than were the consolidation locomotives, this saving is reduced by the amount of the interest and depreciation of the excess cost of the Mallet engines. Nevertheless, there appears to be a clear saving of more than 30 per cent of the total cost of handling the freight traffic.

No. 14 Plain Grinding Machine

Built in two sizes, 10" x 30" and 10" x 48"



If your work calls for a machine to grind spindles, shafts, rolls, etc., up to the sizes above, the advantages of this one are worth considering.

The rigidity of all parts enables heavy cuts to be taken at fast speeds and coarse feeds. An automatic cross feed and universal back rests insure accurate duplicate pieces. The work speeds and table feeds are independent of one another so a correct feed is available for any speed. Simplicity of all parts makes the machine easy to operate. The few handwheels and levers on the front are handy for the operator and do not come in his way when changing or gauging work.

Folding guards on the 10"x30" size

economize greatly on floor space required—a factor of considerable importance in the average shop.

Write for a special circular.

BROWN & SHARPE MFG. COMPANY

PROVIDENCE, R. I., U. S. A.

A NEW METHOD OF REVEALING SEGREGATION IN STEEL INGOTS

The description given by Sir Robert Hadfield in a paper on the above subject, presented before the September, 1912, meeting of the Iron and Steel Institute, is closely related to the text of his paper describing his methods of producing sound ingots, which was also presented at this meeting. The object of the present paper is to describe a method of studying the conditions under which segregation takes place with the view of arriving at some method of eliminating, or at least checking, the formation of segregated sections.

Segregation may be briefly described as the tendency for objectionable impurities in steel—particularly sulphur and phosphorus—to be concentrated at the center of the ingot. The material constituting such segregated sections is defective in strength, and when rails or structural material are rolled from ingots containing such defects, the strength of the resulting product is seriously impaired. Like piping, segregation is caused by the unequal rate at which the solidification of the ingot takes place. It will be remembered that the inner portions are last to solidify, and experience has shown that there is a tendency for the sulphur and phosphorus to be concentrated in these sections by liquidation.

In starting to investigate the conditions responsible for segregation, it was reasoned that the addition of some metallic material could be made to the steel while in its molten form which would throw light upon the subject. A number of experiments were conducted with various metals, and copper was finally selected for the purpose because its specific gravity is slightly greater than that of steel, and also because its color would make its presence apparent when the ingot was broken up. The results of experiments conducted along this line brought out several interesting points. A sand head was used on the ingot molds in order to maintain a liquid riser at the top, and additions of molten copper made at different lengths of time after pouring the steel penetrated those portions of the ingot where piping usually takes place, and thus indicated the exact location where inter-crystalline unsoundness or segregation is developed. It may be mentioned in this connection that such inter-crystalline unsoundness is not seen in the fracture of an ordinary ingot when cold; it is revealed upon a polished and etched section. By making additions of copper at different lengths of time after pouring the ingot, the rate at which the solidification of the steel takes place was determined, as the copper was unable to penetrate steel which had already reached the solid form. It may be mentioned in this connection that these experiments proved that the steel in the inner portions of the ingot remains in a liquid condition for a far longer period of time than was supposed. It can, therefore, be readily understood why there is a greater tendency towards segregation in large ingots. The obvious conclusion is that the greater length of time in which the metal remains in a molten condition offers a greater opportunity for the concentration of sulphur and phosphorus in the central section. This is in line with a long-known fact that the more rapidly solidification takes place, the greater is the reduction of the tendency towards segregation.

The author believes that these experiments should throw some light upon the nature of the phenomena which occur in the cooling down of molten steel to a solid condition, and it would appear that the method outlined presents a valuable source of information in regard to conditions affecting the rates of cooling, segregation and liquidation of steel.

* * *

A pin should not be put through a shaft that transmits a considerable amount of power. If collars or other parts have to be fastened to the shaft, it is better to hold them with one or two keys, as the weakening effect on the shaft of the keyways is not as great as that of a pin hole.

* * *

COMING EVENTS

November 11-16.—Second International Exposition of Inventions in St. Louis, Mo. F. W. Payne, secretary-manager, St. Louis Coliseum Co., St. Louis. Inventions covering a wide scope will be shown, applicable to every profession or trade.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

National Machine Tool Builders' Association. Official report of the semi-annual convention at Atlantic City, N. J., May 16 and 17. James H. Herron, general manager, Cleveland, O.

American Association of Commerce and Trade, Berlin, Germany. Year-book giving officers, board of directors, roll of members, standing committees, annual reports, proceedings at annual meeting and statistics.

American Society of Engineer Draftsmen held its annual meeting in Teachers College, Columbia University, October 1. This meeting was the most important yet held by the organization. A chart was displayed by the president, Mr. E. Farrington Chandler, showing that the membership had quadrupled in the past year. A program comprising interesting constructive features was adopted for the coming year, which included the establishment of a mutual benefit section. The officers elected for 1913 are: Prof. Charles W. Weick, of Columbia University, president; William B. Harsel, first vice-president; and Charles A. Clark, of the Crocker-Wheeler Co., second vice-president. Walter M. Smyth, 116 Nassau St., New York, is the secretary.

NEW BOOKS AND PAMPHLETS

Digest of Workmen's Compensation Laws. 56 pages, 6 by 9 inches. Published by the National Association of Manufacturers, 30 Church St., N. Y. Library edition, 30 cents; paper cover, 15 cents.

A large number of bills concerning compensation of injured workmen have been presented to the state legislatures for enactment during the last two years. The purpose of this work is to form a reference work for the legislator, lawyer, insurance expert, employer and employe in the form of a synopsis of each law, so arranged that a comparison of the laws can be made easily. It is a work that should be available in every manufacturing plant.

The Freezing Point, Boiling Point and Conductivity Methods. By Harry C. Jones. 75 pages, 7¾ by 5½ inches. 15 illustrations. Published by the Chemical Publication Co., Easton, Pa. Price $1.

In preparing the second edition of this book, the author has gone over the text with the view of correcting a few minor errors which existed in the first edition, and has also made the necessary changes to bring the work up to date. The usual texts dealing with this subject have been prepared to meet practical requirements of the laboratory or the theoretical considerations which are dealt with in the class-room. The present book has been compiled with a view of combining the theoretical discussions and practical laboratory methods in the same volume, as it is believed that this is the only way in which an adequate knowledge of the subject can be secured.

Steam Boilers. By W. Inchley. 412 pages, 7½ by 5¼ inches. 140 illustrations. Published by Longmans Green & Co., New York City. Price $2.40.

An attempt has been made in the presentation of this text, to produce within the confines of a book of reasonable size, the principles governing the construction and operation of steam boilers and their accessories. The object in so doing has been to present information in a form suitable for the use of steam users and engineering students generally. Technical details of boiler construction, such as the pitch of rivets, strength of plates, etc., have been purposely omitted, as few readers will find themselves called upon for expert knowledge on such questions. Only the general principles of the strength of parts has been entered into, and higher mathematics has been eliminated wherever possible. It was obviously out of the question to include a complete discussion of all types of boilers and boiler accessories in a book of this size, but an effort has been made to include those types of equipment which have proved most satisfactory in practice.

The Theory of Machines. By Robert W. Angus. 238 pages, 9¼ by 6¼ inches. 147 illustrations. Published by the Engineering Society of the University of Toronto, Toronto, Canada. Price $2.25.

During the writer's experience as an engineer and instructor in engineering subjects, he has had frequent occasion to enter into a discussion of the general theory of the operation of various machine parts. In many cases, it is merely a question of designing such parts to give them sufficient strength, and the principles involved in work of this kind are naturally of the utmost importance in the engineering profession. In such work, however, no direct attempt is made to analyze the conditions under which the machine operates with a view of determining the requirements of size and strength. It was the author's appreciation of the need of such training for engineering students that led to his writing the present book. He does not claim complete originality in the material which he presents, as the current periodicals have been drawn upon wherever desirable information was available. But the quantity of such information was extremely meager and the majority of the text has been developed by the writer, for presentation in this volume.

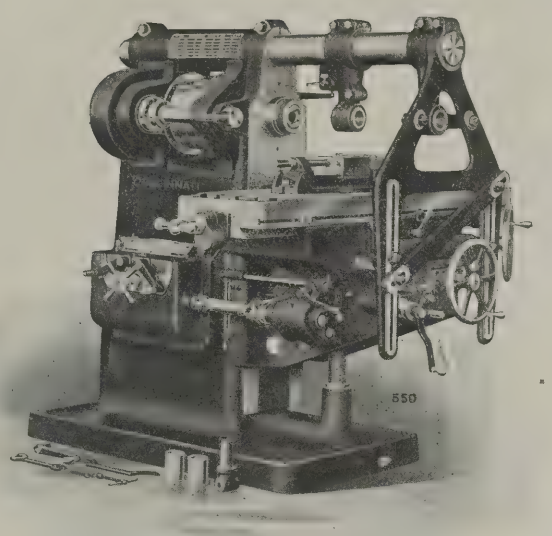
Elementary Machine Drawing and Design. By Wm. C. Marshall. 320 pages, 6⅜ by 9⅜ inches. 181 illustrations. Published by McGraw-Hill Book Co., New York. Price $3.

The material in this book has been arranged in such a way that the work can be undertaken by students of engineering who have already had a course in orthographic projection but who are not yet familiar with simple machine elements or with the subjects of mechanics or strength of materials. The simple forms of machine elements are taken up and current drafting-room methods of drawing them are presented, together with the standard practice in proportioning them for different operating conditions. In connection with this part of the work, test problems are presented at the end of each chapter to give the student practice in applying the principle of design which he has gone over. The book is not intended for home study but rather as a supplement to class-room talks on the subject matter presented. On this account detailed instructions have been omitted in many cases in order to allow the instructor the opportunity to vary the presentation of his subject according to individual requirements.

Modern Organization. By Charles De Lano Hine. 110 pages, 7½ by 5¼ inches. Published by the Engineering Magazine Co., New York. Price $2.

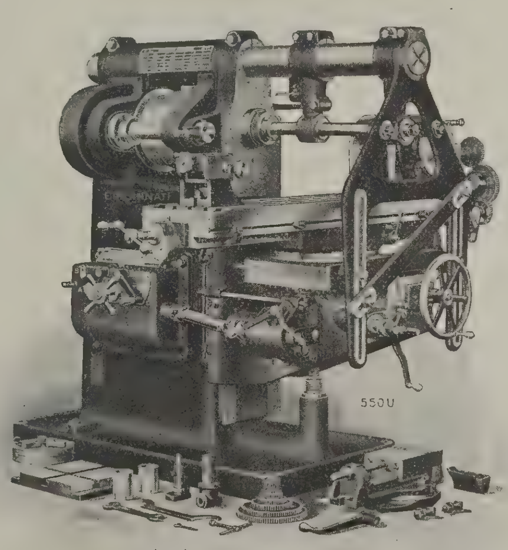
The text of this book was originally presented in a series of articles published in the *Engineering Magazine*, during the period from January to July, 1912, and represents the philosophy of management which Major Hine has had peculiar opportunities of demonstrating. This philosophy, as expressed in the unit system of organization directed toward promoting efficiency in operation in one of the great engineering industries, has been applied upon a scale of magnitude

Much of the Milling in most Shops is not Heavy Cutting



The No. 4 Plain High Power Miller with Cone Drive

Front or operator's side showing arrangement of all operating levers



The No. 4 Universal High Power Miller with Cone Drive

On this work the very powerful single pulley millers do not increase production.

An up-to-date, properly designed, cone-driven machine like our No. 4 Horizontal often proves the better investment.

It is our High Power Miller with cone-driven spindle.

We have simply replaced the Single Pulley, Geared Spindle Drive box with a Double Back Geared Cone of large diameter.

It has ample power for all that work requiring a large machine, but not excessively heavy cutting.

It can be depended upon for long, hard, continuous service, because of its massive "High Power" construction.

Its maintenance cost is low because of its simplicity.

AND IT IS HANDY.

The Feed Changers and Back Gear Lever are where the operator stands to shift the belt.

The Table always feeds in the direction in which the Engaging Lever is set.

This same lever also reverses the feed.

All Controlling Levers are at the front of the knee and saddle. So is the Quick Return.

Everything that has to do with its operation is within easy reach.

And there is an additional lever at the side of the knee controlling the feeds from behind the table, for end-milling or boring or similar work which can't be successfully done when the operator stands in front, as he must do on all other Millers.

Let us help on your milling problems. We make the largest variety of machines and therefore can recommend the ones best suited for your work.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Shutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

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ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Aires.

which has only been approached in one other case. Its success was declared with conviction in specially informed circles, but outside of a chosen audience, the characteristics of Major Hine's work had not been effectively presented until the publication of the articles previously referred to. The ideas embodied are so fundamental in character, that it appears certain that they will exercise a powerful influence in many fields of industrial organization. The policies advocated are most interesting because they depend so little upon mechanism of any kind, so little upon systems affecting the rank and file of equipment, and so much upon the psychological influence, bearing first upon, and then through, the directing officials.

MECHANISM. By Robert McArdle Keown. 169 pages, 9⅜ by 6⅝ inches. 168 illustrations. Published by McGraw-Hill Book Co., New York. Price $2.

The material presented in this book is original in its method of presentation rather than in the actual information contained. The advisability of developing this text suggested itself to the writer owing to the desirable results which were obtained in class-room work based upon this arrangement. The distinctive features may be briefly outlined as follows: A discussion of motions, velocities and linkages are first taken up as they are comparatively simple for the student to understand, and problems can be given out in early stages of the class-room work. Cams are dealt with in detail, as they form part of a subject in which considerable practice is required. The involute system of gearing is taken up before the cycloidal system because it is generally easier for the student to grasp the subject when presented in this way. When the underlying principles of the involute system are thoroughly understood, it is generally an easy matter to master the cycloidal system. Furthermore, the use of the involute system is the more general in current practice. Problems are given at the end of each chapter in order that the student may familiarize himself with all of the principles which have been presented.

ELEMENTS OF DRAWING. By George F. Blessing and Lewis A. Darling. 193 pages, 6¼ by 9¼ inches. Published by John Wiley & Sons, New York. Price $1.50.

This book was prepared by the authors at the request of Dexter S. Kimball, professor of machine design and construction, Cornell University. The object in view was two-fold. First, to obtain a book exactly suited to the needs of an elementary course in mechanical drawing for those who were entering upon courses in engineering at Cornell University. Second, to put into permanent form a collection of ideas on the subject which had been accumulated as the result of past years experience. The authors have had experience both as technical educators and as practical engineers. This combination gives them an intimate knowledge of the requirements of the work in hand. Where the book is used as a text in teaching mechanical drawing, the object may be summed up by saying it is to instruct the student: First, how to select, care for, and use drawing instruments; second, how to make and read technical drawings; third, how to think over the drawing-board; fourth, to consider the relation a drawing bears to design, shop processes, and shop organization. In endeavoring to attain the last two objects, the parts of a wood-turning speed lathe have been adopted for models because it is believed that the average student's familiarity with these objects will enable him to combine with his drawing the necessary attention to design and manufacture of the part in question which is essential to the attainment of satisfactory results. The book also gives particularly good treatment to the subject of freehand lettering of drawings and to freehand sketching, both of which are points in which the average draftsman lacks proficiency.

NEW CATALOGUES AND CIRCULARS

ILLINOIS STOKER CO., Alton, Ill. Catalogue of chain grate stokers.

PNEUMATIC JACK CO., Paul Jones Bldg., Louisville, Ky. Circular of the Taylor pneumatic tandem jacks for car repair work and other railway uses.

NATIONAL SCALE CO., Chicopee Falls, Mass. Folder illustrating the National counting machine for counting screws, bolts, nuts, pins, small castings, printed matter, etc.

READY TOOL CO., Bridgeport, Conn. Circular illustrating the Hill compensating milling machine dog, designed especially for use when indexing taper work held on centers.

J. G. BLOUNT CO., Everett, Mass. Catalogue No. 14 on grinding and polishing machinery, and speed lathes, tailstocks, slide-rests, turrets, countershafts and other accessories.

TATE, JONES & CO., INC., Empire Bldg., Pittsburg, Pa. Circulars Nos. 140 and 141 on appliances for burning fuel oil, which apply to all purposes for which oil is used as fuel.

VULCAN ENGINEERING SALES CO., 2014 Fisher Bldg., Chicago, Ill. Circular of QMS jib cranes with hand and power hoists; QMS hand power traveling cranes; and QMS pneumatic hoists.

KEUFFEL & ESSER CO., 127 Fulton St., N. Y. Circular entitled "How to Select Drawing Instruments," illustrating the "Paragon" instruments, and describing their mechanical features.

CROCKER-WHEELER CO., Ampere, N. J. Bulletins Nos. 155 and 156 on Form Q induction motors for operating on 60-cycle polyphase alternating-current circuits, and motor-generator sets for all purposes.

W. S. ROCKWELL CO., 50 Church St., New York. Catalogue No. 15 on rotary annealing and hardening furnaces for annealing, hardening, tempering, blowing or other heat-treatment of brass, copper, steel and other metals.

WATSON-STILLMAN CO., 192 Fulton St., New York. Catalogue No. 84 on hydraulic accumulators and fittings, special hydraulic apparatus, reservoirs, etc. Seven principal types of accumulators are illustrated and described.

FIDELITY & CASUALTY CO., 92 Liberty St., New York. Pamphlet entitled "Steam-Boiler Explosions" by Wm. H. Boehm, an illustrated lecture delivered at Cornell University before the student branch of the A. S. M. E. May 3, 1912.

LUCAS MACHINE TOOL CO., E. 99th St. & L. S. & M. S. Ry., Cleveland, O. Circular describing new model No. 31 "Precision" horizontal boring, drilling and milling machine. The machine is furnished with a vertical milling attachment to order.

READING IRON CO., Reading, Pa. Pamphlet on characteristics of wrought iron pipe and steel pipe, showing the superior qualities of wrought iron pipe. The results of investigations are both interesting and valuable to users of steel and iron exposed to weather conditions.

TRIUMPH ELECTRIC CO., Cincinnati, Ohio. Bulletin No. 501 on "Triumph-Monitor" reversing motor planer drive, showing its application to a Cincinnati planer, the monitor controller, speed curves during reversal of the dynamic brake type, and the "Triumph-Monitor" equipment.

H. BICKFORD & CO., Lakeport, N. H. Leaflet illustrating and describing the 36-inch Bickford vertical chucking machine, designed and placed upon the market to supply the increasing demand for a low-priced, well made tool, suitable for chucking car wheels, gears, pulleys and work of this character.

LANDIS MACHINE CO., Waynesboro, Pa. Catalogue No. 20 on pipe and nipple threading machinery, illustrating the Landis tangent thread chaser, details of the Landis all-steel die-head, and other features of the machine. Six styles and sizes of the machines are illustrated, and specifications given.

PH. BONVILLAIN & E. RONCERAY, Paris, France. Catalogue No. 6 on foundry equipment and supplies, comprising cupolas, ladles, molding machines, furnaces, blowers, molders' tools, core-making machines, core ovens, blow-torches, pneumatic rammers, tumbling barrels, air compressors, templet cutting machines, pyrometers, etc.

VULCAN ENGINEERING SALES CO., 2014 Fisher Bldg., Chicago, Ill. Circular illustrating "Type 1M" cold metal sawing machine, the smallest metal sawing machine made by the company. This machine is especially adapted to meet the requirements of small shops. The machine has a capacity for rounds up to six inches diameter; squares, six inches diameter; and I-beams, ten inches vertical.

AMERICAN BLOWER CO., Detroit, Mich. Catalogue No. 343 entitled "Mechanical Draft Forced and Induced by 'Sirocco' and 'A B C' Blowers and Exhaust Fans." The catalogue calls attention to the natural advantages realized with artificial draft produced by mechanical means. It is illustrated with photographs of actual installations with a view to making clear the various methods of applying fans to steam boilers.

FAIRBANKS, MORSE & CO., Wabash Ave. and Eldredge Pl., Chicago, Ill. Pamphlet on the electrical equipment of the Louisville Planing Mill & Hard Wood Flooring Co.'s mill, showing the application of Fairbanks, Morse & Co.'s electric motors to double surfacers, inside molder, and Sturtevant blower. A schedule of all the motors in the installation giving horsepower and names of machines is included.

INGERSOLL-RAND CO., 11 Broadway, New York. Bulletin 4209 describing the Temple-Ingersoll electric air drill; Bulletin 4023 describing the 4-E type electric air rock drill; Bulletin 4025 describing the 5-F electric air rock drill; Catalogue 384-F giving instructions for installing and operating the Temple-Ingersoll electric air rock drills; and Form 601 giving instructions for operating 5-F machine and list of duplicate parts.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Catalogue No. 10 on small motors for household and other purposes; descriptive leaflet No. 2444 on motor-generator flywheel sets; descriptive leaflet No. 2457 on commutating-pole rotary converters; descriptive leaflet No. 2359-A on direct-current commutating-pole motors—type SK; and descriptive leaflet No. 3506 on installations of paper mill motors for pulp mill service.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4958 on Direct-Current Railways of 1200, 1500 and 2400 volts. This bulletin comprises 129 pages descriptive of electric railway installations and equipment, profusely illustrated with halftones and line engravings; Bulletin No. 4978, Irrigation with Electrically-driven Pumps; Bulletin No. 4932, Electricity in the Brewing Industry; Bulletin No. 4976, Electric Drive in Grain Elevators and Flour Mills.

BROWN & SHARPE MFG. CO., Providence, R. I. Booklet entitled "Points About Grinding Wheels and Their Selection," taking up abrasives, bond, grade of wheels, selection of wheels, speed of wheels, combination of wheel and work speeds in cylindrical grinding, mounting wheels, balance of wheels, truing wheels, safety, use of water, suggestions for ordering grinding wheels, list of grinding wheels, suggestions on selection of wheels for use on B. & S. grinding machines, etc.

MESTA MACHINE CO., Pittsburg, Pa. Booklet entitled "Brief Description and Illustrations of the Plant and Product of the Mesta Machine Co., Pittsburg, Pa." This booklet is illustrated with halftones showing the buildings and interior views of the various departments of the company's plant, as well as a great number of illustrations of machines of various types built by the concern, including Corliss engines, air compressors, blowing engines, condensers, hydraulic forging presses.

TRAVELERS INSURANCE CO., Hartford, Conn., have begun the publication of a periodical called the *Travelers' Standard* which will deal with engineering matters of all kinds, but will be mainly concerned with safety engineering, as applied to construction work, manufacturing, mining, power generation and transmission, the electrical and chemical industries, and every other form of activity in which machinery or tools are used. The October number contains an article of general engineering interest entitled, "The Factor of Safety."

B. F. STURTEVANT CO., Hyde Park, Mass. Catalogue No. 205 on gasoline electric generating sets for isolated electric generating plants. These sets are built in 5 K. W., 10 K. W., and 15 K. W. capacities. They are admirably suited for electric lighting and power purposes on farms, country clubs, and other places remote from cities and sources of electric power supply. The catalogue illustrates details of construction, and will be found of general interest to all concerned with the problem of generating electric power with small units.

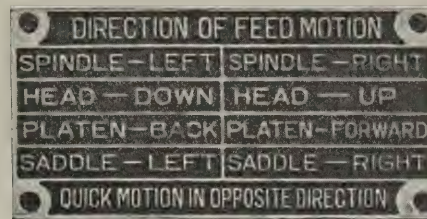
PENNSYLVANIA RAILROAD CO., Philadelphia, Pa., has issued a booklet for distribution in connection with the semi-centennial of the loyal war governors' conference of September 24, 1862, which was held in Altoona, Pa., September 24-26, 1912. The booklet is illustrated with views of the Conestoga wagon, canal packet on the old Pittsburg line, locomotive "Lancaster" and first steam train to the West; facsimile of original poster advertising schedule and rates to Pittsburg, and facsimile of original poster of schedule Philadelphia to Pittsburg trips in four and one-half days.

ARMSTRONG BROS. TOOL CO., 313 N. Francisco Ave., Chicago, Ill. Catalogue of tool-holders, comprising lathe, planer, shaper, slotter and other tool-holders; boring tools, drill-holders, cutting-off tools, side tools, lathe tool cabinets, knurling tools, grinding holders, cutting-off and grinding machines, high-speed steel, lathe dogs, boxed C clamps, planer jacks, drill drifts, blacksmiths' drill sockets, ratchet drills, drilling posts, drop-forged open-end wrenches, hexagon box wrenches, square box wrenches, construction wrenches, automobile wrench sets, socket wrenches, alligator wrenches, etc.

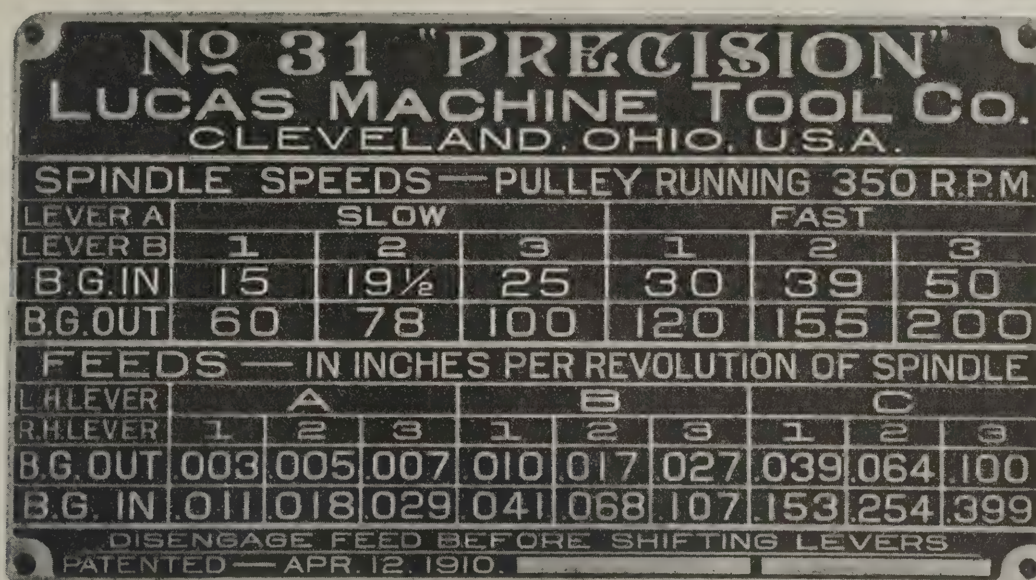
CROCKER-WHEELER CO., Ampere, N. J. Booklet on Ampere, showing its situation relative to New York and Newark, illustrating the plants, railway station, U. S. post office, interior of shops, and other features of mechanical interest, including one of the C. & C. motors made by the Curtis & Crocker Electric Co., the forerunner of the present Crocker-Wheeler Co. The history of the company includes brief biographies of Dr. Schuyler S. Wheeler and Prof. Francis B. Crocker. The booklet is an unusually interesting and attractive piece of literature on the physical and personal characteristics of a large manufacturing plant.

TRAVELERS INSURANCE CO., Hartford, Conn. Pamphlet on grinding wheels, being one of a series of text-books on safety of operation of plants and machinery. The pamphlet treats of emery wheels, stands, bearings, spindles, belt drive, flanges, washers, fitting of wheels, inspection of wheels, tightening nuts, tool-rests, speed, truth and balance, hoods, goggles, causes of accidents, grindstones, proper mounting and safe speed for same, and polishing wheels. Tables of speeds of emery wheels and grindstones, and illustrations of exhaust hoods,

ONLY TWO



PLATES



— ON THE —

"PRECISION" BORING, DRILLING AND MILLING MACHINE

One to show the speeds and feeds, and the other to show the direction of feeds, as the design of the machine is such that no other plates than these are necessary, the function of every lever being obvious and the feeds being of the same number and same value wherever used.

SIMPLICITY SECURES SUPERIOR SERVICE

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U.S.A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

CONTENTS FOR NOVEMBER

The first column of page numbers applies to the Engineering and Railway Editions: the second to the Shop Edition.

safety hoods, mounting for grinding wheels, etc., are included. The practical information and safety matters given in this little book, make it well worth the attention of every mechanical engineer, superintendent, foreman and mechanic.

Pratt & Whitney Co., Hartford, Conn. General office, 111 Broadway, New York. Catalogue of grinding machines, comprising four-inch by thirty-inch automatic cylindrical sizing grinder, six-inch by forty-eight-inch automatic sizing grinder, and three-foot and six-foot vertical surface grinders; circular illustrating and describing the Pratt & Whitney three-foot vertical surface grinder, and double and quadruple magnetic chucks for the rapid production of ground parts; circular of the Pratt & Whitney vertical shaper, designed to supply the needs of a machine suitable for doing regular slotting work which can also handle the work performed on the horizontal shaper; circulars of thread milling machines, spline milling machines and automatic profiling machines.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. Catalogue No. 71 of Barnes upright drills and other machine tools, comprising friction disk drills of 8- and 10-inch swing; upright drill No. 7, 15-inch swing with cone pulley drive, no back-gears, with or without gear tapping attachment; upright drills Nos. 1, 6, 1½, 2, 5 and 9 of 20, 22, 22½, 25 and 26 inches swing respectively; Nos. 2½ and 3 of 28 and 32 inches swing, respectively; upright drills Nos. 4 and 8 of 42 and 50 inches swing, respectively. Gear tapping attachments are furnished for all sizes of drills from 15 to 50 inches swing. The catalogue also illustrates and describes gang drills, horizontal radial drills, adjustable screw presses, motor drives for upright drills, water emery grinders, chucks, drill sockets, Barnes universal sliding chuck attachment, etc.

TRADE NOTES

National Machine Tool Co., Cincinnati, Ohio, will move into its new plant on Spring Grove Ave., about January 1, 1913.

Herbert L. Towle, advertising specialist, has removed to new offices in the Philadelphia National Bank Bldg., 421 Chestnut St., Philadelphia.

S. A. Woods Machine Co., Boston, Mass., the controlling interest in which was recently purchased by Messrs. C. W. H. Blood and H. C. Dodge, now has the following officers: H. C. Dodge, president, and C. W. H. Blood, vice-president and treasurer. The management in other respects will remain practically the same as before.

Ideal Case Hardening Compound Co., United States Rubber Bldg., New York. Pamphlet on casehardening, pack-hardening and annealing steel, containing in condensed form much useful information on the heat-treatment of steel and practical rules for securing the desired results. The pamphlet is one that should be welcomed by all concerned with the heat-treatment of steel. Sent free upon request.

Tate, Jones & Co., Inc., Empire Bldg., Pittsburg, Pa., is compiling a hand-book for the use of blacksmiths and forge-shop workers, which is expected to fill a long-felt want. The compilers request that blacksmiths and forge-workers send in handy receipts and shop kinks. Credit will be given for all these in the book. The effort is being made to compile the ideas of the leading blacksmiths throughout the country and thus make the book the best of its kind.

Brown Instrument Co., Philadelphia, Pa., and its associated company, the Keystone Electrical Instrument Co., have found a large increase in their shop facilities necessary and have arranged to triple the space after January 1. The two companies have had a very large increase in the demand for their pyrometers, thermometers and electrical instruments, and an increase in their factory equipment is necessary to meet the needs of the constantly growing business.

Walter H. Foster Co., 50 Church St., New York, has opened an office in the McCormick Bldg., Chicago, Ill., under the management of Mr. William Brewster, formerly associated with the Celfor Tool Co. The Walter H. Foster Co. will have the exclusive sale in that section for the Baush Machine Tool Co.'s multiple and radial drills, and the Lassiter bolt machinery; also the Quigley Furnace & Foundry Co. furnaces for all industrial requirements, complete furnace equipments, etc.

Sawyer Tool Mfg. Co., Fitchburg, Mass., maker of machinists' small tools, steel scales, etc., will move about November 1 to Ashburnham, Mass. eight miles from Fitchburg. The company has been in business in Fitchburg over ten years, and better facilities are now required to provide for the growth of the business. Three large brick buildings, affording 84,000 square feet of floor space or about seven times the area of the Fitchburg plant, will be occupied. Mr. Carl H. Hubbell is president of the company.

Hess-Bright Mfg. Co., Philadelphia, Pa., has built a new factory and office at Front St. and Erie Ave., having a frontage of 200 feet and a depth of 235 feet. The entire second floor, to the depth of 35 feet, is devoted to offices. Back of the offices the building is one-story high with sawtooth roof. The bulk of the company's product is imported, and the output of the shops will represent but a small proportion of the entire business. The present building forms the nucleus of a much larger plant which is eventually to be erected.

Greenfield Tap & Die Corporation, Greenfield, Mass., a holding company that controls the stock of the Wiley & Russell Mfg. Co. and Wells Brothers Co., acquired the entire stock of the A. J. Smart Mfg. Co. on October 1. The A. J. Smart Mfg. Co. was organized six years ago and quickly established a name for the manufacture of the highest class of taps, dies and screw plates. The company will be continued as a separate organization, and conditions are extremely favorable for the continuation of its rapid growth. The new officers are: President, F. O. Wells; vice-president, Rollin S. Bascom; treasurer and clerk, F. H. Payne; directors, the above, and M. Pratt and J. W. Stevens.

Taylor Iron & Steel Co., High Bridge, N. J., has acquired the business of Wm. Wharton, Jr., & Co., Inc. of Philadelphia, with works at Philadelphia and Jenkintown Pa., and its subsidiary corporation the Philadelphia Roll & Machine Co. The Taylor Co. and the Wharton Co. have both been in business more than fifty years. During the last eighteen years, the business of each company has been largely supplementary to the other in the application and manufacture of manganese steel, and the relations have become so close that a unity of interest has been found advisable. The new concern will be known as the Taylor-Wharton Iron & Steel Co., and the officers will be as follows: President, Knox Taylor; vice-presidents, A. E. Borie, Prof. H. M. Howe and V. Angerer; secretary and treasurer, W. A. Ingram.

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—I

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
Number of Teeth in Cutter to be Fluted = 6										
20	70	23° 18′	0.020	0.7575	0.040	0.7395	0.080	0.7011	0.120	0.6651
	80	39° 40′		0.5251		0.5125		0.4875		0.4625
30	70	16° 32′	0.020	0.7751	0.040	0.7575	0.080	0.7200	0.120	0.6832
	80	29° 22′		0.5750		0.5605		0.5329		0.5020
40	70	11° 58′	0.020	0.7875	0.040	0.7661	0.080	0.7295	0.120	0.6920
	80	21° 48′		0.6035		0.5877		0.5590		0.5310
45	70	10° 12′	0.020	0.7900	0.040	0.7700	0.080	0.7320	0.120	0.6968
	80	18° 44′		0.6120		0.5970		0.5678		0.5395
50	70	8° 39′	0.020	0.7912	0.040	0.7710	0.080	0.7330	0.120	0.6980
	80	15° 59′		0.6190		0.6039		0.5725		0.5450
60	70	6° 2′	0.020	0.7925	0.040	0.7750	0.080	0.7360	0.120	0.6998
	80	11° 12′		0.6300		0.6155		0.5850		0.5551
70	70	3° 49′	0.020	0.7960	0.040	0.7782	0.080	0.7390	0.120	0.7005
	80	7° 10′		0.6340		0.6200		0.5900		0.5595
80	70	1° 52′	0.020	0.7965	0.040	0.7787	0.080	0.7395	0.120	0.7010
	80	3° 30′		0.6355		0.6210		0.5910		0.5601
Number of Teeth in Cutter to be Fluted = 8										
20	60	31° 53′	0.020	0.6380	0.040	0.6210	0.080	0.5901	0.120	0.5478
	70	43° 53′		0.4550		0.4434		0.4219		0.3900
	80	53° 45′		0.2895		0.2825		0.2682		0.2481
30	60	24° 12′	0.020	0.6555	0.040	0.6397	0.080	0.6071	0.120	0.5650
	70	31° 25′		0.4849		0.4725		0.4490		0.4162
	80	42° 55′		0.3298		0.3224		0.3052		0.2835
40	60	18° 15′	0.020	0.6681	0.040	0.6501	0.080	0.6172	0.120	0.5715
	70	26° 33′		0.5048		0.4925		0.4675		0.4331
	80	33° 36′		0.3582		0.3491		0.3319		0.3067
45	60	15° 48′	0.020	0.6701	0.040	0.6530	0.080	0.6205	0.120	0.5754
	70	23° 8′		0.5111		0.4983		0.4740		0.4391
	80	29° 25′		0.3710		0.3608		0.3433		0.3170
50	60	13° 33′	0.020	0.6724	0.040	0.6541	0.080	0.6235	0.120	0.5767
	70	20° 0′		0.5190		0.5032		0.4778		0.4438
	80	25° 30′		0.3785		0.3680		0.3507		0.3240
60	60	9° 37′	0.020	0.6761	0.040	0.6600	0.080	0.6281	0.120	0.5801
	70	14° 20′		0.5249		0.5112		0.4860		0.4485
	80	18° 24′		0.3900		0.3801		0.3600		0.3349
70	60	6° 10′	0.020	0.6810	0.040	0.6626	0.080	0.6300	0.120	0.5804
	70	9° 14′		0.5335		0.5187		0.4930		0.4552
	80	11° 55′		0.4021		0.3910		0.3690		0.3425
80	60	3° 2′	0.020	0.6750	0.040	0.6646	0.080	0.6250	0.120	0.5800
	70	4° 30′		0.5350		0.5225		0.4961		0.4595
	80	5° 50′		0.4065		0.3980		0.3777		0.3497

Contributed by George W. Burley

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—II

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
Number of Teeth in Cutter to be Fluted = 10										
20	45	24° 18′	0.020	0.7340	0.040	0.7091	0.080	0.6591	0.120	0.6091
	50	32° 0′		0.6215		0.6019		0.5627		0.5235
	60	43° 18′		0.4606		0.4451		0.4140		0.3829
	70	51° 50′		0.3204		0.3094		0.2875		0.2656
	80	59° 4′		0.1947		0.1881		0.1749		0.1617
30	45	18° 14′	0.020	0.7422	0.040	0.7160	0.080	0.6636	0.120	0.6112
	50	24° 45′		0.6430		0.6204		0.5742		0.5299
	60	34° 30′		0.4800		0.4630		0.4290		0.3950
	70	42° 3′		0.3433		0.3312		0.3070		0.2828
	80	48° 30′		0.2225		0.2135		0.1956		0.1777
40	45	12° 30′	0.020	0.7680	0.040	0.7421	0.080	0.6903	0.120	0.6385
	50	18° 55′		0.6500		0.6275		0.5826		0.5376
	60	27° 3′		0.4918		0.4746		0.4403		0.4060
	70	33° 31′		0.3601		0.3431		0.3210		0.2953
	80	38° 50′		0.2439		0.2355		0.2187		0.2019
45	45	11° 47′	0.020	0.7500	0.040	0.7235	0.080	0.6705	0.120	0.6175
	50	16° 10′		0.6591		0.6394		0.5999		0.5604
	60	23° 40′		0.4975		0.4700		0.4450		0.4100
	70	29° 24′		0.3682		0.3553		0.3294		0.3036
	80	34° 20′		0.2528		0.2439		0.2260		0.2081
50	45	10° 7′	0.020	0.7465	0.040	0.7206	0.080	0.6687	0.120	0.6168
	50	14° 10′		0.6539		0.6311		0.5856		0.5400
	60	20° 31′		0.5000		0.4826		0.4479		0.4131
	70	25° 40′		0.3725		0.3594		0.3333		0.3072
	80	30° 1′		0.2601		0.2510		0.2327		0.2145
60	45	7° 8′	0.020	0.7500	0.040	0.7240	0.080	0.6720	0.120	0.6200
	50	10° 5′		0.6595		0.6363		0.5898		0.5433
	60	14° 50′		0.5049		0.4875		0.4528		0.4181
	70	18° 37′		0.3804		0.3673		0.3411		0.3149
	80	21° 56′		0.2709		0.2613		0.2422		0.2231
70	45	4° 34′	0.020	0.7503	0.040	0.7243	0.080	0.6723	0.120	0.6203
	50	6° 30′		0.6598		0.6389		0.5920		0.5451
	60	9° 36′		0.5101		0.4924		0.4568		0.4212
	70	12° 8′		0.3872		0.3730		0.3460		0.3190
	80	14° 20′		0.2785		0.2688		0.2494		0.2300
80	45	2° 14′	0.020	0.7498	0.040	0.7238	0.080	0.6719	0.120	0.6200
	50	3° 10′		0.6603		0.6376		0.5923		0.5469
	60	4° 45′		0.5078		0.4902		0.4550		0.4198
	70	6° 0′		0.3875		0.3740		0.3470		0.3200
	80	7° 5′		0.2820		0.2724		0.2532		0.2340

Contributed by George W. Burley

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—III

Number of Teeth in Cutter to be Fluted = 12

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	36° 0'		0.5718		0.5480		0.5004		0.4528
	50	40° 40'		0.5017		0.4807		0.4387		0.3967
20	60	49° 19'	0.020	0.3620	0.040	0.3470	0.080	0.3170	0.120	0.2870
	70	56° 1'		0.2475		0.2371		0.2163		0.1955
	80	61° 50'		0.1454		0.1393		0.1271		0.1149
	45	28° 8'		0.5806		0.5566		0.5086		0.4606
	50	32° 32'		0.5128		0.4912		0.4480		0.4048
30	60	40° 12'	0.020	0.3760	0.040	0.3602	0.080	0.3286	0.120	0.2970
	70	46° 15'		0.2649		0.2537		0.2313		0.2089
	80	51° 25'		0.1657		0.1589		0.1453		0.1317
	45	22° 0'		0.5890		0.5642		0.5146		0.4650
	50	25° 33'		0.5191		0.4973		0.4537		0.4101
40	60	32° 2'	0.020	0.3870	0.040	0.3708	0.080	0.3384	0.120	0.3060
	70	37° 15'		0.2769		0.2653		0.2421		0.2189
	80	41° 44'		0.1803		0.1727		0.1575		0.1423
	45	18° 55'		0.5981		0.5729		0.5225		0.4721
	50	22° 13'		0.5260		0.5040		0.4600		0.4160
45	60	28° 19'	0.020	0.3920	0.040	0.3752	0.080	0.3416	0.120	0.3080
	70	33° 0'		0.2832		0.2714		0.2478		0.2242
	80	37° 6'		0.1865		0.1787		0.1631		0.1475
	45	16° 31'		0.5980		0.5728		0.5224		0.4720
	50	19° 27'		0.5261		0.5039		0.4595		0.4150
50	60	24° 43'	0.020	0.3950	0.040	0.3784	0.080	0.3452	0.120	0.3120
	70	28° 54'		0.2878		0.2757		0.2515		0.2273
	80	32° 33'		0.1937		0.1857		0.1697		0.1537
	45	12° 12'		0.5960		0.5652		0.5156		0.4660
	50	14° 13'		0.5245		0.5001		0.4573		0.4145
60	60	18° 0'	0.020	0.4000	0.040	0.3834	0.080	0.3502	0.120	0.3170
	70	21° 10'		0.2950		0.2826		0.2578		0.2330
	80	23° 58'		0.2021		0.1935		0.1763		0.1591
	45	8° 0'		0.5875		0.5629		0.5137		0.4645
	50	9° 8'		0.5300		0.5080		0.4640		0.4200
70	60	11° 45'	0.020	0.4035	0.040	0.3865	0.080	0.3525	0.120	0.3185
	70	13° 54'		0.2986		0.2864		0.2620		0.2376
	80	15° 45'		0.2082		0.1994		0.1818		0.1642
	45	3° 46'		0.6005		0.5753		0.5249		0.4745
	50	4° 30'		0.5298		0.5078		0.4638		0.4198
80	60	5° 48'	0.020	0.4049	0.040	0.3879	0.080	0.3539	0.120	0.3199
	70	6° 51'		0.3040		0.2912		0.2656		0.2400
	80	7° 48'		0.2120		0.1932		0.1756		0.1680

Contributed by George W. Burley

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—IV

Number of Teeth in Cutter to be Fluted = 14

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	42° 5'		0.4755		0.4525		0.4065		0.3605
	50	46° 0'		0.4132		0.3932		0.3532		0.3132
20	60	53° 4'	0.020	0.2960	0.040	0.2817	0.080	0.2531	0.120	0.2245
	70	58° 40'		0.2000		0.1902		0.1706		0.1510
	80	63° 30'		0.1150		0.1094		0.0982		0.0870
	45	33° 51'		0.4860		0.4630		0.4170		0.3710
	50	37° 27'		0.4226		0.4019		0.3607		0.3195
30	60	43° 50'	0.020	0.3069	0.040	0.2921	0.080	0.2625	0.120	0.2329
	70	48° 52'		0.2128		0.2024		0.1816		0.1608
	80	53° 15'		0.1294		0.1232		0.1108		0.0984
	45	26° 39'		0.4945		0.4705		0.4225		0.3745
	50	29° 50'		0.4296		0.4086		0.3666		0.3246
40	60	35° 20'	0.020	0.3150	0.040	0.2996	0.080	0.2688	0.120	0.2380
	70	39° 40'		0.2231		0.2123		0.1907		0.1691
	80	43° 30'		0.1410		0.1342		0.1206		0.1070
	45	23° 24'		0.4959		0.4719		0.4239		0.3759
	50	26° 10'		0.4360		0.4146		0.3718		0.3290
45	60	31° 19'	0.020	0.3198	0.040	0.3042	0.080	0.2730	0.120	0.2418
	70	35° 18'		0.2275		0.2165		0.1945		0.1725
	80	38° 45'		0.1470		0.1398		0.1254		0.1110
	45	20° 30'		0.4970		0.4730		0.4250		0.3770
	50	22° 59'		0.4370		0.4156		0.3728		0.3300
50	60	27° 27'	0.020	0.3225	0.040	0.3069	0.080	0.2757	0.120	0.2445
	70	31° 0'		0.2320		0.2208		0.1984		0.1760
	80	34° 10'		0.1510		0.1436		0.1288		0.1140
	45	15° 14'		0.4980		0.4740		0.4260		0.3780
	50	16° 45'		0.4384		0.4168		0.3736		0.3304
60	60	20° 5'	0.020	0.3280	0.040	0.3120	0.080	0.2800	0.120	0.2480
	70	22° 50'		0.2371		0.2257		0.2029		0.1801
	80	25° 15'		0.1572		0.1496		0.1344		0.1192
	45	9° 45'		0.4986		0.4746		0.4266		0.3786
	50	10° 55'		0.4410		0.4192		0.3756		0.3320
70	60	13° 11'	0.020	0.3325	0.040	0.3163	0.080	0.2839	0.120	0.2515
	70	15° 0'		0.2437		0.2317		0.2077		0.1837
	80	16° 39'		0.1632		0.1552		0.1392		0.1232
	45	5° 0'		0.4990		0.4750		0.4270		0.3790
	50	5° 24'		0.4420		0.4202		0.3766		0.3330
80	60	6° 32'	0.020	0.3330	0.040	0.3170	0.080	0.2850	0.120	0.2530
	70	7° 29'		0.2474		0.2348		0.2096		0.1844
	80	8° 15'		0.1676		0.1594		0.1430		0.1266

Contributed by George W. Burley

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

DECEMBER, 1912

TRANSCONA SHOPS OF THE NATIONAL TRANSCONTINENTAL RAILWAY

SOME CONSTRUCTION AND EQUIPMENT FEATURES OF A MODERN RAILWAY SHOP

BY GEORGE S. HODGINS*

W. J. Press, Mechanical Engineer of the N. T. Railway

THE National Transcontinental Railway is being constructed by the Government of Canada, with the intention of leasing it to the Grand Trunk Pacific Railway for fifty years. The Transcontinental, itself, extends from Moncton, N. B., to Winnipeg, Man., a distance of 1800 miles. At Moncton are the shops of the Intercolonial Railway, so that when the present undertaking is completed the Dominion Government will own a line from Sydney, on Cape Breton Island, to Winnipeg, Man.—a distance of about 2730 miles. The Intercolonial is both owned and operated by the government. The line from Moncton to Winnipeg will be operated by the Grand Trunk Pacific which is one of the subsidiary lines of the Grand Trunk Railway of Canada.

The following was, in part, embodied in an extensive and detailed report made to the Dominion Government by the writer, acting as consulting mechanical engineer of the National Transcontinental Railway. The writer was formerly connected with the mechanical department of the Canadian Pacific Railway, and has recently been engaged in technical journalism in New York. When the Government of Canada desired to secure an impartial expert opinion regarding shops and equipment, he was selected as a man who was no stranger to Canada and Canadian requirements, and yet had been out of the country long enough so that he would not be acquainted with those engaged on the work.

The Transcona shops were begun in 1909 with Mr. F. W. Walker in charge. On May 23, 1910, Mr. W. J. Press was

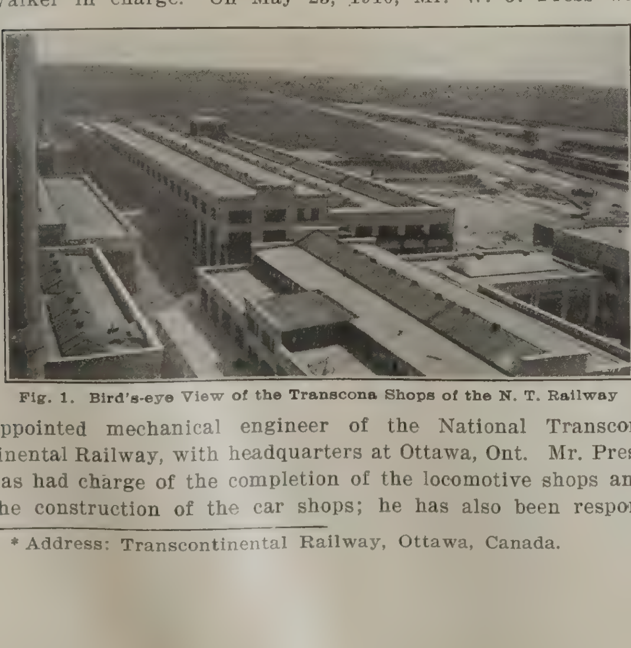


Fig. 1. Bird's-eye View of the Transcona Shops of the N. T. Railway

appointed mechanical engineer of the National Transcontinental Railway, with headquarters at Ottawa, Ont. Mr. Press has had charge of the completion of the locomotive shops and the construction of the car shops; he has also been responsible for the selection and installation of the equipment at Winnipeg, and all the other shops along the line. Mr. Press is an Australian, having served his apprenticeship on a government railway in his own country, where he worked in various capacities. He is, therefore, well qualified for service in building a road in Canada under governmental agency, where conditions are somewhat similar to those in Australia. Mr. Press served with the Royal Engineers during the Boer war, and was given charge of the principal locomotive and carriage shops of the Imperial Military Railways at Pretoria. During the war, he constructed a number of armored trains and had charge of the repair work on a railway taxed to the utmost by casualties among the operating force, and by the destruction and waste of war. It has often been the legitimate boast of mechanical men on a railway, that they are frequently compelled to do a great amount of work with very little material, but in this case ordinary failures were augmented by the wholesale destruction of serviceable locomotives. Over one hundred locomotives were blown up, others were disabled, and much ingenuity had to be exercised in order to keep things moving in the face of a lack of spare

Fig. 2. The Erecting and Machine Shop

parts and scarcity of material. In addition, the repairing of ordnance, gun-carriages, etc., was thrust upon the shop. After peace was declared, Mr. Press became works manager of the Central South African Railway Shops and later joined the staff of the Canadian Pacific Railway in Canada; later on he reentered government employ as mechanical engineer of the National Transcontinental Railway.

The Transcona Shops are built about five miles out of Winnipeg and are on ground slightly lower than the surrounding country. The soil is sticky clay and was overlayed with about four feet of gravel, so that although the surface is dry, the foundations are between ten and twelve feet deep. One of the most striking differences between these and other shops is the floor area and the number of pits. These shops are 612 by 170 feet in size, which gives a floor area of 104,000 square feet. A rough idea of the ratio of pits to floor may be gathered from the fact that there are twenty-four pits, the floor area per pit being about 4000 square feet. It must be remembered, however, that provision for growth has been made in the planning of these shops. The ratio of the floor area of the machine shop, to the area of the gallery is 1.45 to 1. These figures are only approximations, but in a general way they indicate the value of the floor space.

The grouping of the buildings brings the locomotive shops

* Address: Transcontinental Railway, Ottawa, Canada.

in close proximity to each other, and the car shops are also grouped together; the general shops that serve both locomotive and car shops occupy intermediate positions. The shop cranes have open lattice girders that do not seriously obstruct the light; they are operated by A. C. motors of special design, and each crane is equipped with an arrangement which automatically prevents the load being hauled up against the drum. When the lower pulley reaches a certain point, it throws out a limit switch on the lifting circuit and shuts off the current. The fall of a solenoid core results, and draws up a powerful hand brake; a mechanical brake also operates. The load can-

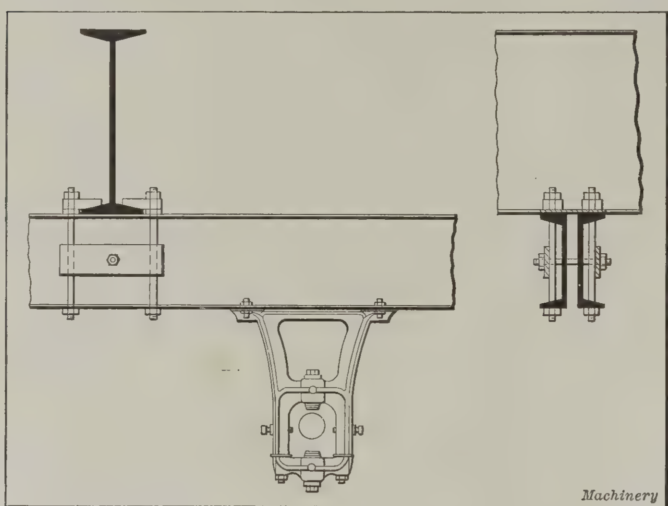


Fig. 3. Method of supporting Shaft Hangers in Transcona Shops

not be overwound, and the intentional release of the brake is necessary before the load can be lowered. The various switches and contacts are covered, so that the operator is protected from accidental contact with them.

The twenty-four working pits are placed at right angles to the length of the shop. This arrangement makes it necessary for an engine that is being placed over a pit or removed to be lifted by the 120-ton crane high enough to pass over the other locomotives. This method has the advantage of doing away with a transfer table, and of avoiding its first cost, maintenance and operating charges, which are necessarily high where the cold is severe and where the snow-fall, if not heavy, is sufficiently dry to drift readily. The cross pits also do away with a series of doors, with their liability to warp or be damaged and broken. Each locomotive enters and leaves by one of two doors, and is placed with the pilot facing the outer wall. The front end is opposite a window, and near a jib crane, one crane being provided for every two pits. These cranes lift smokebox doors, fronts, superheater pipes, etc., and thus leave the 10-ton shop crane to do the work for which it was legitimately intended, without being held up on "local" work. The pits are supplied with cold water and live steam. The pipes for compressed air and cold water, and the wires for electricity are on the posts nearby. The pipes in the pits are placed in grooves in the concrete walls so that they are not liable to damage by material falling on them.

In the machine shop, the tendency today is to replace general utility machines by more highly specialized ones. The old-time lathe and slotter have been largely replaced by machines designed to perform certain kinds of work at higher speeds and with greater facility. Modern multiple-head or turret drills replace the old-fashioned drill press, so that a number of similar operations can be quickly and accurately performed without the necessity of changing the tool.

A uniform method of setting all the machines has been adopted for the purpose of securing rigidity. The great majority of machines stand on reinforced concrete foundations about eleven feet deep. The machines are held by bolts bedded in the concrete, and the foundations are built up to within half-an-inch of the 3-inch plank floor. After being leveled and bolted down, concrete grouting is run around the machine base, flush with the floor and sloping slightly up to the base of the machine. This slight slope is provided to let the water due to condensation or moisture run off from the base of the machine, thus keeping it dry. The bedding of the machine in grouting makes it solid, with no tendency to work loose or to put any strain on the bolts. This method has also been applied to the shop posts, so that there is no tendency for an accumulation of water or moisture to rust or eat into the base of the columns.

The main lineshafting for one set of group-driven machines is in perfect alignment with that of the next set. In case of emergency, this arrangement would enable one group to be driven by the motor of the next group. For example, if motor No. 1 breaks down, one length of shafting can be taken down and have a coupling applied; the shaft may then be replaced and driven by motor No. 2. The hangers for the shop shafting—either main or countershaft—are bolted to steel channels placed on edge with webs inside. These channels are clamped to the steel I-beams of gallery or roof, the arrangement being shown in Fig. 3. Small cast-iron pieces with flat tops rest on the level surfaces of the I-beam flanges. The bolts, when tightened up, hold the small channels in place. Each set of clamping bolts is held together with a small plate and bolts which prevent slipping. These hanger-carriers are easily removed and are capable of application anywhere about the shop.

The placing of the machines has been carefully studied so that no reverse movement of material takes place. Rods, full-sized boiler plates, or other long material may be moved to and from the machines without dodging or swinging away to avoid obstructions, and large pieces can be worked on machines without fouling the posts or obstructing other opera-

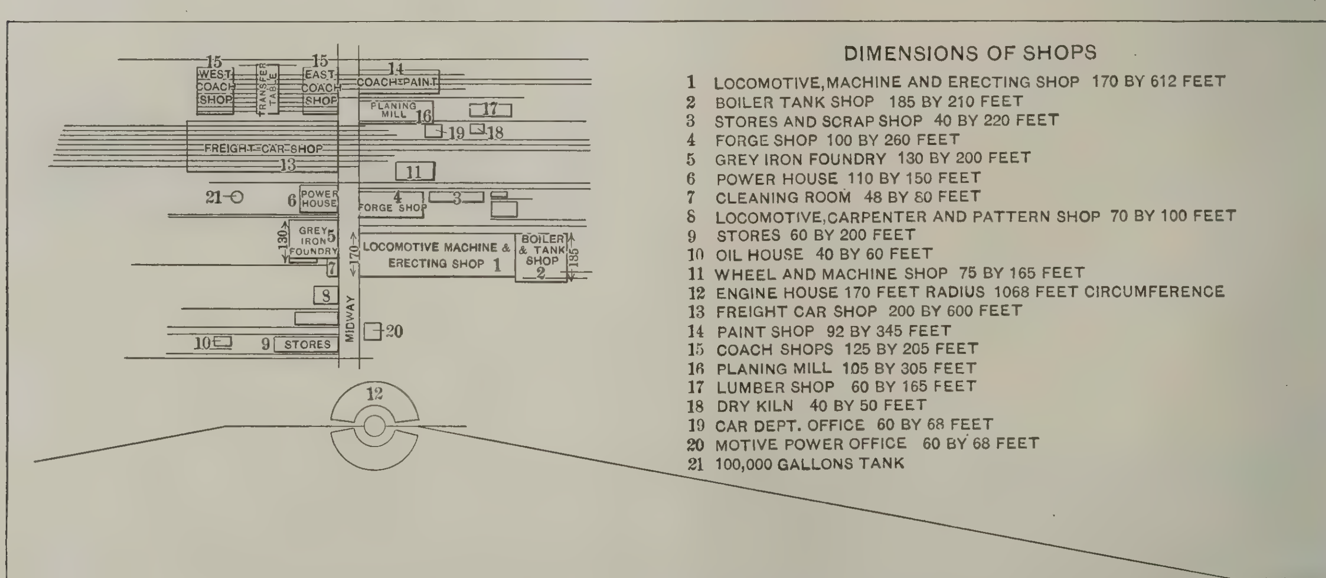


Fig. 4. Plan showing Layout of Shops of the N. T. Railway

tions. The straight-forward approach to each machine, and the adequate working area of each, has a beneficial effect on shop output.

In this shop, there are machines made in Canada, England and the United States. All have been selected on account of their merit, and the American machines give a good account of themselves. Near all large radial drills, pits have been provided so that any article of odd shape, that would not lie on the machine table, can be lowered into the pit and the drill arm swung over it. Belt-shifters and electric control handles of all machines have been placed with reference to the workman's convenience. This facilitates the operation of the machine and reduces the non-productive time and movement of the employe. A good example of a modern American machine used here is the Morton draw-cut cylinder planer and borer. This machine cuts on what would be the return stroke of an ordinary shaper, and gives a powerful stroke. The machine can plane all the flat surfaces of a locomotive cylinder casting, and bore the cylinders and piston valve chambers. It can mill out the steam and exhaust ports for a slide valve and drill all the holes in the cylinder and saddle. This machine is motor-driven, the motor being mounted on the machine. The wire connections which come up through the floor are contained in an upright iron pipe for protection. Flexible cable is used between stationary and moving parts, the cable being cased in a rubber hose.

Draw-cut shapers are used in the shop, on which the table is like a box and presents four surfaces. This box-like table can be revolved on a spindle. In case work has been set and is being done when a rush job has to be handled, the work in progress need not be taken off nor the setting altered. The table can be revolved so that another surface comes uppermost for the new work to be set on. After the new work is finished, the table can be turned back, and the original work proceeded with. This machine saves time and avoids discouraging the workman with two settings for one job.

The electric control for the riveting tower crane is placed on a level with the man who does the riveting. The crane-man does not ride overhead but stands beside the work. He is within speaking distance of those handling the boiler, and he can see what is going on without depending on signals. In the tank shop, an axle lathe is placed in a pit. The centers of this machine are approximately at the same height above the floor as the centers of an axle with wheels. The object of this is so that wheels can be rolled into this lathe without having to be lifted. The large boring machines have concrete pits below the floor so that the working parts, which are often inaccessible in other shops, can be got at with ease. A trap-door provides for entrance to each pit. The working parts are all below the surface and are open for inspection and adjustment. The Ryerson flue-rattler is below the surface, and the flues revolve in flowing water. Broken scale, etc., is effectively collected and removed. A circular pocket is located in the drain into which a bucket just fits. The flowing water fills the bucket and passes on, leaving the pulverized scale which sinks to the bottom; the shop crane draws the bucket and its contents out when required.

The locomotive shop is provided with two motor-driven air compressors, and the boiler shop with one. The pipes leading from the main air compressor in the power house are connected with these auxiliary compressors, the valves being so arranged that in case of breakdown, any of the other compressors can do the work. The shops may receive air from each other, or they may all draw air from the complete system. The locomotive compressors can supply the boiler shop, if both the main compressor and the boiler shop compressor give out. Likewise the boiler shop compressor can supply the locomotive shop, or the main compressor can supply any or all of the shops, in case the auxiliary compressors fail.

The large hydraulic flanger is provided with a simple safety feature. The opening, where the descending platen sinks below the floor, is protected at the edge by a wooden beading on the floor, so that a workman is not likely to get his foot caught between floor and platen. He cannot put his toes over the opening and keep his foot level, so that the unnatural position warns him of danger. The smithy contains steam hammers ranging from 200 to 5000 pounds. There is a pit at each side of these hammers provided with trap-doors. The pits give easy access to parts below, so that anvils may be leveled, and foundations inspected. This feature lessens cost and trouble, for in case adjustments have to be made, the shop floor is not encumbered and no time is lost making excavations. Among the machines in this shop is a cutting-off and centering machine. Axles forged here may be placed in this machine, cut to length and have a roughing cut run over them. They are then ready for shipment to outside stations, where they will be finished when used. Therefore, they do not have to be taken outside the smithy or handled in other shops. The whole of the Transcona plant at Winnipeg is an excellent example of modern design and equipment, of which the mechanical engineer and his staff may justly feel proud.

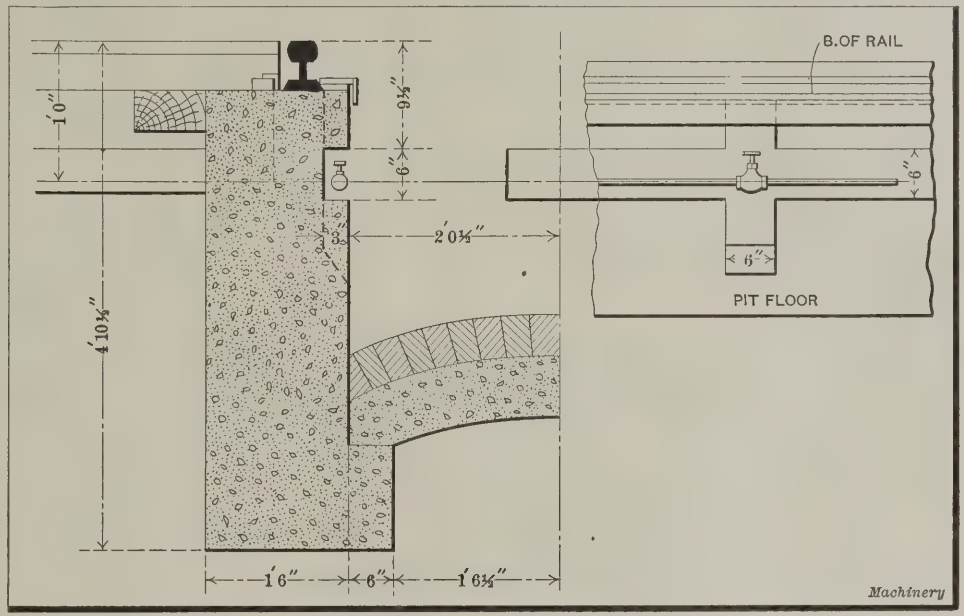


Fig. 5. Method of setting Water and Steam Pipes in Pit Walls

* * *

AUTOMATIC SPRINKLERS AND INSURANCE RATES

Figures gathered by the Chicago Association of Commerce, showing average insurance rates per $100 in that city, may be partially tabulated as follows:

	Buildings	Contents
Mill constructed buildings, with sprinklers....	$0.23	$0.32
Mill constructed buildings, without sprinklers.	.57	1.04
Ordinary constructed buildings, with sprinklers	.31	.40
Ordinary constructed buildings, without sprinklers	.77	1.19

If the contents of the average manufacturing or storage building are assumed to be worth double the value of the building, a general index for comparing buildings protected with automatic sprinklers and those not so protected is available. Mill constructed buildings on this basis will show an index of 87 for the protected building, whereas that of the unprotected building is 265, or more than three times as great a rate. This means that the reduction in the rate is 67.2 per cent. On the same basis, buildings of so-called ordinary construction would show an index of 111 when protected by automatic sprinklers and 315 when not so protected. In this case the reduction in the rate is 64.8 per cent. The saving effected by the installation of automatic sprinklers will ordinarily pay for the entire sprinkler equipment within a period of five years.

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MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 4th day of October, 1912.

CHARLES J. VOLPE,

(SEAL) Notary Public, N. Y. Co.

(My commission expires March 30, 1913.)

DECEMBER, 1912

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UNPROFITABLE REPAIRING OF TOOLS

Machines and tools are often repaired and kept in use when it would be more economical to buy new ones. Some men even pride themselves on what they call the savings resulting from this patching up of old tools. A story that illustrates the extremes to which this habit of repairing old tools rather than buying new ones can be carried was recently told by the mechanical engineer of a plant making machinists' tools.

A complaint was made to the sales department by a toolmaker, who stated that nippers of the firm's make did not stand up well. He mentioned in particular that when he worked at the Jones & Smith Co. one of these nippers was sent over to the toolroom for repairs at least twice a year. The tool in question did not cost more than $2, and had apparently been used for something like five or six years. When asked how long it took him to repair the nippers, the man making the complaint said: "Well, I should say about half a day." He was asked what wages he received, and promptly replied that he was a first-class toolmaker receiving forty-three cents an hour!

It requires no elaborate cost system to point out this moral; yet similar instances are not of unusual occurrence, particularly in the case of the smaller tools used around a machine shop, and the loss on such wasteful repairs may amount to a considerable sum during the year. Often this is caused by a mistaken theory of economy on the part of a foreman, but quite as often the general policy of the management of a shop is at fault. The foreman of the department or the superintendent of the plant has so often been cautioned by his manager against "unnecessary" expenditures, that he tries to avoid sending in requisitions for new tools and prefers to put one or more of his men to repairing old ones, because this work will not show up directly in the expense account, but will be charged to general repairs. Many a foreman remembers well how he has been requested to explain in detail the reason for buying a new device or tool costing but a few dollars, while at the same time wasteful methods of doing work which absorbed daily several times the cost of a new appliance, might be passed by unnoticed. What is needed is closer cooperation between the heads of concerns and the men in charge of the various departments. In many instances considerable economies could be effected if foremen and superintendents were encouraged to follow their own judgment with regard to the buying of new tools and the repairing of old ones; or if this policy in some cases would not be advisable, they should at least be encouraged to state their opinions freely, as it is likely that by their cooperation a great many false economies could be eliminated.

* * *

THE NEED OF POWER

The steam engine is such a common and necessary part of our civilization that few stop to think what a debt we owe to it. The need of man in his struggle with the crudeness and rawness of natural resources has been, is, and always will be for power. He is a comparatively weak creature, barely able to supply his physical needs by unremitting toil if unassisted. The first upward step from savagery was made when a cave man of splendid courage conquered the wild horse and trained him to carry burdens. The harnessing of horses and cattle to the plow was another great step forward that reduced manual labor and increased food production. Removed from the fear of immediate starvation, the needs of the mind as well as the body were ministered to and the march upward toward the civilized state was well begun.

But unhappily the opportunity to live on a higher plane was for only a few. The great mass was still submerged in poverty and in a state of actual or practical slavery. The ancient Greeks believed that civilization without slaves was impossible, and it was true of the conditions then existing. Without power other than that of animals, men must be employed to serve their masters to those comforts and luxuries that the higher life demands, but which the servers could not hope to enjoy themselves.

The invention of the steam engine and the great improvements made by Watt marked a new era which has had no parallel, and, therefore, is not comparable with any recorded epoch of the world's history. While elemental human nature does not change, the environment of man has so changed that predictions of the future based on the past are futile if not foolish. But we know that human servitude has not yet been abolished; it has taken on new forms less galling physically, but still intolerable to sensitive minds. How can liberty be attained? Only by acquiring the means of developing more power.

The growth of a great modern city is consonant with the development of power stations to supply its railways, lights, elevators, manufactories and other urban activities. The energy developed in one comparatively small unit is greater than all the available working force of some of the proudest ancient empires. The great Curtis turbine of the New York Edison Co., developing 30,000 H. P., is the physical equal of over a million men working in three equal shifts throughout the twenty-four-hour day. What a tremendous multiplication of the dynamic energy of the comparatively few men required to attend it and the boilers generating the steam needed to supply it! It is this great multiplier of human force, applicable in one way or another throughout the world, which is required to realize the ideals of the advanced engineer. To make the world small, to bring the produce of the uttermost parts to its markets and distribute the products of manufacturers to those who have furnished the food and crude materials is the great problem of the age. It is the problem of distribution that the engineer must solve as well as that of production; and power in all its many manifestations is the one great necessity for its accomplishment.

GAS ENGINE CAMS

It is a curious feature of gas engine design that the simple, primitive form of valve lifter cam, that is, the form in which the contour is made up of arcs and tangents, is less noisy than the more refined shapes which have often been proposed and but little used. To one familiar with the laws of mechanics and the general requirement to overcome the inertia of matter gradually and progressively to prevent shock, it is natural to conclude that an accelerated motion cam would work more smoothly and create less noise than that shape commonly used in which the lifter is practically a V-shaped boss on the side of a semicircular hub.

The article begun by Mr. Terry in the November number, and concluded in this number, exhaustively analyzes the conditions of gas engine cam action and shows why the primitive form is after all best. The article is lengthy, and so far as the conclusions are concerned it can be summed up in a comparatively few words, but we believe, nevertheless, that the space required for the elaboration of the analysis will be profitably used. It should settle once for all this question, which has caused no little discussion and perplexity among automobile engine designers. The case is one in which rule-of-thumb designing seems to have the best of it and theory to be at fault, but this is only apparent. When all the theoretical considerations are given their due weight, we can clearly see why the supposed refinement of cam design is not an improvement but actually a detriment.

* * *

REFORMING THE PUBLIC SCHOOL SYSTEM

As the defects of our public school system are brought out more and more by the educational deficiencies of the boys entering shops and factories at an early age, the more apparent it becomes that steps should be taken to correct them. Under the present system the public schools are open five days a week, from thirty-nine to forty weeks a year. The pupils go to school considerably less than two hundred days in the year; taking out the holidays, the average is about 190 days.

When it is considered that the children of the working classes have to leave school at fifteen or sixteen in order to contribute to the family support, the question is: "Why not try to improve the years when they can go to school"? Continuation schools are merely to make up for lost time. The average boy and girl in the towns and cities would be better off going to school six days a week fifty weeks in the year than loafing around, as many must, during the vacation period. This schedule would give them fifty per cent more hours of school work in a year, and that would be equivalent to two years extra schooling between the twelfth and sixteenth years. The boy who has to leave school at sixteen under this schedule should be as far advanced as he is at eighteen under the present system.

The arguments against the continuous school term are the strain on teachers, objections of parents, hot weather in July and August, and the need of pupils for long seasons of rest. As to the teachers, it is hardly necessary to point out that employes in stores, mills and factories work longer hours every day in the week and in many cases every week in the year. The parents' objections would become inconsequential when the benefits of the plan became apparent. School buildings can be made cool in summer, and will be made comfortable when the continuous school term becomes general. Pupils advance relatively faster when the school work is continuous. Several days or weeks are lost every opening term in the process of getting back into harness and regaining the receptive frame of mind largely lost during the vacations.

The continuous school term is being tried in several cities and towns with satisfaction. A feature of no little importance is that the better utilization of school buildings has lessened the need of new structures, meaning a saving of thousands of dollars annually in a large city. But the chief advantage is that the general adoption of the continuous school term will raise the educational standard of the workers' children to a plane that will better fit them for their duties not only as efficient industrial workers, but also as citizens.

LOCATING BALANCE WEIGHT CHAINS ON HORIZONTAL BORING MACHINES

BY W. G. DUNKLEY*

The most frequent problem met with in determining the correct location for the balance weight chains for the spindle slides of horizontal boring machines, is that in which the slide is under-balanced. In this case the difference in weight between the spindle slide and the balance weight is carried by the vertical screw. Consequently, there is a reaction on the slide, equal in value to the load on the screw, which acts along the axis of the screw. If the presence of this reaction is ignored, it will give rise to a turning moment on the slide which will cause the latter to bind on the upright. Such a binding action between the slide and upright would have been avoided if the proper means had been taken to locate the balance weight chains correctly. It will be readily understood from the preceding that the location of the balance weight chains is a matter of considerable importance in the design of horizontal boring mills.

In order to enter into this subject in detail, a case will be considered in which the spindle slide weighs eight tons and the balance weight only four tons. In this case, the reaction of the screw on the slide is equal to the difference between the weight of the slide and counterweight, or four tons. The load on each chain is two tons, as illustrated in Fig. 1, and, as a result, the vertical downward force of eight tons is balanced by the vertical upward forces, which have a total value of eight tons as shown. The slide is not in equilibrium, however, unless the moment of all the forces about any point is zero. If the moment of the vertical forces on the slide about any point is not zero, this moment must be balanced by a moment due to the reactions Q of the slide on the vees, because the slide is in equilibrium. In this problem, the friction between the slide and the face of the column is neglected. The center of gravity of the slide is located on the line CC which is ten inches from the screw. With this data at hand, the problem consists in determining the correct location for the chains. Bearing in mind that the reaction of the screw is four tons, the chains should be placed as indicated by the full line arrows, and with such an arrangement, the vertical forces are depended upon to keep the slide in equilibrium. There may still be a tendency for the slide to turn in a plane at right angles to the face of the upright.

Neglecting the reaction of the screw, the chains will naturally be placed at equal distances on either side of the center of gravity of the slide, as indicated by the dotted lines in Fig. 1. With such an arrangement, the turning moment of the vertical forces about an axis at the center of gravity will equal $4 \times 10 = 40$ ton-inches. This moment has to be neutralized by the moment of the forces Q which are determined as follows:

$$Q \times 60 = 4 \times 10 \times 2000 \text{ pound-inches.}$$

$$Q = \frac{4 \times 10 \times 2000}{60} = 1335 \text{ pounds}$$

This twisting action on the slide may attain a still greater value for increased inaccuracy in the location of the counterweight chains, but where these chains are properly placed, the presence of any twisting forces Q on the slide will be entirely avoided.

In some cases an additional chain is provided at the outer end of the slide, as shown at E in Fig. 2. Where such a design is adopted, it is necessary to provide an auxiliary standard to carry the balance weight. Where this practice is followed, it is necessary to be particularly accurate in designing; otherwise the arrangement is open to question, so far as the turning moment on the slide is concerned, but in any case the result secured will depend largely upon the location of the center of gravity of the slide. For example, if the slide shown in Fig. 1 were balanced according to the design shown in Fig. 2, the turning moment due to the vertical forces on the slide would be 130 ton-inches, 120 ton-inches of which would be due entirely to the force at E. In such a case, the amount

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of the moment Q due to the reaction of the vees would be considerable, with the result that there would be excessive binding of the slide on the upright.

Let us next consider a case in which the center of gravity of the slide lies on the line DD shown in Fig. 2. The twisting moment due to the vertical forces would then be zero, and in such a case the action of the slide will be free from any tendency toward binding. There is one point about the arrangement shown in Fig. 2 that is particularly worthy of attention. Any alteration of the load at E will give a corresponding alteration of the reaction of the screw on the slide, which will result in a considerable variation in the twisting moment on the slide. This makes it possible to vary the load at E until the slide is properly balanced and binding action

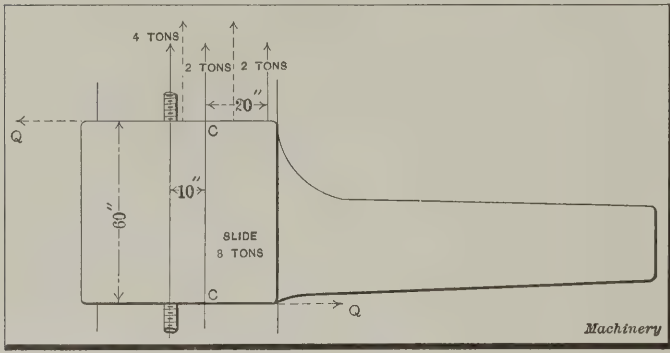


Fig. 1. Correct and Incorrect Methods of balancing Slide with Two Chains

eliminated; in this way, any inaccuracy in the calculation of the position of the center of gravity may be compensated for.

The calculation of the center of gravity of a heavy slide is not a simple matter, and as a result, it is apt to be avoided. This is obviously poor practice, as the proper action of the slide on the upright has been shown to be dependent upon having the counterweight chains correctly located in regard to the center of gravity of the slide. For example, the vertical hand adjustment of the slide is sometimes difficult to accomplish, and is made even more difficult if there is an excessive binding action between the slide and upright. In the preceding discussion, the balance of the slide has been treated for cases where the slide is stationary. Since there is binding action between the slide and upright, due to the resistance of the cut when working, it is obviously desirable that the binding action should be reduced to a minimum when the

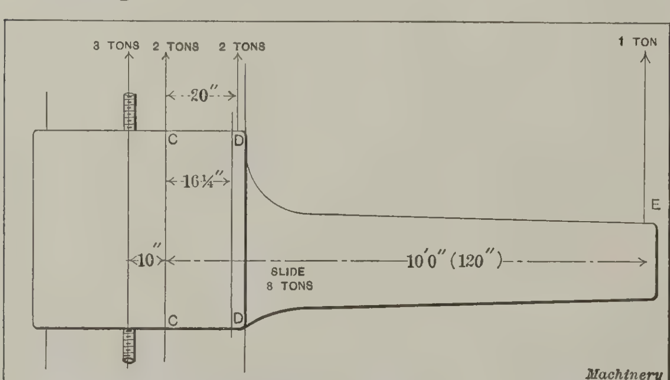


Fig. 2. Correct and Incorrect Methods of balancing Slide with Three Chains

slide is stationary. In some cases an attempt is made to put the screw under the center of gravity of the slide, but a consideration of the conditions shown in Fig. 1 will make it evident that there is no necessity for so doing in order to obtain a proper balance. For example, let us consider a case where the slide is engaged on a milling operation. In such a case, the force of the cut introduces an additional force between the screw and the slide, with the result that the turning moment on the slide, due to the force of the cut, is equal to this force multiplied by the distance between the screw and the line of the cut. It is thus evident that the screw should be as near the cutting face as possible, in order to reduce this turning moment to a minimum. If the screw is made to coincide with the position of the center of gravity of the slide, the distance to the face of the cut is increased; consequently it is not advisable to do this in order to obtain the desired balance of the slide, on account of the increased twisting moment that is introduced. The width of the guiding surface does not enter into the calculations in any way.

* * *

THE PYROMETER AND TIME STUDY IN STEEL TREATMENT

The general experience of a maker of lathe and planer cutters for tool-holders, outlined briefly in the following, shows how necessary are exact scientific methods to insure the production of uniformly satisfactory high-speed steel tools:

"Investigations in machine shops and tool-rooms indicate that the fault of most importance to the managers, is the lack of uniformity in results obtained from high-speed cutting tools. Many places were found where attempts were made to treat steel by faulty methods or with inadequate facilities. The lack of pyrometers, failure to use pyrometers when provided, hardening in charcoal furnaces insufficiently heated and treating without preheating, were a few of the practices noted that produced ununiform results—a few good pieces and many almost worthless.

"It seems to be the general opinion among those not getting results, that pyrometers are not of much use, that they do not give correct readings, and that better results can be gotten by depending on a man's experience than on any mechanical device. Now in the treatment of cutters we have had failures with pyrometers, but at the same time have found the cure for it, and that is frequent calibration. There is no question but what a man's eye is a better judge of the heat in a furnace than an incorrectly calibrated pyrometer.

"In the treatment of our cutters we have probably employed no more skilled men than are used in many large plants for treating high-speed steel, but the methods that they use and depend on are scientifically correct. Since the adoption of the improved Taylor-White treatment of high-speed steel we have sent out thousands of cutters and have received practically no complaints. Our experience has shown that a cutter treated today is the same as one treated six months ago and will be the same as one treated six months from now. We have tested all makes of high-speed steel, and have proved that with proper heat treatment any one of four or five of the real high-grade high-speed steels is entirely satisfactory and, in fact, cutters made from all of them cannot be told apart in use.

"All our cutters are preheated in a low-heated furnace at a temperature of 1350 degrees F. This heating takes out all strains in the metal and puts it in the best possible condition for bringing quickly to the high heat necessary to get the best results from high-speed steel. Every cutter from the smallest to the largest is treated in accordance with its sectional area and size. It goes from the low heat into the high heat furnace and stays there for a time that has been determined for each size by tests. We use pyrometers constantly on both furnaces, which are tested twice a week, having found that this is as long as they can safely go without being checked. The heat-treating room is provided with a specially made clock which starts on the pull of a lever by the man running the furnace, who knowing the proper length of time required for the cutter being treated, sets the clock accordingly. At the end of the predetermined time the clock rings a bell and stops, and the operator takes out a cutter and puts it into the proper medium.

"Our experience shows that it is necessary to bring the high-heat furnace to a temperature above the melting point of high-speed steel to get satisfactory results. This, of course, requires positive accuracy of the time chart as a fraction of a minute too much in the furnace would ruin the cutter, and too short a time would not give sufficient heat. Another reason for this is that to get the best results from high-speed steel, it is necessary to quickly raise the heat from 1350 F. to the highest heat required.

"We believe that the essentials for proper treatment of high-speed steel are: a first-class quality of high-speed steel, preheating, quickly raising the temperature of the steel to the proper quenching heat in a high-heat furnace, the use of accurately calibrated pyrometers and a correct time chart."

* * *

The Harvard engineering school has recently instituted all-the-year-round courses. The course for master's degree in engineering now can be taken in two years, there being no summer vacation. The students work from eight to ten hours per day, and the total vacations in the year amount to only about four weeks. The University of Chicago has also for some years maintained a summer term having equal weight with the other three-quarters of the year. This is a movement in the right direction. The inefficiency and waste of time due to the time-honored system of long summer vacations is out of place especially in engineering schools.

SPECIAL KNURLING OPERATIONS*

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

BY DOUGLAS T. HAMILTON†

The knurling operations dealt with in the previous articles by the writer are what might be called "standard," and are met with frequently in automatic screw machine practice. The following examples are more of a special nature, and illustrate unusual applications of knurls. The data which follows should be of suggestive value to the designer of screw machine tools, inasmuch as it presents commendable methods of applying knurls to the work under varying conditions.

Bevel Knurling Tools Operated from the Turret

The simple bevel knurling tool shown in Fig. 2 is provided with a tapered shank and is held in a standard floating holder in the turret. The piece to be knurled, *A*, is a small German

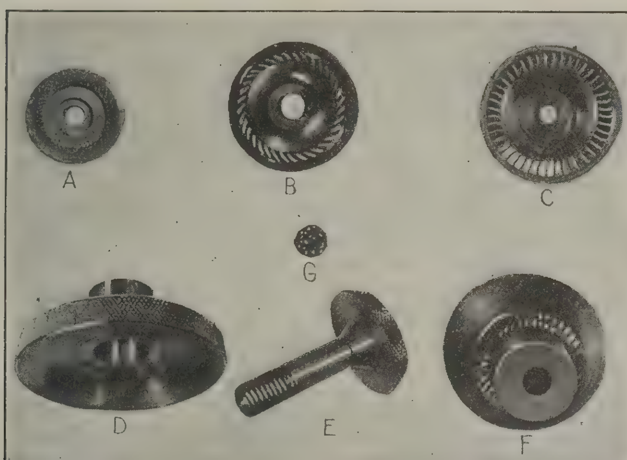


Fig. 1. Examples of Work requiring Special Knurls and Knurl-holder Applications

silver button which has a convex face, but as the curvature is slight, a straightface diamond knurl can be used. In applying the knurl to the work, the center line *BC* of the knurl should be at right angles to that portion of the work it is required to knurl. This particular holder was used in a No. 00 Brown & Sharpe automatic screw machine, which was operated at a spindle speed of 1492 R. P. M., and with a feed to the knurl of 0.0023 inch per revolution of the work.

Another example of end-knurling from the turret is shown

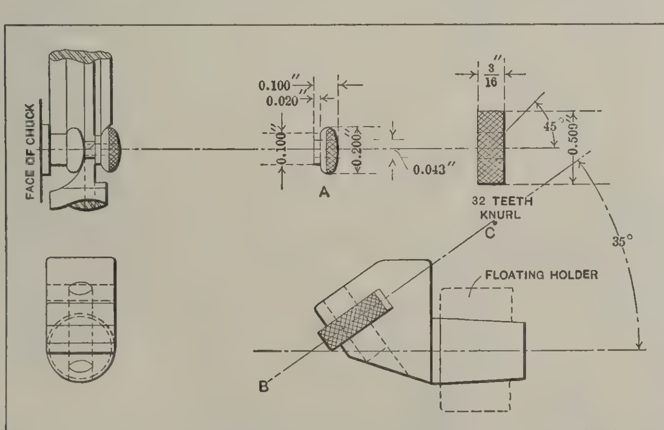


Fig. 2. End-knurling Tool held in Floating Holder

in Fig. 3. The piece to be knurled is shown at *A*, and also at *F* in Fig. 1. The knurl is presented from the turret under the body of the work, and produces a single spiral knurl, the teeth of which are at an angle of 25 degrees with the axis of the work. The holder is held in a No. 2 Brown & Sharpe automatic screw machine, and the work is rotated at 1200 R. P. M., with a feed to the knurl of 0.0024 inch per revolution.

The knurl holder consists of a shank *B* which fits the hole in the turret, and a holder *C* held to the body *B* by a screw, and located by a tongue and groove. The hole for screw *D* in holder *C* is larger than the body diameter of the screw, to provide for adjustment. The knurl which is shown detailed at *E* is provided with a shank which is a running fit in the

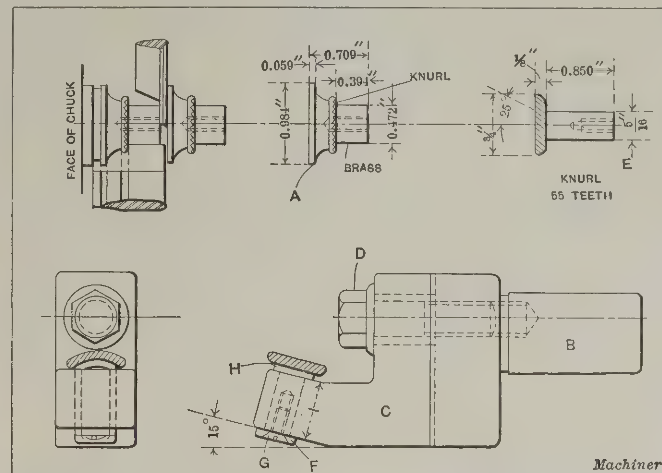


Fig. 3. End-knurling Tool held in Turret and operated at an Angle

hole in holder *C*. It is retained by a washer *F* and screw *G* and rotates on a hardened washer *H*. The distance *I* on the knurl shank is slightly greater than the width of the holder, so as to allow the knurl and washer *G* to rotate freely.

The knurl *B* and the knurl holder *D*, shown in Fig. 4, are

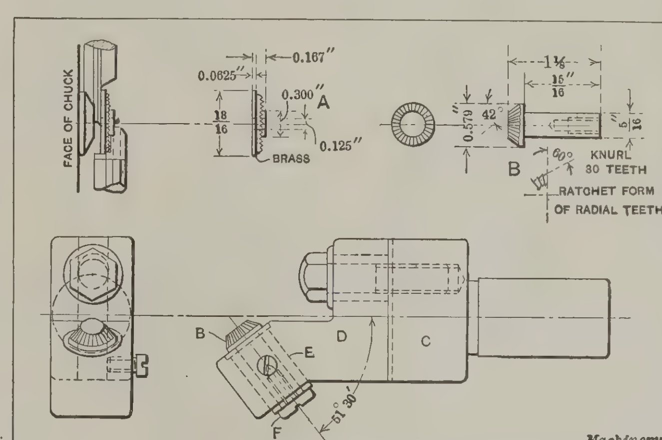


Fig. 4. Knurl and Knurling Tool-holder for producing Ratchet Form of Radial Teeth

used to produce a ratchet form of radial teeth in the shoulder of the piece shown at *A*, and also at *C* in Fig. 1. The teeth in the knurl are cut at an angle of 60 degrees and are radial with the center line. The work is rotated at 1216 R. P. M.,

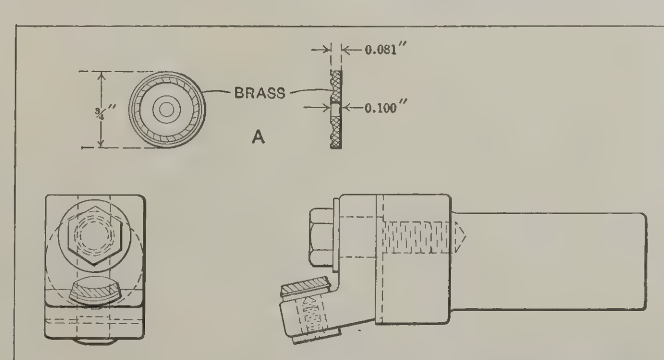


Fig. 5. Knurl and Holder for producing "Tangential" Form of Knurl

and a feed of 0.0008 inch is given to the knurl per revolution of the work.

This holder is held in the turret of a No. 2 Brown & Sharpe automatic screw machine, and consists of a body and shank *C* to which the holder *D* is held by a screw. The knurl *B* ro-

* See MACHINERY, June and July, 1909, "Knurls and Knurling Operations."

† Associate Editor of MACHINERY.

tates in a phosphor-bronze bushing *E* which is prevented from turning by a screw. The knurl is retained in the bushing by a large-headed screw *F* provided with a shoulder. There is sufficient end play to allow the knurl to rotate freely. It

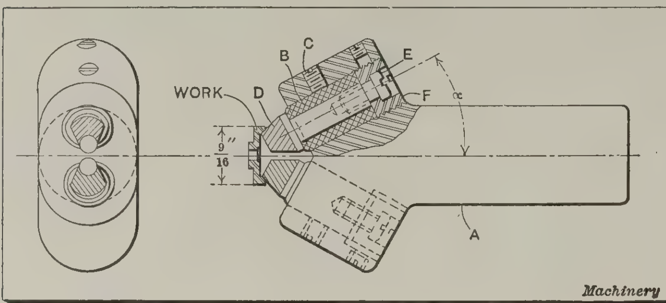


Fig. 6. Special Knurls and Holder for Internal Bevel Knurling

should be noted that in presenting the knurl to the work, the bottom of the teeth should be at right angles to the center line of the work holder.

A knurl holder having a marked similarity to that shown

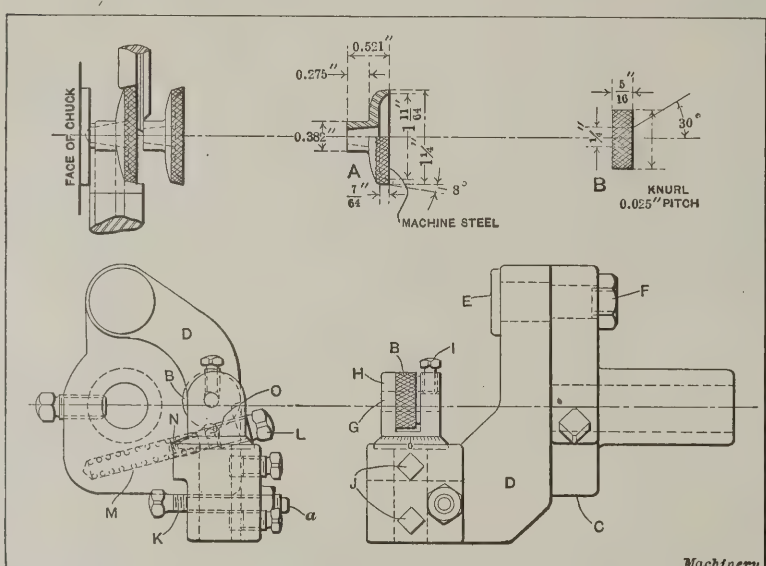


Fig. 7. Swing Type of Turret Knurl-holder for knurling at Various Angles

in Fig. 4 is illustrated in Fig. 5. In this case, however, the knurl is used for producing "tangential" teeth, as shown on the piece *B*, Fig. 1, and consequently it is provided with spiral teeth. It is not inclined at so small an angle with the center line of the holder, and approaches, when in operation on the work, as closely as conditions will permit, the action of a helical gear in mesh.

Internal Turret Knurl Holder

A special application of two bevel spiral knurls to the work is shown in Fig. 6. Here the portion of the work to be knurled is beveled at an included angle of approximately 90 degrees, and as shown at *A* in Fig. 1, a diamond-shaped knurl is to be produced. This operation can be more easily accomplished in this case with two spiral knurls than would be possible with one diamond knurl. Under these conditions it is advisable to have the angle *a* slightly less than half the angle on the work, so that it will be possible to use a bevel knurl, as a straight knurl would not work freely when operated from either the turret or cross-slide.

The holder *A*, Fig. 6, which is held in the turret, is made from a machine-steel forging and has two lugs, bored to receive the phosphor-bronze bushings *B*, these being retained in the holder by screws *C*. The knurls *D* are provided with shanks and are retained in bushings *B* by screws *E*, which rotate with the knurls. The end thrust of the knurls in this holder is considerable, so that it is necessary to back up the bushings *B* with screws *F*.

Special Swing Knurl Holder

A special knurl holder which is held in the turret and operated from the cross-slide by a rising block under the front tool-post, is shown in Fig. 7. The work is shown at *A*, and also at *D* in Fig. 1. It will be noticed that the work is considerably greater in diameter than that suited to the ordinary capacity of the No. 2 Brown & Sharpe automatic screw machine, thus requiring the use of a special outside feeding attachment, the ordinary feed tube being removed. The work is revolved at 240 R. P. M., and the knurl holder advanced at the rate of 0.00077 inch per revolution of the work. This is the speed at which the swinging arm *D* is moved, so that the actual feed of the knurl will be somewhat less than this amount.

The main body of holder *C* is provided with a shank held in the turret, and the swinging member *D* is held to its front face by a bolt *E* and nut *F*. The knurl *B* is held on pin *G* retained in the swivel holder *H* by screw *I*. The holder *H* is provided with angular graduations reading to degrees, so that the knurl can be set to the desired angle with the work. In the illustration the knurl is set straight, but in actual operation it is set around at an angle of 8 degrees. The shank of holder *H* is retained in the swinging member *D* by two set-screws *J*, which operate on bronze shoes to prevent marring the shank.

In operation, the rising block on the cross-slide comes in contact with the point *a* of the adjusting screw *K*, forcing the knurl into the work. The swinging member is returned to adjustable stop-screw *L* by a spring *M*, plunger *N* and pin *O*, the latter being driven into the swinging member and operating in an elongated hole in the holder *C*.

Special Opening Knurl Holder

An opening type of knurl holder is shown in Fig. 8. Two bevel knurls *B* are held in the swinging arms *C* and *D* in the manner shown in the sectional view. These arms are provided with offset lugs bored to receive the phosphor-bronze bushings *E*, which are prevented from turning by set-screws *F*. The knurls *B* are provided with shanks and are retained in the bronze bushings by screws *G*. The type of holder shown gives better results on the piece shown at *A*, and also at *E* in Fig. 1, than would a holder held on the cross-slide which would force the knurl straight into the work. The reason for this is that in operating a bevel knurl from the cross-slide on a tapered piece of work, the knurl has a tendency to glide off and produce an imperfect form of knurl. The opening type of holder obviates this difficulty to a considerable extent, as the power can be applied, so to speak, at right angles to the surface

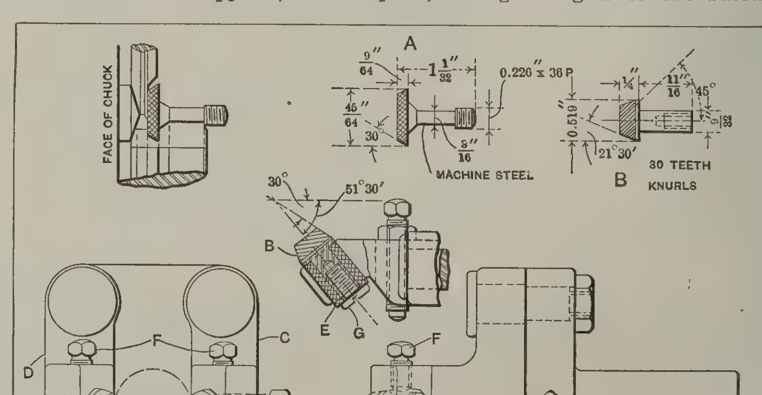


Fig. 8. Opening Type of Turret Knurl-holder for Bevel Knurling

knurled. The knurls are brought into position by the turret, and then fed into the work by the rising block on the cross-slide.

SPIRAL GEAR DESIGN*†—1

TO CALCULATE THE ELEMENTS OF FORTY-FIVE DEGREE COMBINATIONS

BY JAMES H. CARVER‡

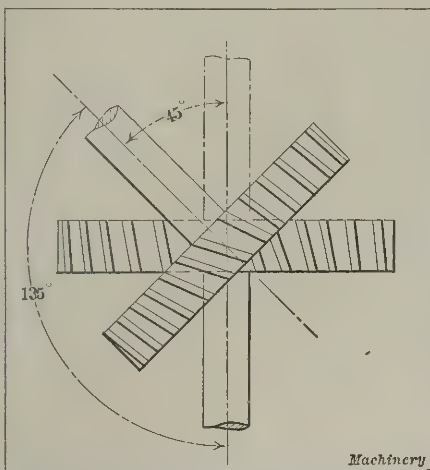
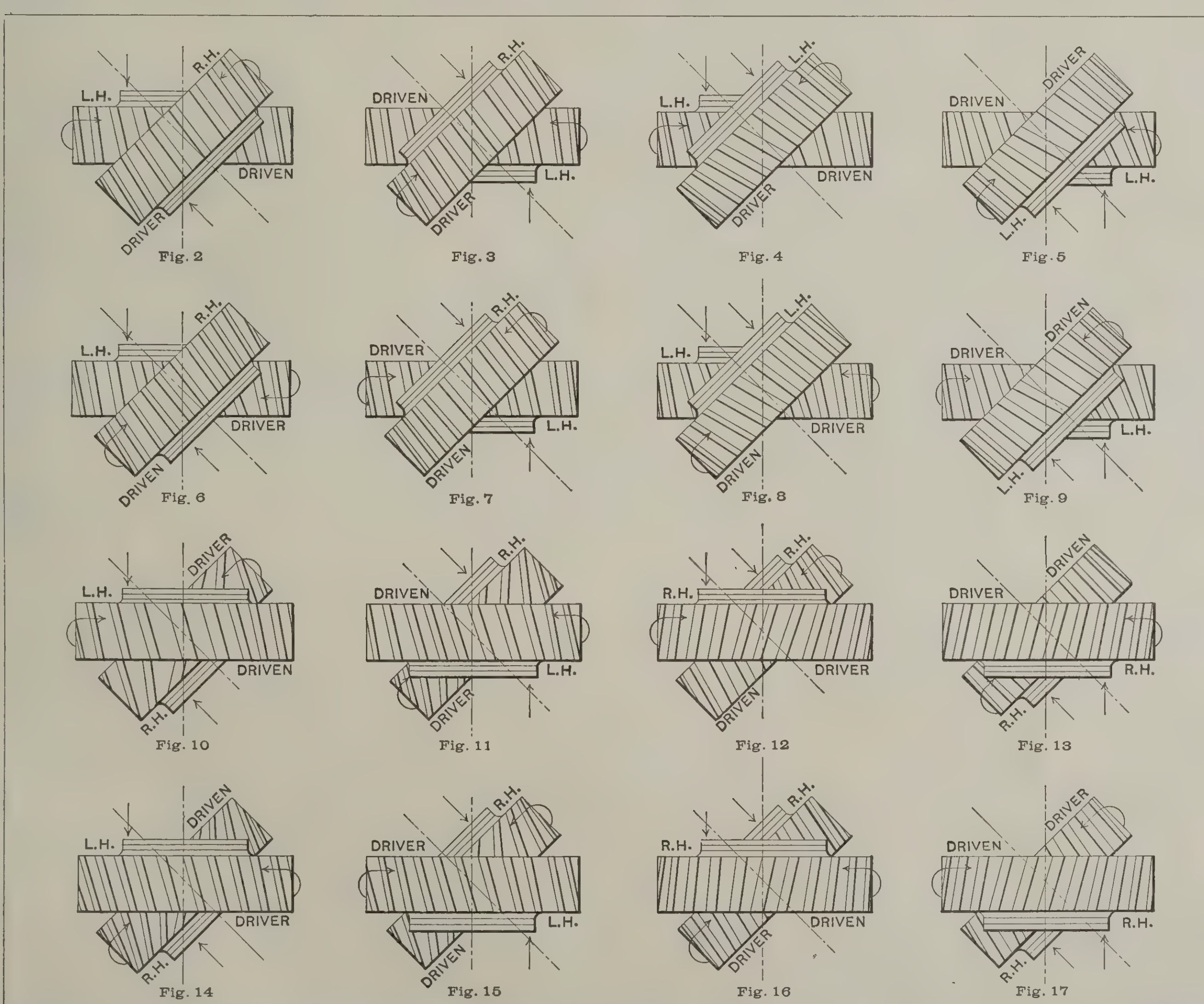


Fig. 1. Diagrammatical View showing General Arrangement of Spiral Gearing with Shafts at 45-degrees Angle

In the September, 1911, number of MACHINERY, the design of spiral gears with parallel shafts was dealt with, and in the October, 1911, number, spiral gears with shafts at right angles were treated. In the present article and in the accompanying Data Sheet Supplement, formulas will be given for calculating spiral gears with a shaft angle of 45 degrees. As seen in Fig. 1, the treatment, as far as the design is concerned, will be the same for a 135-degree shaft angle as for an angle of 45 degrees. Thrust diagrams Figs. 2 to 17 are given, the same as in the previous articles referred to, as an aid in determining the directions of thrust and rotation, and the direction of spiral, whether right- or left-hand. The arrows shown indicate the direction of the reaction against the thrust caused by the tooth pressure.

The relation between the direction of rotation, direction of spiral and spiral angle may be studied in Figs. 18 and 19. In Fig. 18 two spiral gears are shown, one in front of the other, with shafts at an angle of 45 degrees to each other. Line AB represents a right-hand spiral tooth on the front side of gear C. Assume gear C to rotate in the direction shown; then when the tooth AB reaches the rear side, it will be represented by line EF, which also represents the tooth direction on the front side of gear G. Angle BOH equals angle EOH, and it will be seen directly that the spiral angle of either gear equals 45 degrees minus the spiral angle of the other, both gears being right-hand. In Fig. 19 the spiral angles are shown to be of opposite hand, and one spiral angle is 45 degrees plus the other angle. From these illustrations we may draw the following conclusions relative to gears with a shaft angle of 45 degrees:

When the spiral angle of either gear is less than 45 degrees, then the spiral angles are the same hand, and one spiral angle is 45 degrees minus the other. When the spiral angle of either gear is greater than 45 degrees, then the spiral angles are of opposite hand, and the spiral angle of one gear is 45 degrees plus the spiral angle of the other.



Figs. 2 to 17. Thrust Diagrams for Spiral Gears with Shafts at 45-degrees Angle

The four cases which are dealt with in the accompanying Data Sheet Supplement are:

1. Shafts at 45-degrees angle, ratio equal and center distance approximate. 2. Shafts at 45-degrees angle, ratio equal

* With Data Sheet Supplement.

† See "Spiral Gear Design", MACHINERY, September, 1911, engineering edition, and the articles there referred to. See also MACHINERY'S Reference Book, No. 20, "Spiral Gearing", and MACHINERY'S Data Sheet Book, No. 6, "Bevel, Spiral and Worm Gearing".

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and center distance exact. 3. Shafts at 45-degrees angle, ratio unequal and center distance approximate. 4. Shafts at 45-degrees angle, ratio unequal and center distance exact.

The Data Sheet Supplement gives the required formulas for calculating gears for each of these cases. In the following the derivation of some of these formulas is explained.

1. Shafts at 45-degrees Angle, Ratio Equal, and Center Distance Approximate

As already stated, the spiral angle of one gear must equal 45 degrees plus or minus the spiral angle of the other. The formulas in the Supplement in Part (*a*) are to be used when the spiral angles of both gears are 22½ degrees, which will often be the case. The pitch diameter of both gears will be equal, and are found by the formula (see Data Sheet Supplement for notation):

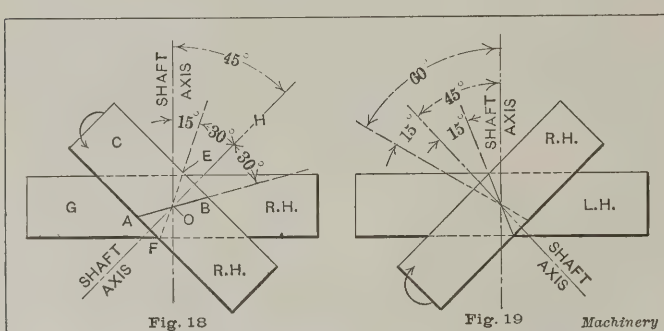
$$D = \frac{N}{P_n \cos 22\tfrac{1}{2}^\circ} = \frac{N}{0.92388\, P_n}$$

Further

$$T = \frac{N}{\cos^3 22\tfrac{1}{2}^\circ} = \frac{N}{0\ 788}$$

$$L = \pi\, D \cot 22\tfrac{1}{2}^\circ = 7.584\ D$$

The other formulas are the same as those given in the articles referred to at the beginning of this article. Part (*b*) is used for unequal spiral angles.



Figs. 18 and 19. Relation between the Spiral Angles of Teeth in Two Gears

2. Shafts at 45-degrees Angle, Ratio Equal, and Center Distance Exact

Following the same method of reasoning as in Case (6), "Spiral Gear Design", MACHINERY, October, 1911, the approximate number of teeth in each gear is found from the equation:

$$\frac{N}{P_n \cos \alpha_a} + \frac{N}{P_n \cos \beta_a} = 2\,C$$

from which, multiplying by $P_n \cos \alpha_a \cos \beta_a$,

$$N \cos \beta_a + N \cos \alpha_a = 2\ C\,P_n \cos \alpha_a \cos \beta_a, \text{ or}$$

$$N = \frac{2\ C\,P_n \cos \alpha_a \cos \beta_a}{\cos \beta_a + \cos \alpha_a}$$

After the exact number of teeth to be used in each gear is found from the last equation, the spiral angles are found from the same equation used in finding the approximate number of teeth.

Let $\dfrac{N}{P_n \cos \alpha} + \dfrac{N}{P_n \cos \beta} = 2\,C$, where α and β are now the exact spiral angles. The secant being the reciprocal of the cosine,

$$\frac{N}{P_n} \sec \alpha + \frac{N}{P_n} \sec \beta = 2\ C, \text{ or } \sec \alpha + \sec \beta = \frac{2\,C\,P_n}{N}$$

By using a table of secants, reading to minutes, angles can be found to satisfy this equation, after very few trials.

3. Shafts at 45-degrees Angle, Ratio Unequal and Center Distance Approximate

A formula for finding the number of teeth in the small gear is found from the equation:

$$\frac{N}{P_n \cos \alpha} + \frac{n}{P_n \cos \beta} = 2\ C$$

by solving for the value of n, the relation of N to n being:

$$R = \frac{N}{n}, \text{ or } N = Rn$$

Then multiplying by $P_n \cos \alpha \cos \beta$, we have:

$$N \cos \beta + n \cos \alpha = 2\ CP_n \cos \alpha \cos \beta$$

and substituting Rn for N:

$$n = \frac{2\ C\,P_n \cos \alpha \cos \beta}{R \cos \beta + \cos \alpha}$$

After finding the number of teeth N from the relation $Rn = N$, the pitch diameters are found in the manner previously described. In Part (*a*) are given the formulas to be used when both spiral angles are 22½ degrees. The constants were found from the numerical values of the functions in the formulas of Part (*b*), which latter formulas are used for unequal spiral angles in the two gears.

4. Shafts at 45-degrees Angle, Ratio Unequal, and Center Distance Exact

This case could be used under the same conditions spoken of in Case (8), "Spiral Gear Design", MACHINERY, October, 1911. The number of teeth is found exactly as in Case (3) of the present article, after which the exact spiral angles are found by trial from the equation:

$$R \sec \alpha + \sec \beta = \frac{2\,C\,P_n}{n}$$

which is found from the equations

$$\frac{N}{P_n \cos \alpha} + \frac{n}{P_n \cos \beta} = 2\,C, \text{ and } N = Rn$$

in the same manner as before. When using these equations for finding spiral angles, the table used must give values to minutes in order to insure accuracy.

* * *

HOW TO PATCH A CONCRETE FLOOR

When a cement floor surface becomes worn, it is often necessary to patch it. Mr. Leonard C. Wason, president of the Aberthaw Construction Co., Boston, in a recent paper describes the common, or wrong way, and the right way, as follows:

Commonly a sand and cement mortar is made, some cutting is done and the mortar is put in and scrubbed with a steel trowel until smooth. It is then covered up for a while. If the concrete under the patch is left dry, it soaks up the water of the mortar. As a result, the mortar does not set. If the room is dry or hot the surface of the patch dries out and for the same reason it does not set. If the concrete under the patch is dusty the patch does not adhere to the concrete. If the materials in the mortar are not suitable, naturally the patch wears badly, particularly as it is obviously located at a point of severe wear.

To proceed in the right way, cut down the worn place at least one-and-a-half inch. This cutting should be carried into the strong unbroken concrete and the edges should be cleanly undercut. The bottom of the cut should then be swept out, clean-blown out with compressed air or a pair of bellows, if available, then thoroughly wet and scrubbed with a broom. In this way, small loose particles of broken material which the chisel has driven into the surface are removed. A grout made of pure cement and water, about the consistency of thin cream, should be scrubbed into the pores with a broom or brush, both at the bottom and sides of the cut. Following this a stiffer grout, about the consistency of soft putty, should be thoroughly compressed and worked into the surface, which has already been spread with grout. Finally, before the grout is set a mortar made of one part cement to one part crushed stone or gravel, consisting of graded sizes from one-half inch down to the smallest, excluding dust, should be thoroughly mixed and put in place, then floated to a proper surface. Cover with wet bagging, wet sand, sawdust or other available material. All trucking should be kept off and the surface kept thoroughly wet for at least one week or ten days.

If a particularly hard surface is required, six-penny nails are sometimes mixed with the mortar and other nails stuck into the surface when the patch is finished. This will produce a surface which is extremely hard and durable.

* * *

When a man thinks that he is too old to learn, it simply means that he is getting either too self-satisfied or too stubborn and contrary, for there is no age limit to learning.

MAKING ANNULAR BEARINGS*

SOME OF THE MACHINERY AND METHODS EMPLOYED IN THE MANUFACTURE

BY ROBERT H. GRANT†

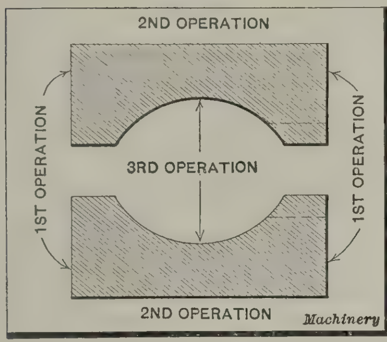


Fig. 1. Order of Grinding Operations on Races

The rapid increase in the use of annular ball bearings has led to many improvements in their design. Such improvements have required a corresponding development in the methods used in the manufacture of these bearings, until they have now reached a very complete stage. The inner and outer races were formerly made from separate pieces of bar stock and this method was responsible for a waste of at least eighty per cent of the raw material. This operation was improved by the writer so that both races were produced from the same bar, as described in a previous article in MACHINERY.

Use of Drawn Tubing

The next development in the production of the races came in the form of the tubing made by the Becker Steel Co., New York City. The smaller sized races can now be made very rapidly from this stock, using an automatic screw machine. The larger sizes are produced on Fay automatic lathes of the type made by the Jones & Lamson Machine Co., Springfield, Vt. In making the larger sized races, tubing or forgings of suitable size and material are used. The Fay automatic lathe shown in Fig. 2 has a worm-driven head which gives ample power for driving several tools at a time. The turning and facing tools are worked together, and the rounding of the corners is done by the same facing tools. The bar used for boring the races has two sets of tools inserted in it, the finishing tool starting right after the roughing tool has gone through the ring. Owing to the semi-automatic action of the machine, it is possible for one man to run four machines, thereby reducing the cost of machining to a minimum.

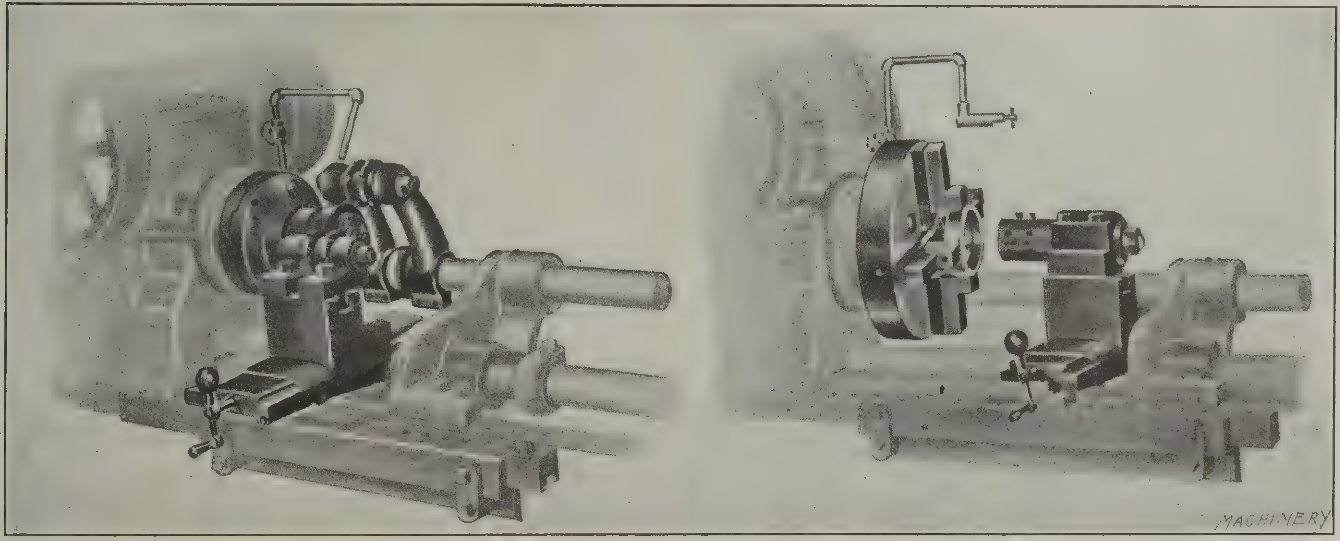


Fig. 2. Fay Automatic Lathe used for forming Blanks for Races

Hardening and Grinding

The extreme thinness of the bearing races makes it difficult for them to hold their shape. Consequently they must be very carefully treated in the hardening department. The method of procedure followed in the hardening operation was fully dealt with in a previous article in MACHINERY. After being hardened, the work is ready for grinding, the order of the operations being shown diagrammatically in Fig. 1. The first grinding operation, which consists of roughing out the blanks, has the effect of relieving the strains in the work. This important operation is performed on a Pratt & Whitney or a Blanchard face grinder. The work is held in a magnetic chuck so that a number of races can be ground at a time and still maintain the required degree of accuracy. The outer races are next mounted on a gang-arbor, as shown in Fig. 3; this arbor is considerably smaller than the hole in the work, the size being indicated in the illustration. A simple method of loading the arbor consists of having a V-block to support the work, and adjustable V-blocks that support the arbor at each end. These blocks are set in such a position that the work is centrally located on the arbor when the clamping nut is tightened. The work is now ready to be ground on the outside. The outside of the inner races is ground in the same way. The hole in the inner races is also ground in a gang fixture, as shown in Fig. 4. This will be seen to consist of a sleeve of the proper size to hold the work, which is secured between the shoulder at one end and a threaded cap at the other. When the sleeve has been loaded with work, it is held in a universal chuck. This method of grinding has effected a considerable reduction in the cost of manufacturing. The grooves in both the inner and outer races are rough-ground with a form wheel. After grinding, the work is allowed to

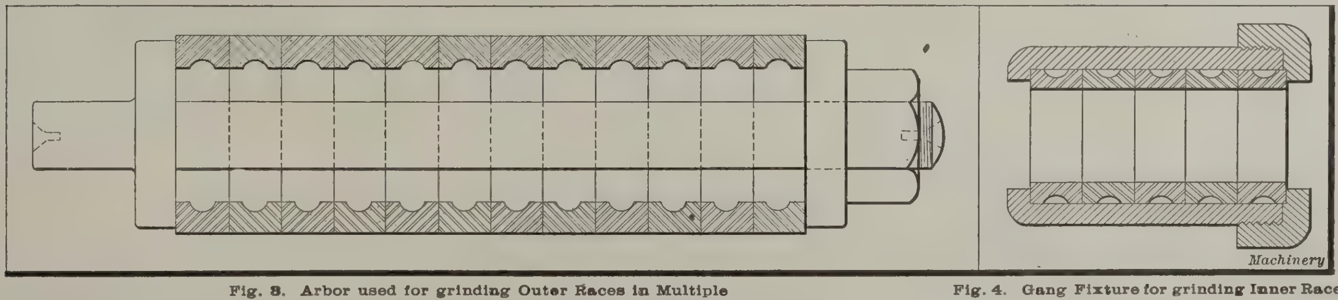


Fig. 3. Arbor used for grinding Outer Races in Multiple

Fig. 4. Gang Fixture for grinding Inner Races

* For additional information on the manufacture of ball bearings, see article entitled "The Manufacture of Steel Balls" published in MACHINERY for February, March and April, 1912; also article entitled "Ball and Roller Thrust Bearings" published in August, 1912, and other articles there referred to.

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"rest" for two or three weeks, after which time it is ready for finishing. The high finish which is produced on the ball bearings of foreign manufacture has made it necessary for the American product to be brought to corresponding perfection in order to compete in the open market.

The grinding of the grooves in the races is, of course, one of the most important steps in manufacturing ball bearings.

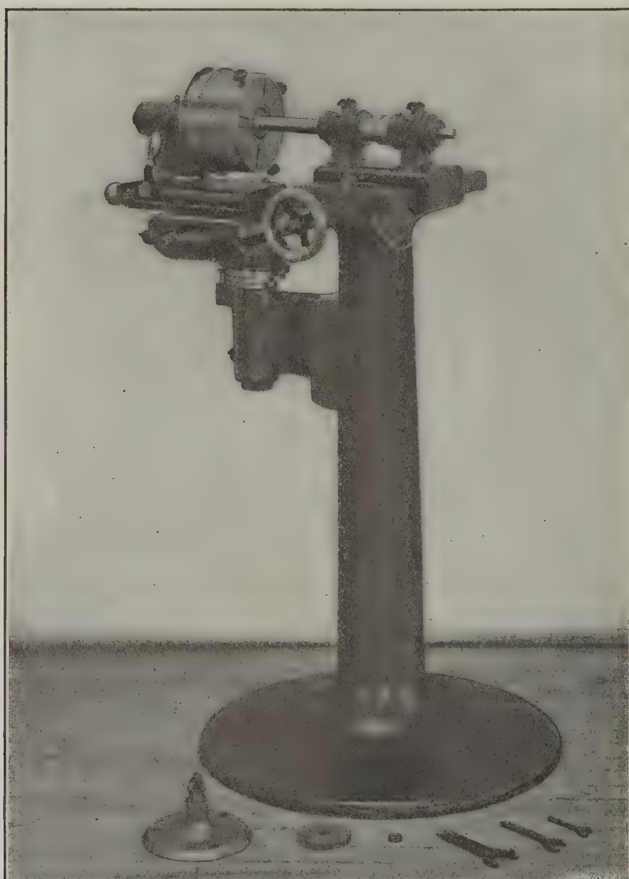


Fig. 5. Simple Form of Machine for grinding Grooves in Races

The machinery for doing this grinding has seen a great many improvements, and has now been brought to a stage where it is well nigh perfect. Fig. 5 shows the original type of grinder made for the trade by the Brown & Sharpe Mfg. Co., Providence, R. I. This was a very simple head that was mounted on one of the bases of the B. & S. No. 2 cutter grinder; the machine had a special head so that it could be used for radius grinding on both the inner and outer races. The column of the machine has a bracket attached to it, which is provided with a vertical adjustment and bored out to receive the grinder head that is equipped with two slides, thus providing for adjustment in two directions. The lower slide has a scale graduated on it, and a pointer is screwed to the bracket; this provides for setting the head over so that any radius can be ground, as the center of the wheel and the center of the bracket are kept in a direct line. The upper slide carries the work spindle and has a rack and pinion arrangement which provides for moving the head back from the wheel, so that the work can be measured at any time without disturbing the adjustment. This slide is also provided with an adjusting screw; in case the work which is carried in the spindle gets out of line with the wheel, it can be adjusted very easily. The work head has a pulley attached to it and is driven from the countershaft at constant speed. The slide which carries the wheel head is fastened to the base, and is equipped with stop pins that control the length of movement. The spindle runs in phosphor-bronze bearings, which are arranged with the usual form of take-ups so that they always fit closely. The drive is provided by two-step cones, to which a belt runs direct from the countershaft.

At the time of receiving our order, the Brown & Sharpe Mfg. Co. was so busy that it was unable to make us more than five of these machines, but the company lent us the patterns and sold us all the standard parts so that we were able to build these grinders in our own factory. The oscillatory motion of the head on this type of grinder was produced by hand and made it necessary to assign one man to operate each machine. This suggested the possibility of improvement by providing means for securing the oscillatory movement by power. The method by which this was finally accomplished, is shown in Figs. 6 and 7, where it will be seen that a bracket is attached to the column of the machine about 18 inches from the floor. This bracket carries a worm and worm-wheel, which are driven by a three-step cone pulley. A plate is mounted at the top of the worm-wheel spindle; this plate has a T-slot cut through its face so that the driving rod, which connects with the grinder head and produces the oscillatory motion, can be set at different distances off center. This provides for giving the work head any amount of throw which is necessary to grind the grooves in the races. The transmission of power from the plate on the worm-shaft to the grinder head is effected by a rack which is cut in the end of the connecting-rod. The teeth of this rack drive a suitable spur gear which is a loose fit on a shaft that is part of the lower work head slide. A plate is keyed to the shaft above this gear and carries a plunger that can be raised or lowered by a lever. When it is required to throw in the drive, this lever brings the plunger down into a hole in the spur gear and starts the head oscillating. Fig. 7 shows a machine of this type, and by referring to this illustration, together with the line drawing, the method by which the head is oscillated will be readily understood.

Holding the Races for Grinding

The next important advance which was made in the design of machinery for grinding the races of annular bearings consisted of an improvement in the method of holding the work. Formerly, the work was held in the head by means of a split ring and adjusting screws. These screws were manipulated to locate the work in the desired position; this was a very tiresome job, as it frequently took from five to eight minutes to get the races in a central position. Fig. 8 shows the improved method, which consists of taking the same head and inserting a hardened steel ring that is tapered on the inside. A master chuck was made to fit this taper and pads were then made to fit any race, the construction being similar to that used in an ordinary screw machine. A hole was drilled

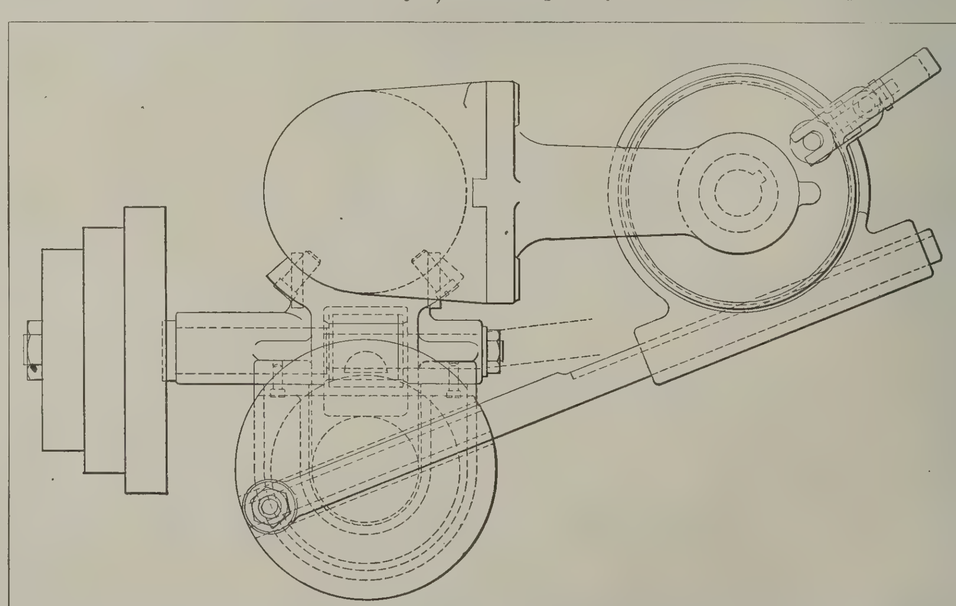


Fig. 6. Mechanism of Power Drive for oscillating Grinder Head

through the spindle to carry the drawback bar, which is fitted with a knob at the outer end that is turned to open or close the chuck by hand. The chuck is prevented from turning, while the work is being put in or taken out, by means of a pin which is carried in the grinder head. As it was not necessary to grind the races to one diameter on the outside, the variation allowed the center of the work to come out of center with the emery wheel. To avoid this trouble, three stop-pins

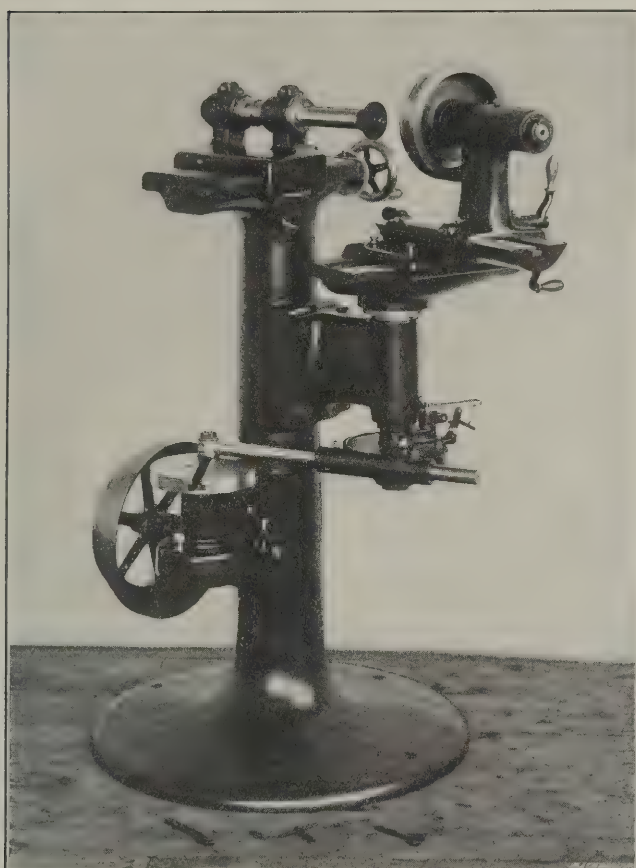


Fig. 7. Type of Machine with Head oscillated by Power

were arranged on the inside of the chuck, the pins being fastened to the head. This allowed the race to come against the pins while the chuck was being closed, thereby holding it central with the emery wheel.

Wet Grinding the Ball Races

Up to this time we had been using a dry wheel, which of course made the work very slow. In order to increase production, the problem of equipping the machines to use a wet wheel was next undertaken, and a solution was finally found in equipping the machines with water guards. It will be

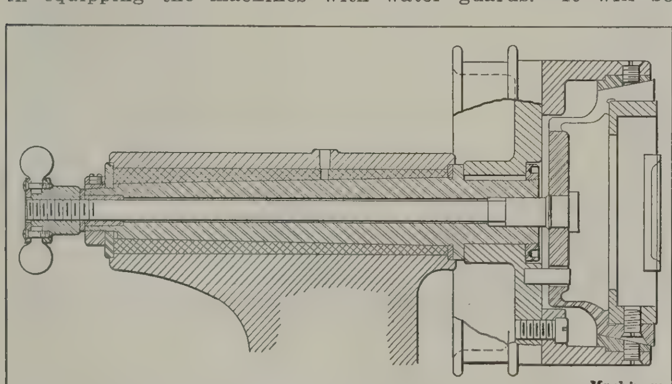


Fig. 8. Improved Type of Grinder Head Chuck

readily understood that this was not an easy matter, as the oscillation of the head caused the water to be thrown in all directions. Fig. 9 illustrates a machine equipped with water guards of the type that was finally devised. The application of wet grinding created a material increase in the amount of work produced. Further increase in this direction arose from equipping the machine with a power feed for the wheel head; this made it possible for one man to run four machines and still produce a very fine grade of work. The power feed for the wheel head was accomplished by means of a regular ratchet wheel and a friction disk which allowed the emery wheel to be fed into the work to a certain point and then stop at any place at which the stop on the friction disk had been set.

The process of grinding the intake groove that is used for assembling the balls in the races requires a great deal of care. This groove must not be too deep or it will permit the balls to jump and catch; if it is too shallow, it will cause the races to be sprung out of shape during the assembling process. The emery wheel used for grinding this groove is slightly larger than the diameter of the balls used in the size of annular bearing race being ground. The depth of the groove is determined by the use of a ball-point micrometer caliper, with which the distance between the bottom of the groove and the outside diameter of the race is measured.

The final operation before assembling consists of polishing or lapping the work. American manufacturers have been considerably behind their European competitors in regard to their polishing methods; it has been the custom to polish only the grooves of bearings made in America, whereas the foreign

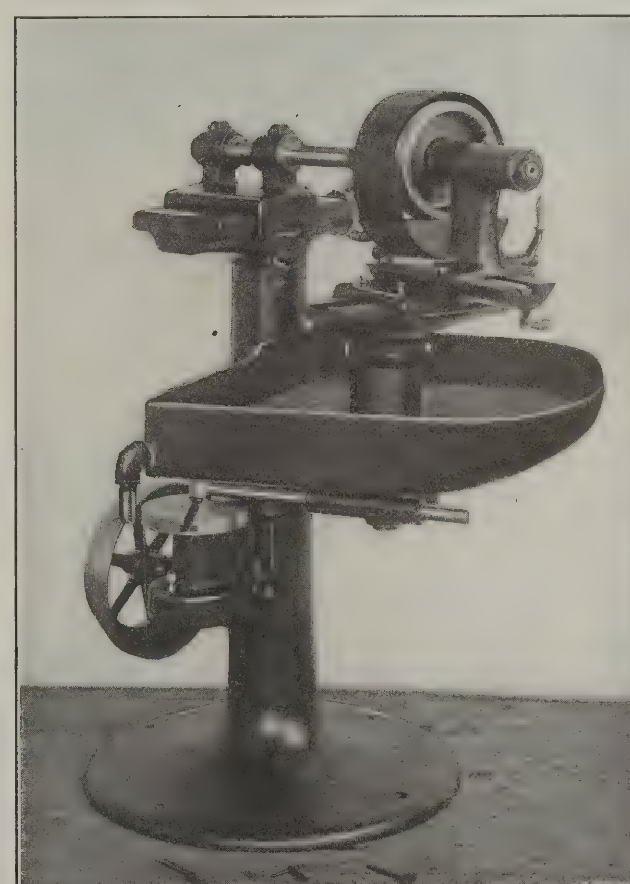


Fig. 9. Type of Water Guards used for Wet Grinding

manufacturer laps the entire surface of the bearing. The finishing operation is conducted by remounting the work in the grinder and using a hard wood wheel covered with crocus, going through the same operation as was formerly followed in grinding the bearing from the rough.

Assembling Bearings

The method of assembling this type of annular ball bearings is a very simple matter. Fig. 10 shows a view in the assembling room which is equipped with tables upon which cast-iron surface plates are mounted. These plates are provided with auxiliary plates of tool steel, which are first hardened and then carefully ground to a perfect surface. Five boxes are located at the rear of each assembling table and each of these boxes contains balls of different sizes. These sizes are as follows: O. K., 0.0005 inch large, 0.0005 inch small, 0.001 inch large, and 0.001 inch small. In assembling a bearing, the assembler takes three balls from one of these boxes and forces them into the bearing by means of the arbor press which is fastened to the table. He then distributes these

balls around the bearing and tests it for the closeness of fit. If the bearing is either too loose or too tight, he forces the balls out and replaces them with the next larger or smaller size, according to the fit that was produced with the first balls tried. This process is repeated if necessary, until the proper size has been secured; the bearing is then filled with balls if it is of the full type, or with one less than the number required to fill the races if a cage is to be used. The foreign manufac-

Fig. 10. Equipment of Room where Annular Bearings are assembled

turers grind all their bearings to one size and consequently they only require an O. K. ball. This is a more expensive process, and to reduce the cost of production American manufacturers have adopted the method previously described. After the assembling process is complete, the assembled bearing is subjected to a final grinding process in order to make the outside of the outer race concentric with the center. As the inner races are a trifle thinner than the outer races, the bearings can be assembled on a gang arbor in the same manner as shown in Fig. 3. In this case, the arbor is of the proper size to fit accurately in the hole in the inner races, and the side faces of the outer races bear against each other. The work is accurately located in this way, and when the grinding operation is finished, the outside of the races is concentric with the center, provided the assembling has been properly done. The finished bearings are tested and then marked to indicate their eccentricity and the degree of side motion that the outer race has when revolved on the inner race. The degree of accuracy required runs from 0.0005 inch to 0.0015 inch according to the diameter of the bearing.

* * *

Steel hardened in oil has not so hard a surface as when hardened in water. This is due to the fact that when water is used for quenching, the cooling of the heated steel takes place at a much more rapid rate than when the cooling is in oil. Experiments show that a piece of steel will cool from 700 to 600 degrees C. (from 1292 to 1112 degrees F.) in five seconds when quenched in pure water, while, when quenched in oil, forty-three seconds was required to cool off the same amount.

* * *

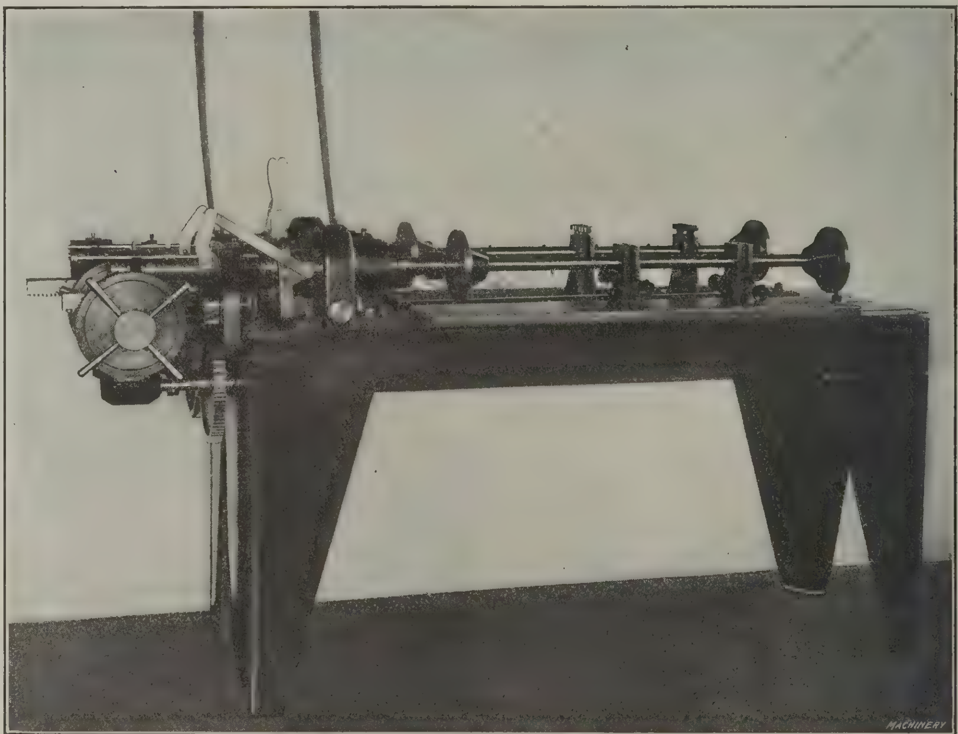
The motor boat *Baby Reliance III* is probably the fastest in the world, having a speed record of 53.8 miles per hour. She is driven by a twelve-cylinder Van Blerck engine fitted with Bosch magnetos.

A DOUBLE-SPINDLE CRANK-CASE BORING MACHINE

A double-spindle horizontal boring machine which will bore a crank-case in two and one-half minutes, when it formerly took fifteen minutes, has just been completed by the tool construction department of the H. H. Franklin Mfg. Co., Syracuse, N. Y. The machine bores two crank-cases at a time; each case has five crankshaft bearings, so that ten bearing holes can be bored at one setting. The operator adjusts one crank-case on the machine and starts boring. While the first crank-case is being bored he adjusts the second, and by the time it is ready, the first crank-case is finished. In this way, continuous operation is obtained.

It will be seen from the illustration that there is an auxiliary table for the different sizes of crank-cases. The work is clamped to the auxiliary table, and two pedestals steady the boring-bars in the center. There are heads at each end of the boring-bars which fit in the ends of the crank-cases, holding them in their true position and practically making each case its own aligning jig. Each boring-bar has five pairs of cutters, which reduce the size of the chips on each cut. These cutters can be adjusted to bore different sized bearings for the different sizes of crank-cases. They bore holes from 1½ inch to 2 inches in diameter.

The boring-bars are driven by a semi-universal joint from the main spindle of the machine. Each spindle is independent and has an independent control. The feed drive is similar to that on any other horizontal boring machine; both heads are driven by worm-wheels from one shaft which runs at 1100 revolutions per minute, and drives the boring-bars at 200 revolutions per minute with a feed of 0.005 inch per revolution. There is a clutch for each main drive and one for each feed; these clutches have an automatic knockout for stopping the spindle and feed. The feed on this machine is obtained by a rack and pinion operating through a train of gearing from the main spindles.



Double-spindle Machine for boring the Crank-cases of Franklin Motor Cars

The machine is designed for one speed and one feed. All bearings have solid bushings to prevent changes in the feed and speed, and to prevent the operator from needlessly adjusting the bearings and getting anything out of order. A safety device on the clutch keeps the spindle from starting unintentionally, thereby protecting the operator from injury while setting the bars or crank-case.

* * *

Good lockers for the men should be a part of the equipment of every modern shop and factory.

FORMS OF BABBITTING FIXTURES

BY JOHN A. H. PHILLIPS*

The work of babbitting bearings offers considerable opportunity for the use of different forms of fixtures that are capable of making a material increase in the efficiency with which this operation can be carried on. During the writer's experience, he has had occasion to babbitt a variety of bearings, and in the following article a description is given of the different types of fixtures which he has used.

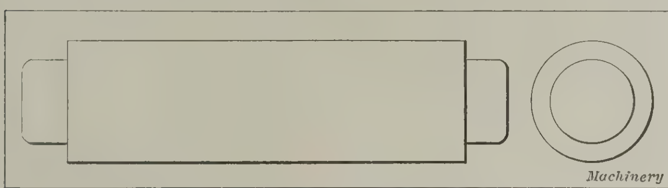


Fig. 1. A Simple Form of Babbitting Mandrel

Fig. 1 shows the most common of all forms of babbitting mandrels. This is merely a piece of shafting of the required size, which is turned down at the ends to fit into the corresponding hole in the supporting plate *A*, shown in Fig. 7. This plate is a piece of cast iron with a number of different sized holes bored in it to fit various sizes of mandrels. The body of the mandrel is turned with a taper of 0.0025 inch per foot of length in order to make it easy for the operator to remove it from the finished bearing. The mandrel is painted with a coat of thin white lead each time it is used.

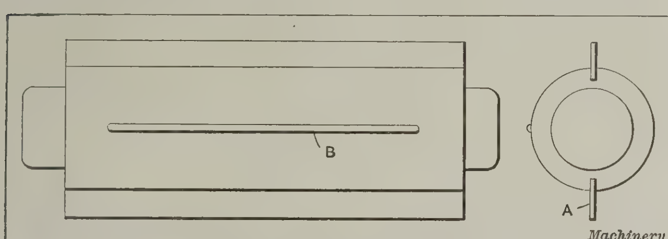


Fig. 2. Mandrel for babbitting Plain Bearing Caps

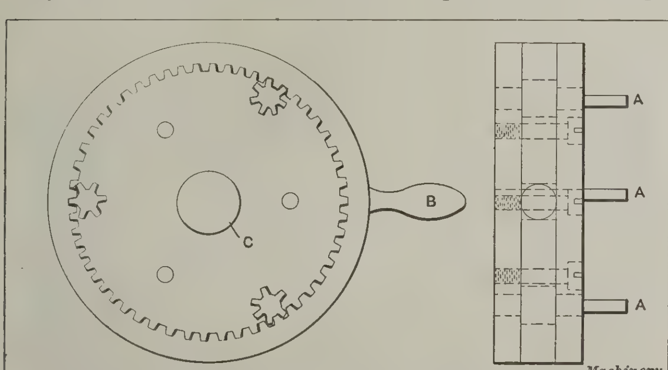


Fig. 3. Fixture used for locating Bearing at Center of Wheel

Fig. 2 shows an arbor for babbitting the cap of a plain bearing. Two thin pieces of steel *A* are inserted in this mandrel, and the space occupied by these strips while babbitting is replaced by liners in the finished bearing. *B* is a projection on the mandrel which forms the oil groove in the bearing, obviating the necessity of cutting it after the babbitting operation has been completed. The fixture shown in Fig. 7 is used for clamping the bearing to the mandrel.

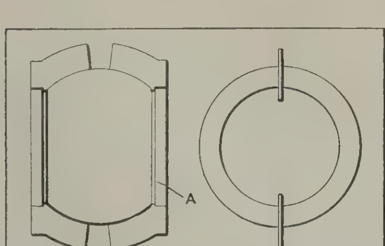


Fig. 4. Fixture for babbitting Spherical Bearings

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Fig. 6 shows a rather more complicated form of babbitting mandrel which is used for ring oiling bearings. The two rings *A* are attached to the mandrel and serve to give clearance for the oil rings in the cap. The two small rings *B* are not fastened to the mandrel but are placed in the bearing to prevent the babbitt from running out; the space around these rings is carefully plugged up with putty before the babbitt is poured. Bearings of this type must be babbitted in a horizontal position, the six notches cut in the sheet-steel feathers being used to provide space through which the babbitt is poured.

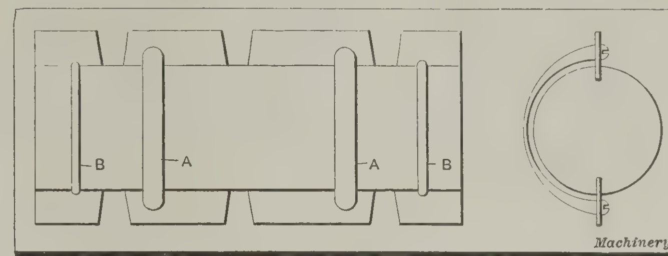

Fig. 6. Mandrel for babbitting Ring Oiling Bearings

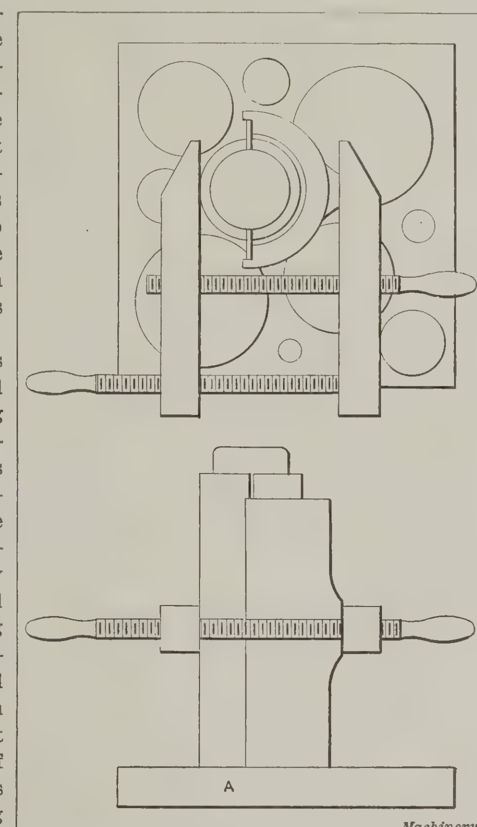

Fig. 7. Fixture for supporting Babbitting Mandrels

Fig. 4 shows a fixture used for babbitting spherical bearings. In this case, the shoulders *A* are made to fit the castings as closely as possible, and any remaining cracks are carefully plugged with putty in order to prevent the escape of the babbitt. This type of bearing is babbitted in halves similarly to the ring oiling bearings, the babbitt being poured through the notches in the thin steel plates, as in the preceding case.

The mandrel shown at *A* in Fig. 5 is used for babbitting the bearing *B*, which is a type that is extensively used on belt conveyors used for handling a variety of loose materials.

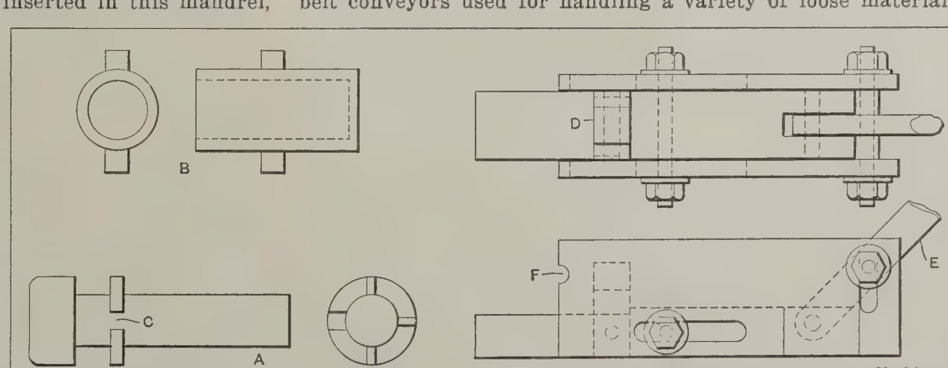

Fig. 5. Mandrel and Fixture used for babbitting Bearing B

The four notches *C* are used as sight holes for centering the mandrel in the bearing; one of these notches is cut larger than the others and is used for pouring the babbitt into the bearing. The jig shown at the right-hand side of the illustration is used for removing the bearing from the mandrel. The

mandrel is placed in the slot *D* with the bearing projecting, and when the lever *E* is brought forward, the notches *F* come into contact with the lugs on the bearing and force it off the mandrel.

Fig. 3 shows a fixture for babbitting cast-iron rollers and wheels. This fixture was designed to provide a means of locating the bearing in the exact center of a wheel; it is made in two halves with teeth cut on the inside of the ring as shown. The three pins *A* are turned eccentric with the pinions of which they are a part, and by swinging the handle *B*, the wheel is accurately centered. A mandrel of the type shown in Fig. 1 is used in connection with this fixture, the mandrel being placed in the central hole *C*.

* * *

HOW TO FORGE AND HARDEN A COLD CHISEL

BY C. C. SEMPLE*

Some blacksmiths advocate hammering a cold chisel at a black heat to refine and toughen it. After taking the pains to do this, they will replace the tool in the fire and heat it hotter than it was when they began to refine it, after completing the heavy forging. In such cases, the temperature is often still further increased to secure heat enough to draw the temper. When the required temperature has been reached, the tool is taken from the fire and the cutting end is immersed in the bath, part way up the length of the heat. It is then withdrawn and the blade is next polished with a stick covered with emery or with emery cloth. The blacksmith then waits for the temper to run down from the red hot part above the blade, and when the desired temper shows by color, the whole chisel is immersed in the bath. When sufficiently cool, it is given to the man who is to use it.

By this treatment, the blacksmith has undoubtedly undone a part of the mischief and all of the good—if any—that was produced by his cold hammering. In nine cases out of ten, he has heated the vital part of the tool too hot for good refining in order to make the heavy part hot enough to draw the temper. Any steel that will not stand this treatment and make a good chisel is condemned by him.

Now let us see how a blacksmith who keeps the tools in order for a gang of more than 100 men does such work. He takes a piece of steel of the right length for a chisel, heats it to a bright red heat for one-third of its length, and draws the cutting end down on his steam-hammer to about twice its finishing thickness. This being done, he returns the tool to the fire and reheats it to about the same temperature as before. The work is next taken to the anvil, and by means of a hand-hammer and light sledge in the hands of the helper, the chisel is quickly shaped, with the blade still red-hot, or nearly so, when finished. Instead of resorting to cold hammering to refine the steel, the chisel is again returned to the fire, and a second piece that has been getting warmed up on the side of the fire is also moved to the center at this time. The chisel just forged, when heated to a low red heat, is thrust into the annealing box and left to cool. All the subsequent chisels are treated in the same manner, and if any of them are required for immediate use, the ones that were forged first are selected; if not entirely cold, they are plunged into water to make them so.

The hardening process used for chisels cooled by either of the preceding methods is as follows: A piece of iron is laid across the fire and partially buried. The thin edge of the chisel is laid on this iron and the heat allowed to take hold some distance back and run up to the edge. The blade is then dipped and hardened well up, so that in most cases there is not enough heat left to draw the temper. In hardening chisels by this method, the temper is drawn at a light blue. Chisels hardened and tempered in the manner described are put aside for future use, and it is claimed that if they are allowed to remain several days they are better than when used at once.

It may seem that this is quite a rigmarole for forging and hardening so simple a tool as a cold chisel. The question arises, does the end justify the means? The fact that this blacksmith keeps the tools in shape for more than 100 men, and that every one of these men will swear that the tools are the best he ever used in any shop where he has worked, leads to the supposition that there is something in it.

This same method of treatment may be safely applied to all forged tools, so far as omitting the cold hammering and heating of the larger parts to draw the temper is concerned. It is an established fact that many of the high-carbon and alloy steels require reheating to relieve the forging strains and tnat they are improved by being reheated and allowed to cool slowly after forging. It is also an established fact that these steels are ruined if they are hammered at any temperature much below a red heat. The inference is plain that the steel made nowadays does not require the old time blister-steel treatment, and that it will not stand it and yield the best results. The most economical steels to use are now made in such a way that they need no refining on the part of the blacksmith. You will get less hardening cracks by hardening in saturated brine than by hardening in water, but in any case the piece must be kept moving in the hardening fluid. These notes were supplied to the writer by the manufacturer of a well known and extensively used brand of Swedish steel (Fagersta), but the method is equally applicable to all high-grade steels.

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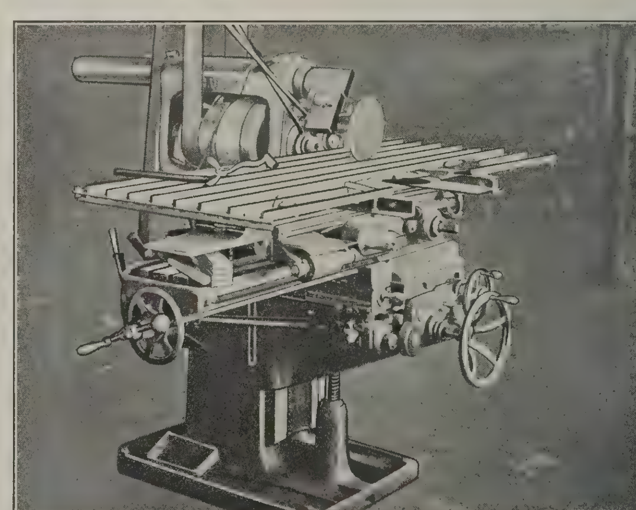
* * *

A COMBINATION OF GRINDER AND MILLING MACHINE

BY S. A. MCDONALD*

The accompanying illustration shows a way of combining two machines to perform an operation on a piece of work which could not be handled otherwise with the average small shop equipment. The work done consisted of a special machine table 5 feet long and 2 feet 2 inches wide, to which were fastened a series of rows of ½ by ¾-inch cold-rolled steel bars. Five of these guide bars were to be parallel within a variation of less than 0.005 inch for their full length; hence, it was considered necessary to grind them.



A Combination of Grinder and Milling Machine

This was a job for a large plain grinder, but, as such a machine was not available, the following method was resorted to:

The platen and grinder bed of a No. 2 Walker grinder were placed on the table of a No. 14A Garvin milling machine, the grinder bed being clamped to the table of the milling machine, and the table to be machined bolted to the grinder platen. By this arrangement the combined travel of the grinder and milling machine tables was sufficient to cover the work. A lathe grinding attachment was fastened to the overhanging arm of the milling machine. This attachment was belted to a pulley on the lineshaft. By shifting the arm in or out, the emery wheel was set to approximately the right position, and the arm clamped. The final adjustment was then made by the transverse feed of the milling machine. The grinding was done with the side of the wheel and a very smooth finish was obtained, well within the limits of accuracy required.

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DYNAMICS OF GAS ENGINE CAMS—2

AN INVESTIGATION INTO THE RELATIVE MERITS OF DIFFERENT TYPES OF CAMS

BY M. TERRY*

In the previous installment of this article an analysis was made of a tangential cam, such as is commonly used in gas engine design for automobile engines. In the present installment, it is proposed to make a similar investigation with relation to a uniformly accelerated and retarded motion cam, in order to definitely determine if the latter possesses advantages over the tangential cam.

In comparing different types of cams, or even cams of the same type, we must make them alike in all respects but the one we wish to investigate. It is evidently impossible to draw any conclusions by comparing cams of different lifts and base circles and driven at different speeds, or having followers of different diameters, possessing different clearances and producing different timing of valves.

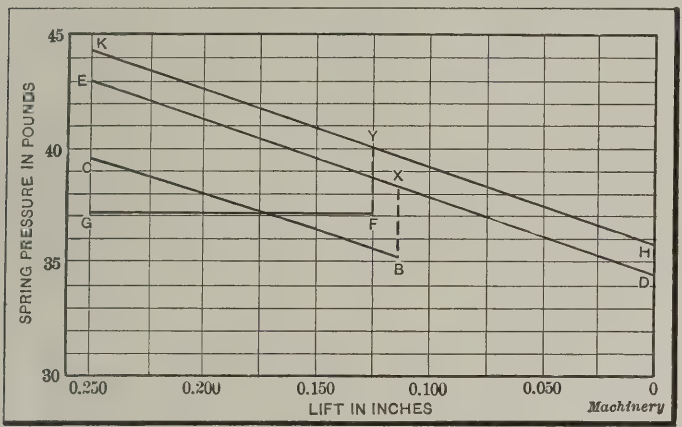

Fig. 14. Spring Pressure Diagram for Tangential and Uniformly Accelerated Motion Cams

Since the object of our investigation is to find out which shape of the two cams is more suitable in a dynamic respect, we shall make our uniformly accelerated aand retarded motion cam identical with the tangential cam discussed in the first installment. In other words, our new cam must comply with the following requirements:

Base circle = 1.000 inch in diameter.
Roller circle = 1.000 inch in diameter.
Lift = ¼ inch. Full lift must be attained in the same length of time, *i. e.*, in 53 degrees of the angular motion of the cam.
Weight of reciprocating parts = 1.6 pound.
The same rotary speed, *i. e.*, the camshaft turns through 1 degree in 1/5000 second.
The same timing, which, so far as individual cams are concerned, means that the exhaust and inlet valves should stay open 110 degrees and 100 degrees, respectively.
The same amount of clearance between the valve lifter and the valve stem.

The last item, it will be noted, does not call for the 5 degrees clearance angle assumed with the tangential cam, and the reason for this will be shown presently.

Clearance and Clearance Angle

In the early part of the first installment reasons were given for the necessity of clearance whenever the poppet type of valve is used. The amount of clearance given is, in general, arbitrary, and with different manufacturers it varies from 0.004 to 0.010 inch. With the valve gear arrangement shown in Fig. 15 a backlash of, say 0.006 inch is obtained by inserting a steel gage 0.006 inch thick between A and B; the timing gears are then adjusted so as to secure the timing originally intended for that motor. When this last object is attained with a reasonable degree of accuracy the screw B is locked securely in place, and only a slight pull should be sufficient to remove the gage.

It is clear, then, that the valve lift is equal to the cam lift less the clearance, and that the follower would rise the amount of backlash before the valve proper is started on its upward journey. This loss in valve lift is generally neglected, but its effect on valve timing is universally recognized.

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In Fig. 16, O is the center of the tangential exhaust cam which turns counter-clockwise. The cam and its follower are shown in the position where the latter starts on its upward motion. As before, assume that the cam is stationary and that the roller moves to the right; its center C will describe a straight line CC_2, and in doing so the distance between O and C will increase. When such a point, C_1, is reached that $OC_1 - OC$ equals the backlash, the valve will begin to open. The angle COC_1 is known as the clearance angle or the angle of backlash.

$$\cos COC_1 = \frac{OC}{OC_1} = \frac{OC}{OC + \text{backlash}}$$

In general, the amount of backlash is assumed first and the angle of clearance is determined afterwards. Since, however, in the case analyzed in the previous installment of this article we have assumed the angle of backlash to be 5 degrees, our first problem is to determine the amount of clearance corresponding to 5 degrees.

$$\cos 5 \text{ deg.} = \frac{1}{1 + x}, \text{ or } x = 0.00382 \text{ in.}$$

Our next problem is to determine the clearance angle of the uniformly accelerated and retarded motion cam corresponding to this amount of backlash, *i. e.*, 0.00382 inch.

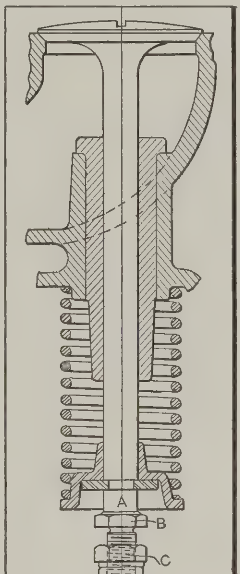


Fig. 15. Valve Mechanism

Uniformly Accelerated and Retarded Motion Cam

Almost every text-book on mechanisms mentions the uniformly accelerated motion type of cam. In our case it would be a cam so shaped as to impart to the roller center a uniformly accelerated motion during the first half of the lift, and a uniformly retarded motion during the second half.

If A = acceleration per second, in feet per second (constant),
t = time in seconds,
v = velocity in feet per second,
S = lift in feet,

Then

$$v = A \times t \qquad (1)$$
$$S = \tfrac{1}{2}At^2 \qquad (2)$$

These equations can be applied only within the limits of one-half the lift. A is unknown for the present, but its value can be readily determined from the last equation. In the present case:

S = 1/8 inch, or 1/96 foot,
$t = 26\tfrac{1}{2} \times 1/5000 = 0.0053$ second,

$$A = \frac{2S}{t^2} = 741\ 2/3 \text{ feet per second per second.}$$

To find the clearance angle x corresponding to a backlash of 0.00382 inch:

$$t^2 = \frac{2S}{A} = \frac{2 \times 0.00382 \times 1/12}{741\ 2/3}$$

from which we find $t = 0.000926$ second. But

$$t = x \times \frac{1}{5000},$$

from which $x = 5000 \times t = 5000 \times 0.000926 = 4.63$ degrees, or 4 degrees 38 minutes.

The clearance angle of the uniformly accelerated and retarded motion cam being equal to 4 degrees 38 minutes, the

total angle of the exhaust cam = 110 deg. + 2 × (4 deg. 38 min.) = 110 deg. + 9 deg. 16 min. = 119 degrees 16 minutes (see Fig. 17), and the total angle of the inlet cam = 109 degrees 16 minutes.

The cam shown in Fig. 17 is what may be termed the equivalent of the tangential cam, Figs. 9 and 10, previous installment.

In order to plot an accurate lift curve (Fig. 18), as well as to draw the contour of our new cam (Fig. 17) we shall make a table of lifts for each degree of the cam.

TABLE IV. ANALYSIS OF UNIFORMLY ACCELERATED MOTION CAM

α	a	L	α	a	L
1	0.000356	0.000178	15	0.000356	0.040050
2	0.000356	0.000712	16	0.000356	0.045568
3	0.000356	0.001602	17	0.000356	0.051442
4	0.000356	0.002848	18	0.000356	0.057672
5	0.000356	0.004450	19	0.000356	0.064258
6	0.000356	0.006408	20	0.000356	0.071200
7	0.000356	0.008722	21	0.000356	0.078498
8	0.000356	0.011392	22	0.000356	0.086152
9	0.000356	0.014418	23	0.000356	0.094162
10	0.000356	0.017800	24	0.000356	0.102528
11	0.000356	0.021538	25	0.000356	0.111250
12	0.000356	0.025632	26	0.000356	0.120328
13	0.000356	0.030082	26.5	0.000356	0.125000
14	0.000356	0.034888	..	....	....

Equation (2) may be put in the form:

$$L = \tfrac{1}{2} a \alpha^2$$

where L is the lift of the cam follower in inches, α is the cam angle in degrees, and a the acceleration per degree, in inches per degree; this acceleration is, of course, constant and can be readily determined:

$$a = \frac{2L}{\alpha^2} = \frac{2 \times 0.125}{(26.5)^2} = 0.000356 \text{ inch.}$$

(Since full lift is attained in 53 degrees, a lift of 0.125 inch corresponds to an angular motion of 26½ degrees.)

Knowing now the value of a, and by assigning various values to α in the equation just given, we can determine the lift or position of the roller center for every degree of the cam. This is done and the results are compiled as shown in Table IV. With the help of this table we can now plot a complete lift curve, since the latter is symmetrical both with respect to XX and YY, Fig. 18.

Again, with O as the center of our cam (Fig. 17) strike two arcs AA of 1 inch radius and CC of 1¼ inch radius, and from intersections of these arcs with the radial lines of the cam lay off proper lengths as indicated in the third column, Table IV. A line through the points thus obtained represents the path of the roller center; if from these points as centers we strike a number of arcs the radii of which are equal to the radius of the roller, the curve drawn tangent to these arcs will give us the contour of the cam.

The Valve Spring

In the previous installment we have fully discussed the functions of the cam and of the valve spring, and the conclusions there arrived at hold good for the uniformly accelerated and retarded motion cam. It remains now to select a suitable valve spring. If

T = spring pressure in pounds,

A = acceleration per second in feet per second required by the cam,

m = total mass of the reciprocating parts of the valve gear plus one-half the mass of the spring proper, we have:

$$T = m \times A = \frac{A \times 1.6}{32} = \frac{742 \times 1.6}{32} = 37.1 \text{ pounds.}$$

Since A is constant, 37.1 pounds of pressure is all that is required of the spring at any point from one-half to full lift of the cam. In other words, the ideal spring for a uniform motion cam is the one whose stress-strain curve is a horizontal line. This, of course, is an impossibility, for within its elastic limit any spring will exert pressure directly proportional to its distortion.

In Fig. 14 (reproduced from the previous installment) the line FG represents the spring pressure required by the uniformly accelerated and retarded motion cam. If we wish to use the same spring that we have designed for the tangential cam, and give it the same excess of pressure at F as it has anywhere between the lines BC and DE, we shall obtain HK for our actual spring pressure line. This would give us a spring, the initial and final pressures of which are 35.8 pounds and 44.4 pounds, respectively. In other words, a greater spring pressure is required for the uniformly accelerated and retarded cam.

Our conclusions in regard to the relative stiffness of springs required for the two cams are substantiated by an actual test of two engines identical in every respect but for the shape of their timing cams. The two engines were originally equipped with identical valve springs. The follower of the uniformly accelerated motion cam developed a tendency to "jump" the cam at from about 2100 to 2200 R. P. M. of the engine; the follower of the tangential cam showed signs of the same tendency when the engine speed exceeded 2400 R. P. M. The "jumping speed" of the first follower was raised to about 2500 R. P. M. by equipping its motor with additional valve springs.

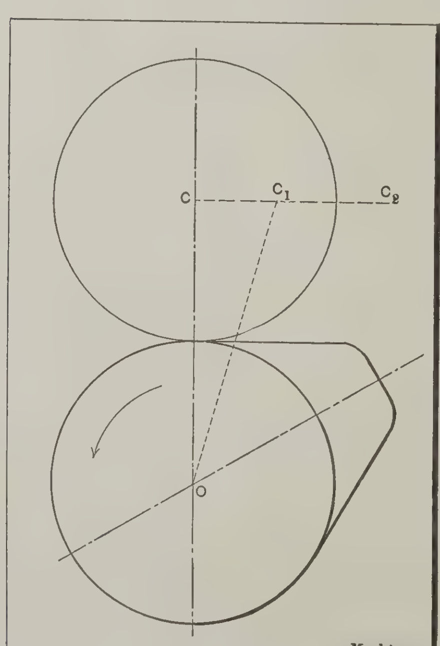


Fig. 16. Relation between Clearance and Clearance Angle

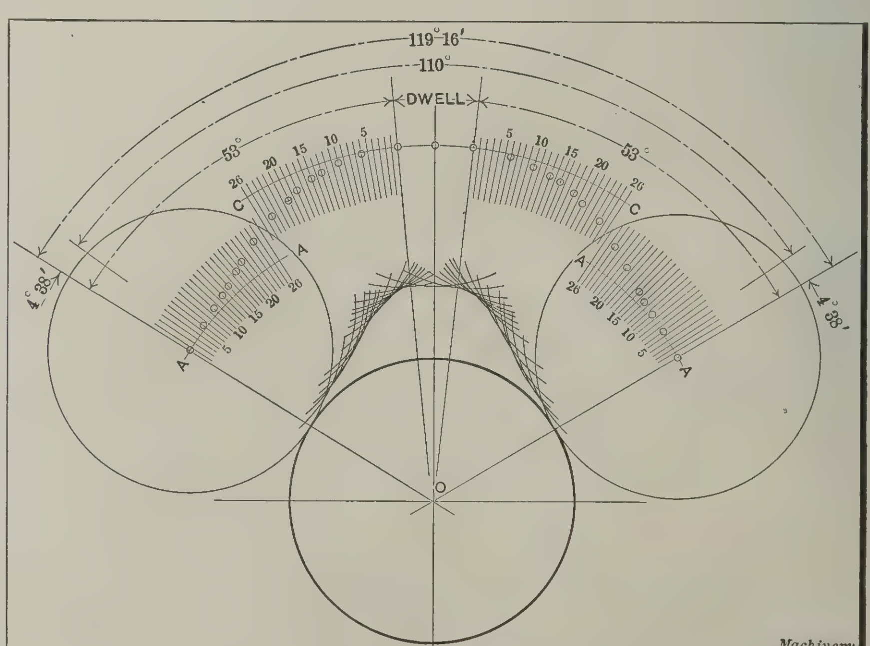


Fig. 17. Lay-out of a Uniformly Accelerated and Retarded Motion Cam

The two motors were built for racing purposes, and if the writer remembers correctly, the valve lift was 7/16 inch (unusually high for automobile engines); the weight of reciprocating parts of the valve gear was 2.7 pounds, and the spring pressures were 175 pounds for the tangential and about 200 pounds for the uniformly accelerated motion cam. The experiment referred to took place over two years ago, and its results were contrary to the expectations of all concerned, for the prevailing opinion among designers is that of the two cams it is the tangential one that requires the stronger spring. To quote Mr. P. M. Heldt (*Horseless Age*, July 5, 1911, pages 4 and 5): "* * * this computation is based on supposition that acceleration and deceleration of the valve are uniform. With a tangential cam this is not the case, and the spring should then be made slightly stronger."

The author takes exception to this opinion. A glance at Fig. 14 will suffice to convince anyone who is even slightly familiar with mechanics. Assume a multiple cylinder engine equipped with cams of both types; the valve springs are all alike, their pressure line being represented by *DE*. As the speed of the engine rises above the assumed maximum, the lines *BC* and *FG* would rise parallel to themselves; *DE* would, of course, remain stationary, for the spring pressure is independent of the engine speed. It is clear, then, that *FG* would be the first line to cross *DE*, or to put it in other words, the uniformly accelerated motion cam would be the first one to exceed the capacity of the spring.

It would not be out of place here to mention the fact that if one is very anxious to prove the contention that a tangential cam requires more spring pressure than one with a uniformly accelerated motion outline, he can easily do so by "juggling"

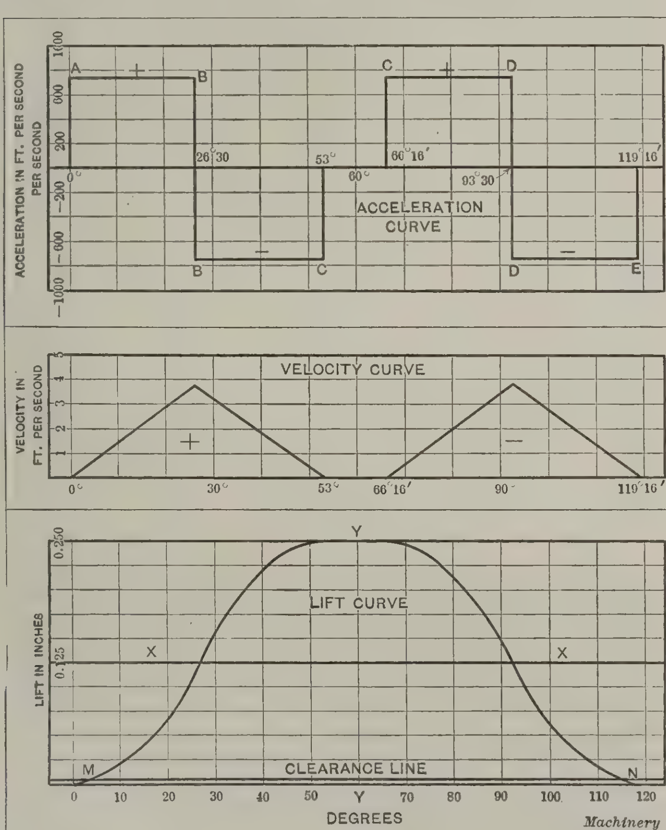


Fig. 18. Acceleration, Velocity and Lift Curves for a Uniformly Accelerated and Retarded Motion Cam

with the former. For instance, he can take the cam described in the first installment and give it a fillet of 1/16 inch radius instead of ⅛ inch. This will put a heavier duty on the spring, requiring it to perform the work of retardation and of acceleration in less time; but in this respect our comparison of the two types of cams has been absolutely fair, for not only was the total time required to lift the valve to its full height the same in both cases, but in each case the time was equally divided between acceleration and retardation, and that is as far as one can go in making the two cams alike. The only difference between them lies in the nature of their accelerations: it is constant in one and variable in the other; and, as has already been proved, in the case of the tangential cam it varies in such a manner as to favor the spring.

Origin of Noise

In a lecture delivered before the automobile class of the West Side Y. M. C. A., New York, Mr. C. E. Reddig, engineer of the United States Motor Co., speaking on the Silent-Knight motor, said, in part:

"The Knight engine is not different from standard engines, except in its valves; the cycles are performed in the usual manner, the gas is drawn from the carbureter, is compressed,

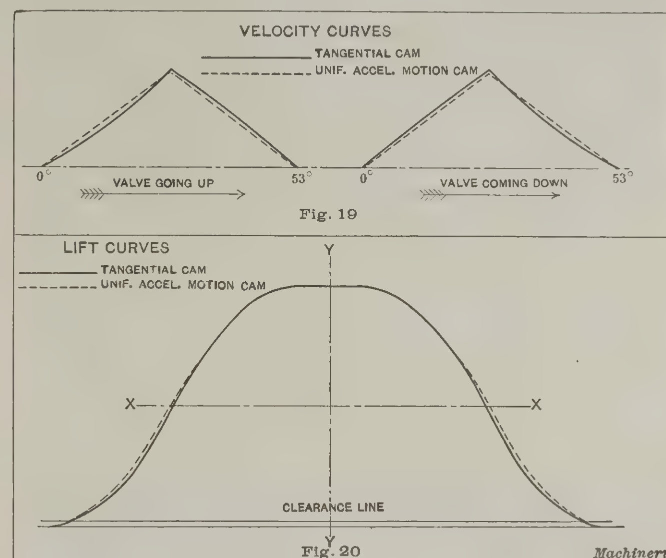


Fig. 19. Comparison of Velocity Curves. Fig. 20. Comparison of Lift Curves

combustion takes place, and it exhausts, in the same manner as in any of the four-stroke cycle engines.

"The changes which in the Knight engine constitute the great improvement over ordinary types of engines are the silent, tremorless, sliding sleeves working away perfectly without care or attention. They make no noise, for they strike nothing. They cause no vibration."

Indeed, they make no noise, for they strike nothing. Not so with the poppet valve. In what follows we shall limit our discussion to the type of mechanism shown in Fig. 15. The complete lift curves, Figs. 12 and 18, represent the motion of the follower and of all the parts rigidly connected to it. The motion of the valve proper, while following along the same curve, does not commence until after the cam follower rises the amount of the backlash. In other words, the valve motion begins at *M*, the point of intersection of the lift curve with the clearance line; likewise it ceases at *N*.

If at *M* and *N* we erect ordinates until they intersect the velocity curve, the cause of noise will become apparent: 1. The cam follower possesses a definite velocity at the instant it comes in contact with the valve stem. 2. The valve possesses the same velocity when its head comes in contact with the valve seat. Whenever two bodies possessing different velocities come in contact, impact takes place; and in the case of poppet valve engines, there are two impacts per cycle for each valve in the engine.

The impact due to the valve striking its seat can be most readily analyzed. Owing to the rigidity of construction of both the valve head and the cylinder casting, practically no deformation of either can take place after the impact, and, consequently the velocity of the valve must vanish almost instantly. At the instant the valve strikes its seat, the former, owing to its velocity, possesses a definite amount of kinetic energy, the value of which is $\frac{1}{2}mV^2$, where m is the combined mass of the valve, and of all the parts attached to it, plus one-half the mass of the valve spring, and V is the velocity of the valve at the instant it strikes the seat. Since, after the impact, V vanishes almost instantly, the kinetic energy of the valve must also completely disappear. However, energy cannot be created nor destroyed, and the kinetic energy of the valve merely undergoes a transformation and reappears in other forms of energy, namely: heat and sound.

In just what proportion the kinetic energy resolves itself

into the above two forms is, of course, impossible to tell. Simple observation seems to indicate that the pounding noise increases very rapidly with the speed of the engine, and we are justified in making the assumption that, at all ordinary engine speeds, noise constitutes a constant percentage of the kinetic energy of the valve at the moment of impact. We can write then:

$$\text{Noise} = c \times \tfrac{1}{2} m V^2 = K V^2$$

where K is a constant.

This assumption is very useful for the purpose of comparing the pounding action of valves due to different cams.

Tangential vs. Uniformly Accelerated Motion Cams

Sub-figures ($_1$) refer to uniformly accelerated motion cam, and sub-figures ($_2$) to the tangential cam.

Let S_1 = backlash in feet,

A_1 = acceleration per second, in feet per second,

V_1 = velocity of the valve in feet per second at the moment of impact,

β_1 = angle of backlash = 4 deg. 38 min., or 4.63 degrees,

t_1 = time in seconds required for the cam to turn through the angle of backlash $= \beta_1 \times 1/5000$.

S_2 = backlash in feet,

A_2 = average acceleration per second, in feet per second during the angle of backlash,

V_2 = velocity of the valve in feet per second at the moment of impact,

β_2 = angle of backlash = 5 degrees (see previous installment),

t_2 = time in seconds required for the cam to turn through the angle of backlash $= \beta_2 \times 1/5000$.

Then

$$V_1 = A_1 t_1 \qquad (3)$$

$$V_2 = A_2 t_2 \qquad (4)$$

$$S_1 = \tfrac{1}{2} A_1 t_1^2 \qquad (5)$$

$$S_2 = \tfrac{1}{2} A_2 t_2^2 \qquad (6)$$

Substituting (3) and (4) in (5) and (6), respectively, we obtain:

$$S_1 = \tfrac{1}{2} V_1 t_1 \qquad (7)$$

$$S_2 = \tfrac{1}{2} V_2 t_2 \qquad (8)$$

But $S_1 = S_2$, since the amount of backlash allowed was the same in both cases. Hence $\tfrac{1}{2} V_1 t_1 = \tfrac{1}{2} V_2 t_2$ (9)

and

$$\frac{V_1}{V_2} = \frac{t_2}{t_1} \qquad (10)$$

Now since $t_1 = \beta_1 \times 1/5000$ and $t_2 = \beta_2 \times 1/5000$,

$$\frac{t_2}{t_1} = \frac{\beta_2}{\beta_1} \qquad (11)$$

Substituting (11) in (10):

$$\frac{V_1}{V_2} = \frac{\beta_2}{\beta_1} = \frac{5}{4.63} \qquad (12)$$

Now, then, everything else being equal, we can write:

$$\frac{\text{Noise due to the uniformly accelerated motion cam}}{\text{Noise due to the tangential cam}} = \frac{V_1^2}{V_2^2} = \frac{\beta_2^2}{\beta_1^2} = \frac{5^2}{4.63^2} = 1.16,$$

or 16 per cent greater.

The fact that in the early stages of opening and the late stages of closing, the valve velocity due to the uniformly accelerated motion cam is greater than that due to the tangential cam can be shown graphically by superimposing the velocity curves of the two cams. (See Fig. 19.)

Lift Curves Compared

Our study of the two cams would remain incomplete if we failed to compare their lift curves. As a matter of fact, these are the only curves that the majority of designers ever take pains to construct and to compare. The object of their comparison, however, has nothing to do with the dynamics of the cams themselves.

In Fig. 21 is shown what is known as a flat-seated valve. The effective area for the passage of gases is that of a cylindrical surface whose diameter is D and whose height is Y. This area is equal to πDY, where π and D are constants, and Y at any instant is the actual rise of the valve. When a cone-seated valve is used, the relation between the effective area-opening and the valve lift is somewhat more complicated.

It is the aim of every designer to provide as large gas passages as possible in order to increase the volumetric efficiency, and—along with it—the output of his engine. At any instant, then, the lift regulates the amount of charge admitted, and, thus, the former can graphically represent the latter. The total charge taken in during the suction stroke of the engine, and consequently, the output of the latter can be represented by the lift-integral, *i. e.*, by the area bounded by the lift curve and the clearance line.

It is clear, then, that the output of the two identical engines equipped with different cams would be approximately proportional to their lift-integrals, and it is for the sake of

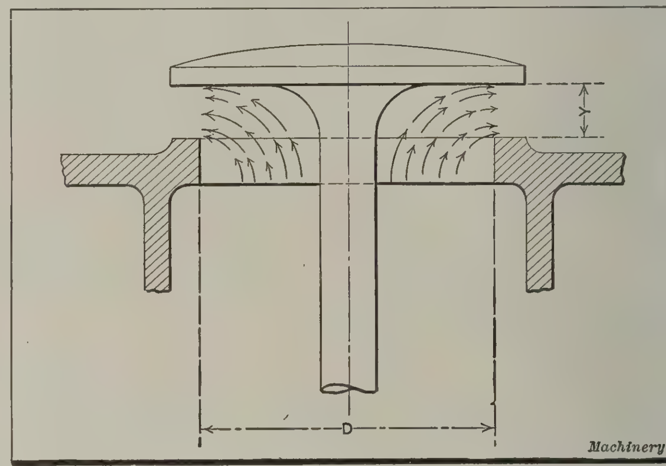


Fig. 21. Relation between Lift and Discharge Area

comparison that we have superimposed the lift curves of our two cams, as shown in Fig. 20. The advantage is in favor of the uniformly accelerated motion cam, but the amount of this advantage is very slight, as anyone can see at a glance.

To sum up our results:

1. A tangential cam requires less spring pressure than a uniformly accelerated and retarded motion cam.
2. It produces less noise.
3. It can be manufactured more cheaply and accurately.
4. The indicated horsepower of the engine would, in all probability, be the same, no matter which type of cam were employed.

* * *

OIL-MIXED PORTLAND CEMENT CONCRETE

A serious drawback to the general use of concrete for tanks, cisterns, house walls, cellars, etc., is its permeability to moisture. A concrete cistern, unless specially treated, is likely to be leaky, and even if leakage is not serious, it is usually objectionable on account of the dampness resulting from it. Concrete block houses are often damp and unhealthful. Several formulas for making concrete waterproof have been successfully used but some of them are too expensive for general application. One of the simplest, cheapest and most effective yet found is that developed by the U. S. Geological Survey in the office of public roads by Mr. L. W. Page. Mr. Page found that a heavy residual mineral oil of 0.93 specific gravity, mixed with Portland cement, makes it waterproof and does not weaken when the concrete consists of, say, cement, one part, sand, three parts, and oil not more than ten per cent by weight of the cement. Concrete mixed with oil requires about fifty per cent longer time to set hard, and the compressive strength is slightly decreased, but not seriously. The bond or grip of oil concrete on steel is much decreased when plain bars are used, but formed bars, wire mesh or expanded metal act as effectively in it as in ordinary concrete.

* * *

It has hitherto been believed that pitchblende, the mineral containing the largest amount of radium of any mineral known, was principally to be found in Austria. It is now stated, however, that this mineral is found in even greater quantities in one of the northern provinces of Sweden, and that it is only a question of time when these deposits will be worked for obtaining the radium contained in them.

MODERN METHODS OF A PRESS WORKING PLANT

DESCRIBING WORK DONE BY THE WORCESTER PRESSED STEEL CO.

BY CHESTER L. LUCAS*

Nestling under a hillside at Greendale, one of the pretty suburbs of Worcester, Mass., are the works of the Worcester Pressed Steel Co., an "aviator's view" of part of which is presented in Fig. 1. The buildings of the plant embrace the main press working factory; the foundry for making special tool castings for dies, die beds, etc.; a new building for pickling, with ventilated roof 45 feet high; the rolling mill for cold-rolling strip steel; the acetylene gas generating house; the annealing and casehardening building; the storage and shipping building; the office building and the power house. The business was established in 1883 under the name of the Worcester Ferrule & Mfg. Co., at which time it occupied 7000 square feet of floor space and employed 20 hands. At the present time the plant covers 70,000 square feet of floor space and gives employment to 250 men.

Fig. 1. Aviator's View of Worcester Pressed Steel Co.'s Plant

This manufactory specializes in cold drawing, pressing, forming and stamping shapes to order from steel, brass, aluminum and other sheet metals.

Rolling the Metal

On account of the accuracy and various thicknesses of steel required for pressed and seamless drawn metal products, as well as the necessity for having sheet metal with highly finished surfaces, this company maintains a pickling and rolling department of its own, for cold-rolling the steel to its finished gage. A section of this department is shown in Fig. 2. On the two machines shown, the steel rolls themselves are 12 inches in diameter. During the rolling operation, the rolls are kept flooded with oil. To furnish adequate facilities for this work, a new building 70 feet by 110 feet has just been completed and equipped with most modern vats, cranes and appliances. Work has also been started on another new cold-rolling mill, 150 feet by 100 feet in size and of steel and glass construction. A fireproof addition to the main press shop, 90 feet by 100 feet in size, is now being erected.

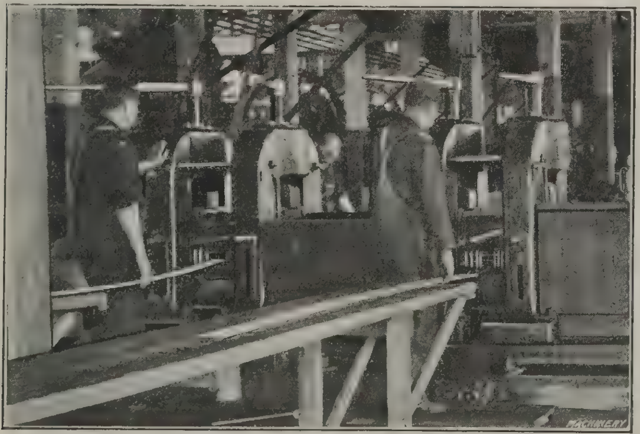


Fig. 2. A Corner of the Sheet Metal Rolling Department

Making Radiator Fans

One of the interesting jobs of press work done in these works is the making of a one-piece steel fan for an automobile radiator. These fans are 14 and 16 inches in diameter, made of cold-rolled sheet steel 0.035 inch thick, and reinforced at the edge by an enclosed wire ring which stiffens the entire fan. The different stages in making the fan may be seen by referring to Fig. 3. Commencing with the blank at the left-hand upper corner, these pieces represent the work done: blanking; flanging edge; closing in preparatory to wiring; closing the wire in position; piercing between the blades; shaping the blades; electrically welding the spider and hub; and piercing the rivet holes in the hub.

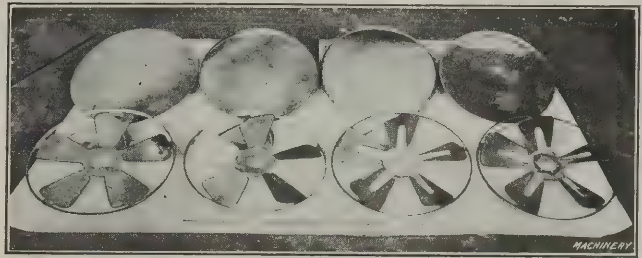


Fig. 3. Evolution of a Radiator Fan

The blanking, flanging and closing-in operations are ordinary jobs of press working. The welding operation which connects the spider with the blades of the fan is performed upon a National electric welding machine, known as a spot welder. This operation is shown in Fig. 4. A helper clamps a spider upon the fan with a simple fixture, which centers the hole in the spider with the opening in the fan and holds both parts securely in place. This being done, the welding machine operator spot-welds an arm of the spider to a corresponding blade on the fan, hands it back to the helper, who has, in the meantime, prepared another fan and spider for welding. The helper now removes the fixture from the fan and the welder completes the work on the other blades, while another fan is being placed in the fixture. There are three welds to each blade and fifteen welds to a fan. A welder and a helper will

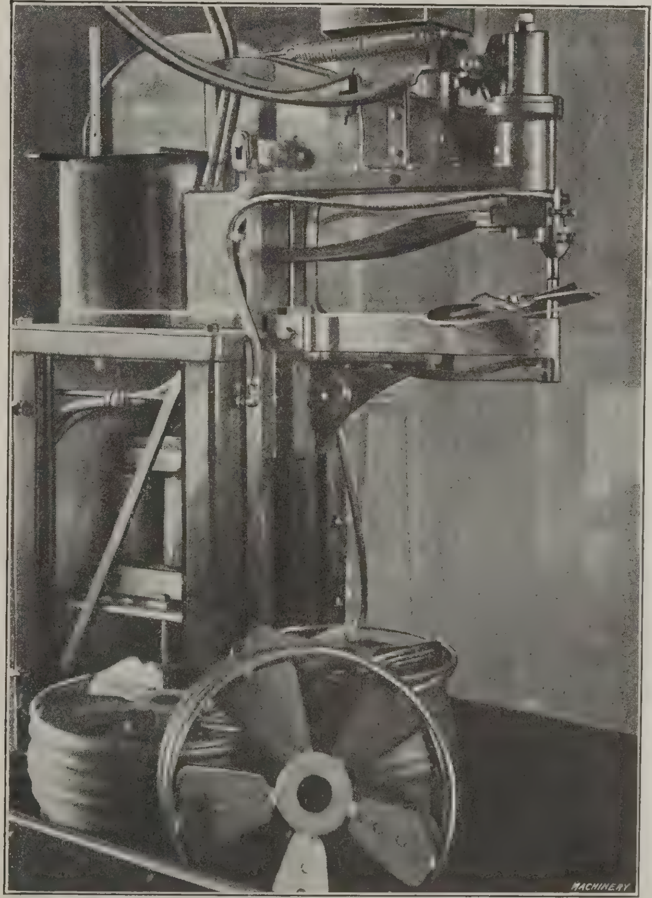


Fig. 4. Welding Fan Blades on a National Spot Welder

* Associate Editor of MACHINERY.

turn out about 400 fans per day of ten hours, which makes a total of about 6000 welds per day. There are four of these machines in this department.

Cold Forging

A somewhat unusual branch of press work was developed and is followed to a considerable extent in this shop, *viz:* cold forging. Cold forging is the name commonly applied to the process of producing sheet metal shapes or pieces having raised bosses or projections upon their surfaces. Some typical examples of this class of work, as well as the steps followed in making them, are shown in Fig. 5. Such work requires powerful presses, the samples shown being made in a heavy, 1000 ton capacity knuckle-joint, Toledo press, which is shown in Fig. 6. Needless to say, such work requires dies that will stand this heavy pressure, and Vulcan steel is one of the steels which has proved very satisfactory for these dies. In the making of pieces of this nature, blanks are used which are oftentimes waste punchings from the production of other pieces. These pieces are struck between the dies, which, except for the depressions for forming the bosses or panels, are flat. Such being the case, the result of this cold forging operation leaves the work in the condition shown by the central pieces of each of the groups in Fig. 5. In each case, the blanks are shown to the left. All that now remains for the completion of the pieces is to run them through blanking operations to trim off the surplus metal. While there is nothing especially difficult about doing this class of work after the tools and methods are designed, it requires presses which are extremely powerful, and above all, dies which will withstand the severe work they must do.

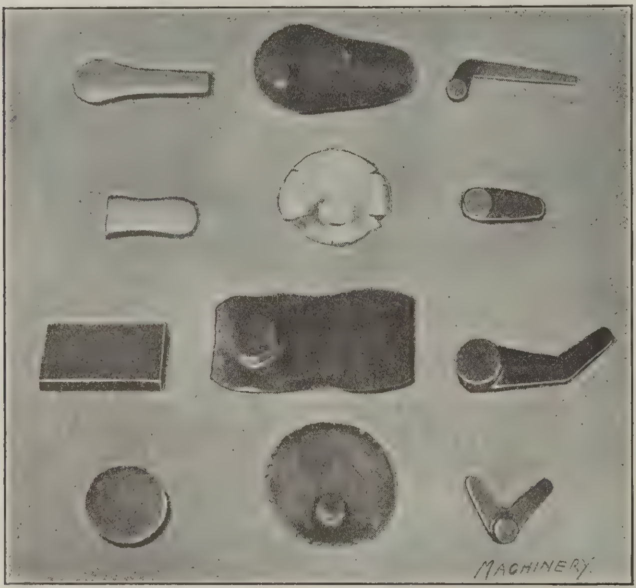


Fig. 5. Steps in making Cold-forgings

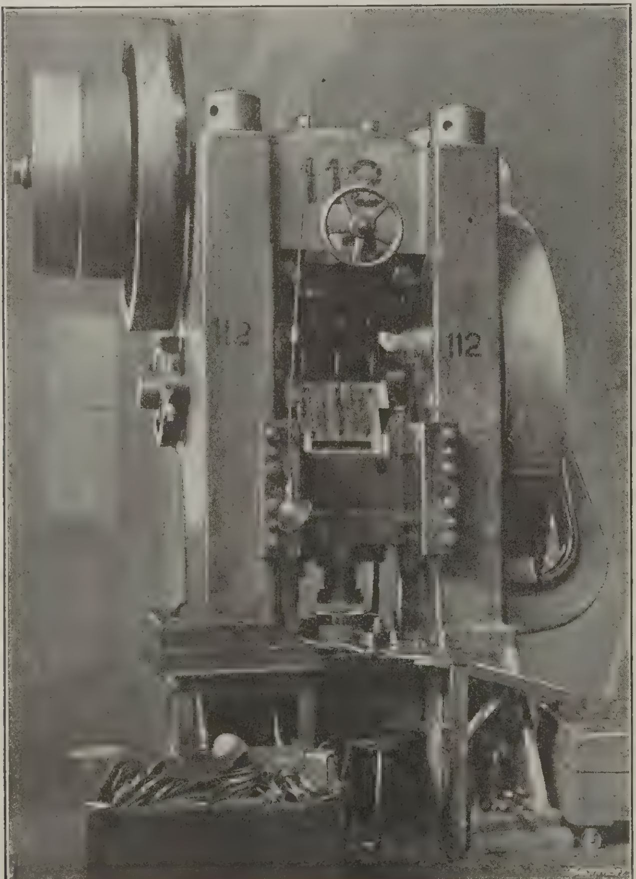


Fig. 6. Heavy Knuckle-joint Press used for Cold-forging


Fig. 7. Making a Difficult Stamping

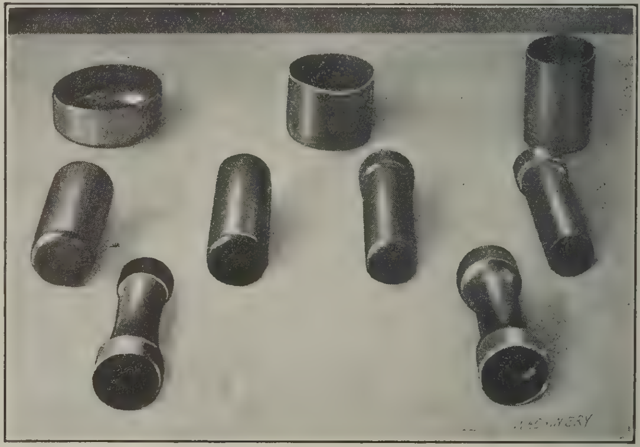


Fig. 8. An Unusual Stamping and its Evolution

Successive Steps in Forming Typical Stampings

Three sets of stampings showing the steps taken in making the respective pieces are shown in Figs. 7, 8 and 9. In Fig. 7, the piece shown is very difficult to produce, mainly on account of the small diameter of the small end. In producing this piece, the first step consists of cupping the blank, as shown at the extreme upper left-hand corner. From this blank, the stock is gradually worked toward the point to get enough metal into position to form the narrow thimble-shaped end, without enough strain being exerted upon the metal to tear it. The pierced end is, of course, the result of the final operation. The metal is kept a uniform thickness throughout.

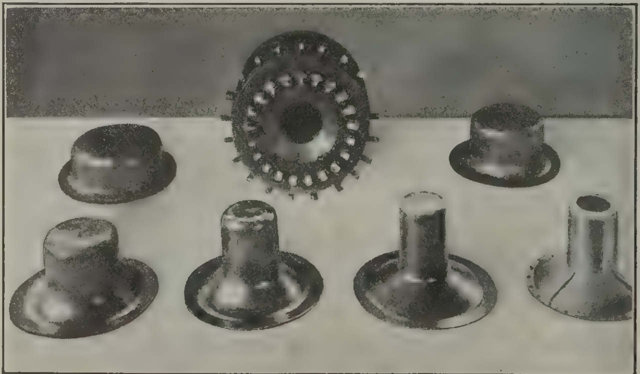


Fig. 9. Steps in Drawing a Flanged Cup and the Last Operation Punch

In Fig. 8, an unusual piece of work is shown in the making

of a special steel ferrule. The difficulty in producing this ferrule lies in the fact that it must be opened out from the small end after being drawn. It takes nine operations to complete this piece, the first operation consisting in drawing the shell in the usual way, leaving a shoulder at the mouth, and the final operations consists of punching out the bottom, expanding the small end and shaping the finished piece.

In Fig. 9, six steps in making the special stamping at the right-hand lower corner are shown, together with the piercing punch used in the final operation. Up to this final operation, the work consists of plain drawing, but the last operation embraces the cutting of the central hole, the formation of the ribs on the beveled section, and the piercing of the small cuts around the edge. It will be noticed that these cuts are not round holes, but are made by a combined shearing and forming operation effected by the special punch shown in the center of the illustration. The individual punches on this tool are held in position by set-screws so that they are easily renewable if broken.

Perforating Tools

Except by those directly connected with the manufacture of telephone mouth-pieces, it is not generally known that the best type of these pieces is made with a steel core be-

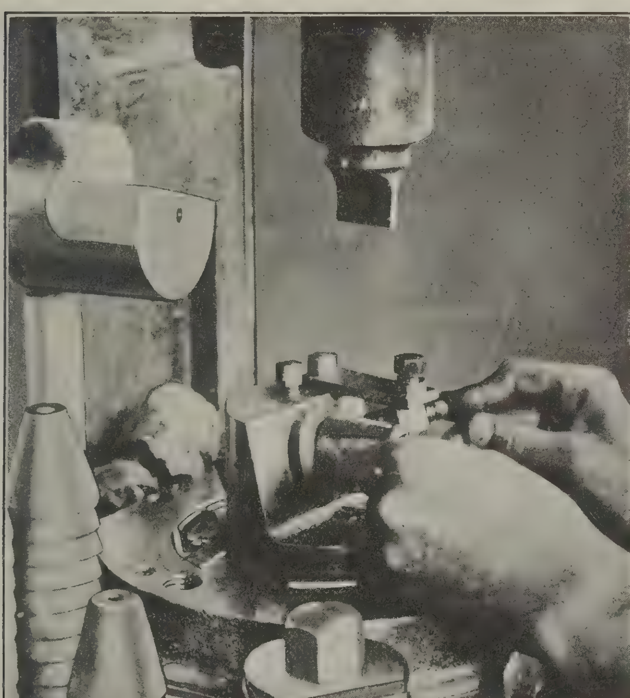


Fig. 10. A Simple Set of Perforating Tools

neath a hard rubber covering. It is, of course, apparent that the strength of such a mouth-piece exceeds the solid rubber article, and, moreover, more durable threads are secured when cut in the steel core than is the case when the threads are cut directly in the rubber. For the purpose of making the rubber adhere firmly to the steel core, it is necessary that perforations be made in the metal, through which the rubber can run. Two sets of tools for this operation are shown in Figs. 10 and 11. Fig. 10 shows the simpler set in which the die is mounted within the arbor, which is shown just behind the operator's left hand. This arbor is, in turn, supported by a base which is clamped to the press bed. The punch is shown directly over the arbor which, of course, holds the die. For indexing, a spring finger, the rear end of which is shown in contact with the operator's finger, is supported by a suitable bracket from the base of the fixture. Pressure upon the end of this finger causes the gaging end to extend, and the slot previously cut in the core is turned against the end of this finger while the next slot is being punched. This operation is repeated until all six of the slots have been perforated, when the finger is released and springs back out of the way. After the completed piece has been taken from the arbor, the six pieces of scrap drop through the arbor.

A second set of perforating tools is shown in Fig. 11. These tools are a little more complicated in design, but they are also more efficient and more interesting. They consist essentially of the bedplate upon which the base block of the fixture is mounted, supporting the work on the arbor, which may be seen at the center of the illustration. The punch is fitted with a spring stripper. The die, of course, is mounted in the arbor. Rotation of the work upon the arbor is secured by means of the automatic indexing mechanism, which is oper-

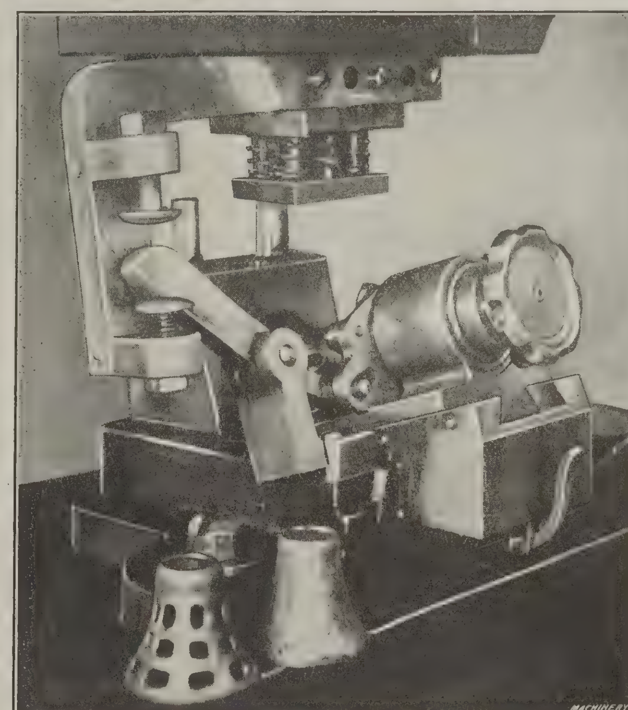


Fig. 11. Perforating Tools with Provision for automatically rotating the Work

ated through a bracket that extends downward from the ram of the press. This bracket is fitted with adjustable button head "pushers" which reciprocate the end of the lever, one end of which appears between the pushers. This lever communicates with the indexing plate by means of a pin at its opposite end. A handwheel operates a friction disk which acts against the end of the work. When the lever is depressed, the index plate turns the work by means of a ratchet, just 1/8 of a revolution; therefore, after the press has operated continuously for eight revolutions, a new piece is put on the arbor. The latch at the extreme lower right is used to facilitate the removal of the work.

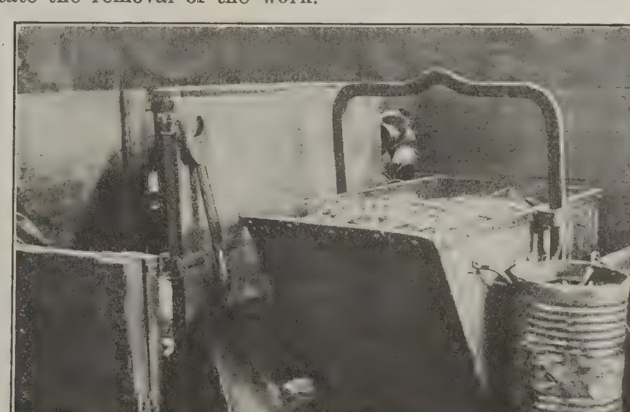


Fig. 12. Flexible Bins and Steel Buckets for Handling Stampings in Quantities

An important part of the work done by this concern is making high-grade rear axle housings, brake drums, hub flanges, hub caps, ball bearing cups and retainers, and other stamped parts for automobiles, motorcycles, bicycles, cream separators, textile and electrical machinery, and for many other purposes.

Production Methods

For handling steel stampings in large quantities many unusual methods are employed. In Fig. 12 may be seen a method

of bin construction which is used for handling heavy stampings in large lots. These bins consist of sections which may be fastened together, forming a semi-flexible arrangement that may be moved to any position on the floor and expanded or contracted at will, as there is no bottom. A method of transporting work about the factory, is by means of sheet steel buckets handled by an electric traveling crane. Punchings and stampings except those which are light and easily bent, are thus treated like so much building material, being shoveled into the bucket and dumped from it in the same manner. Small cans like that shown at the right, are common to all shops for holding small quantities of work.

Power is derived from a hydro-electric plant, situated on the Connecticut River, sixty miles away. This power is carried to the factory at a tension of 23,000 volts, at about half the cost of steam power if produced by coal at the plant. All the presses are driven by individual electric motors.

Credit is due Mr. F. C. Cutler, sales manager of the above company, for cooperation with the writer in preparing this article.

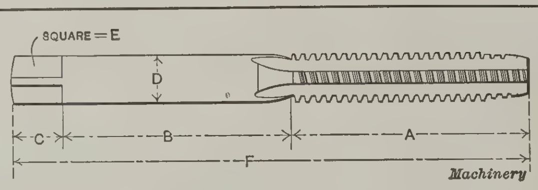
* * *

STOVE-BOLT TAPS

BY A

In the March, 1909, number of MACHINERY, an article accompanied with tables was published giving data for the making of stove-bolt taps. As is well known, there is no standard for this class of taps that has been accepted by all the different makers, and the diameters of taps made by different manufacturers vary to a great extent. The dimensions given in the upper part of the table below represent the practice of two of the more prominent tap manufacturers, the dimensions of whose stove-bolt taps agree with slight (and practically unimportant) differences. The dimensions for the pitch diameters have been obtained by measuring the taps with the ordinary type of screw thread micrometers for the

TABLE OF STOVE-BOLT TAPS



Nominal Size	Actual Outside Diameter	Pitch Diameter	Root Diameter	Flat in Bottom of Thread Corresp'ding to	Flat on Top of Thread, Inches	Number of Threads Per Inch
5/32	0.166	0.1500	0.134	20 U. S.	0.0110	28
3/16	0.197	0.1745	0.152	20 U. S.	0.0094	24
7/32	0.223	0.1965	0.170	18 U. S.	0.0079	22
1/4	0.257	0.2285	0.200	11 U. S.	0.0112	18
5/16	0.317	0.2855	0.254	10 U. S.	0.0067	18
3/8	0.354	0.3165	0.279	10 U. S.	0.0067	16

Nominal Size	A	B	C	D	E	F
5/32	7/8	1 5/32	7/32	0.166	1/8	2 1/4
3/16	15/16	1 3/16	1/4	0.197	9/64	2 3/8
7/32	15/16	1 1/4	1/4	0.223	11/64	2 7/16
1/4	1	1 7/32	9/32	0.257	3/16	2 1/2
5/16	1 1/8	1 5/16	5/16	0.317	15/64	2 3/4
3/8	1 1/4	1 5/16	3/8	0.354	9/32	2 15/16

standard number of threads per inch within the range of each micrometer. As the thread, however, is not a regular U. S. standard thread, but is provided with a wider flat at the bottom of the thread than that corresponding to the number of threads per inch in the taps, care had to be taken when measuring these angle diameters so that the spindle would not bear upon the flat in the bottom of the thread; in other words, the point of the spindle at *A*, in the accompanying illustration, had to be flattened sufficiently so as to clear the bottom of the threads.

It will be seen that some of the dimensions differ from those given in the March, 1909, number. It would, of course, be desirable to the trade if all the tap manufacturers could agree upon one standard, and it is believed that the table given herewith represents the practice to which probably the largest proportion of this class of taps conform. The thread has an angle of 60 degrees, with an arbitrary flat on the top, and a flat at the bottom corresponding to that of the standard U. S. thread for pitches coarser than the actual number of threads per inch in the tap. Hence the taps can be cut with regular U. S. standard thread tools selected for a coarser pitch than that of the thread to be cut. For example, when cutting the thread in a 3/16 inch stove-bolt tap, the lathe is

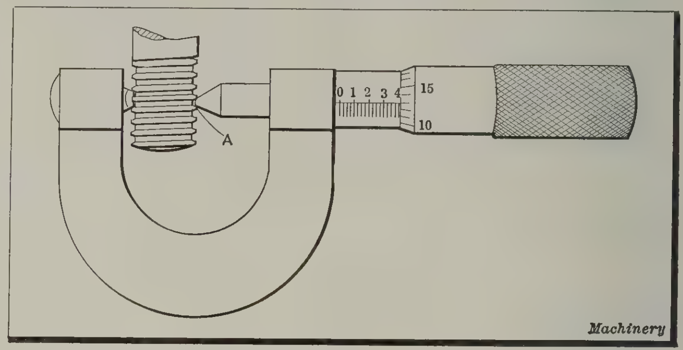


Illustration showing Modification of Point of Measuring Screw of Thread Micrometer for measuring Threads with Very Wide Flat at Bottom

geared to cut 24 threads per inch, but a threading tool for 20 U. S. standard threads per inch is used. It is of considerable advantage to settle upon a width at the bottom of the thread that corresponds to certain U. S. standard threads, because the expense and trouble connected with making special thread tools for these taps is thus avoided. As was mentioned in the previous article referred to, stove-bolt taps are made considerably larger in diameter than is the diameter of the screw, so that the nuts have a loose fit—a fit, in fact, that would not be tolerated for regular U. S. standard bolts and nuts. All taps of this kind have four flutes.

* * *

THERMO-ELECTRIC METHOD FOR TESTING THE STRENGTH OF MATERIALS

An interesting development in the testing of the strength of materials is that known as the thermo-electric method. It has been found that a bar of a given material, upon being subjected to a tensile stress, will absorb heat as long as the stress does not exceed the elastic limit of the material, but that beyond this limit heat will be generated by the friction of the particles sliding over each other. The observations are made by thermo-electric couples, the terminals of which are connected to a sensitive galvanometer. The elastic limit of the material is recognized by the reversal in the temperature curves, presuming, of course, that the temperature indication does not lag behind the stress to which the material is subjected. The extended experiments undertaken by Messrs. T. R. Lawson and J. A. Capp of Schenectady, N. Y., as recorded in a paper before the International Association for Testing Materials, at its congress, September, 1912, indicate, however, that the break in the thermo curve invariably occurs at a higher stress than the elastic limit, as shown by the extensometer.

* * *

FOURTH DIMENSION SPACE ANALYSIS

In a paper on the "fourth dimension" published in the *Polytechnic Engineer* for 1912, William J. Berry mentions a practical use for the mathematical analysis developed to prove the existence of four-dimensional space as follows: "The problem of motion in three-space is stated in terms of four variables—three for space and one for time. Now it is a well-known fact that the analogous problem in two-space may frequently be simplified by regarding it as a geometrical problem in three-space. The suggestion of a geometry of four dimensions to perform a like service for the problem of motion in three is inevitable. This is what makes four-dimension space analysis important, and is, in a large measure, the justification for its study."

THE MECHANICAL TESTING OF FILES*

THE DEMAND FOR STANDARD MECHANICAL TESTS AND TEST METHODS

BY GEORGE W. BURLEY†

The association of standard test specifications with the purchase of engineering materials and tools is a distinctly modern condition, though in certain outstanding cases, engineering materials have been purchased subject to their satisfactorily passing prescribed tests (more or less standard) for a considerable time. At present, however, it is an almost universal practice to demand standard tests on materials and tools where variations can exist in composition, design, construction, or manufacture. Practically nothing is left to chance, and any material or tool which does not excel, or at least equal the test standard, is rejected; if such material or tool represents a sample of any given quantity, the entire quantity is likewise condemned and rejected. The matter of a standard test is a most important one when viewed in connection with large contracts, as the acceptance of large quantities of materials or tools, which are not of the best quality obtainable at the purchasing price, is a source of loss that every progressive management seeks to eliminate. For this reason, the requirements of some commercial engineering departments are very stringent, though considering modern demands and needs, it cannot be said that they are anything but fair.

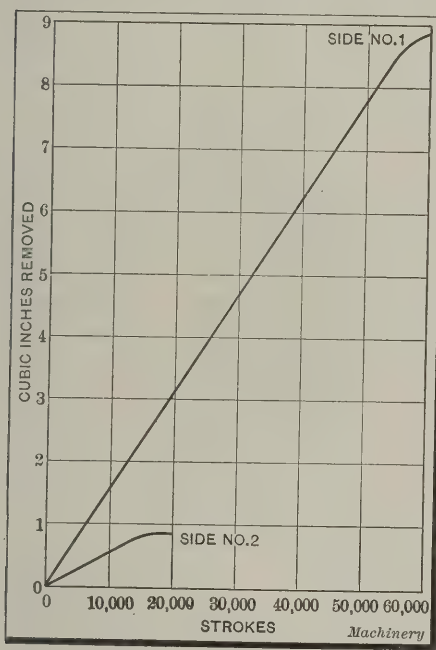


Fig. 1. Difference of 11 : 1 between Durability of the Two Sides of a File

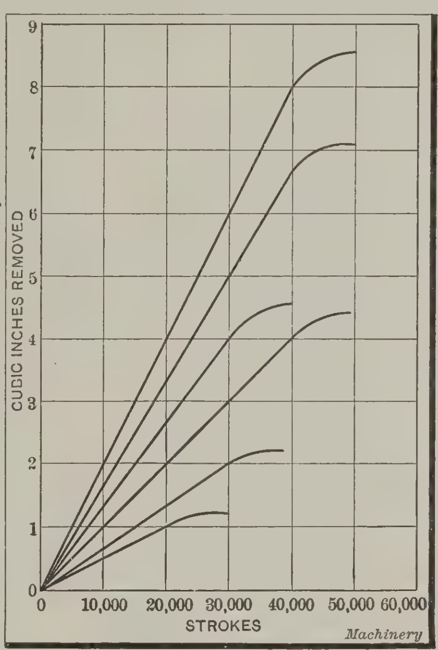


Fig. 2. Typical Curves obtained from File Testing Machine Recorder

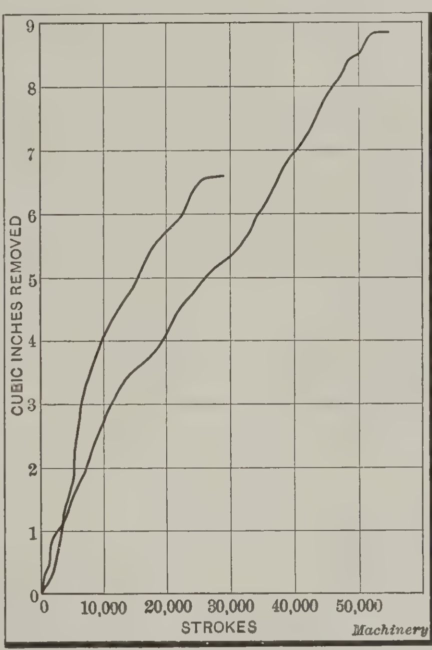


Fig. 3. Abnormal Curves showing no Dependence upon an Operating Law

Of the latest engineering materials and tools to come within the scope of standard commercial tests, one of the most important is the ordinary file, of which it is no exaggeration to say that tens of thousands are made, used, and worn out every year. Now in every file-manufacturing works, it has been the practice to test each file for sharpness by means of a "prover" before it is passed. A prover is nothing more nor less than a short piece of comparatively soft steel which is drawn over the face of the file by hand. If the prover drags as it is being drawn over the face of the file, the latter is passed; whilst if it slips too easily, it shows that the file is not cutting properly, and such files are rejected. This method of testing files, which in the hands of an experienced operator may produce fairly reliable results, is not entirely satisfactory because it depends too much upon the judgment of the workman for its results. Everyone knows that personal judgment is a variable quantity, and likely, therefore, to lead to variable results. In engineering works where files are used, the old-fashioned method of testing files—and one still in vogue in quite a large number of such establishments—consists of distributing files of the brands that are to be compared among a number of reliable workmen, with the order to try them on the materials ordinarily worked on in the shops and report as to the order of merit of the different brands. These reports express each man's judgment and form the basis of the decision of the purchasing department as to the brand to be finally selected when issuing orders for the files. This is not, however, a very reliable method of testing files, as it is a notorious fact that workmen can become so accustomed to the use of one brand of file, that even when called upon to choose between two or more brands, they will select the brand that they are used to—which they discover in some subtle manner—whether, in their honest opinion, that brand is better than the others or not. This is, of course, evidence of the conservatism of man.

Early History of Mechanical File Testing

Until the advent of the mechanical method of testing files embodied in the Herbert file-testing machine some five or six years ago, the above methods—each in its own sphere—were regarded as being the only two methods of testing files which were available—though a mechanical file tester has existed in a very crude form for something like twenty years. Mechanical file-testing can be adopted by both file manufacturers and file users—the former for the purpose of improving the cutting and wearing qualities of their products: the latter for the purpose of comparing files of different brands and also files of any one brand against the standard, in their effort to get the best that are available at the price.

The history of the mechanical testing of files, although so brief, is one in which conservatism and opposing interests have played a very large part. It is certain, however, that every manufacturer of high-grade files is now quite prepared to allow his products to be submitted to a mechanical test, provided the conditions of the test command his complete confidence. On the other hand, it is quite as certain that he will not willingly submit his products to a test in which he believes there is a considerable element of doubt as to the fairness and accuracy of the results. Consequently, it is of the utmost importance that the file test imposed should be one which commands the confidence of every one concerned—whether file manufacturer or file user. Care should be taken in applying the test to see that uniform conditions are maintained, and that the truth respecting any file is not masked by outside influences brought to bear on the machine or test. The Herbert file-testing machine was described in detail in the

* For further information on file making and file testing, see "Manufacturing The Vixen File," September, 1912, and other articles there referred to.

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December, 1907, issue of MACHINERY. The results of tests made with this machine have been subjected to a tremendous amount of both favorable and adverse comment, on the part of file manufacturers and file users alike, though more especially the former. The reason why file manufacturers were and in many cases are still opposed to the use of the Herbert file-testing machine, for the purpose of determining the cutting qualities of their files and comparing them with a standard, has been because many of the results forthcoming were inexplicable and appeared to be contradictory. Thus, files which both manufacturers and users have regarded as being of the very best quality have given extremely poor results in the Herbert file-testing machine. In many cases, great differences in cutting power and durability are reported to have been discovered, by means of this machine, between the two sides of one and the same file. Similarly, files of the same grade and make have shown great variation, even when the utmost care has been taken in the process of manufacture to eliminate differences and to produce files similar in every respect. According to tests made on this machine, differences between the two sides of a file as great as 30:1 have been reported, while a difference of from 4:1 to 10:1 is by no means uncommon, even amongst the very best brands of files. Fig. 1 shows a difference of 11:1. Under ordinary circumstances of manufacture, it is not feasible to suppose that such huge differences can possibly exist, and it is these extraordinary results that have shaken the confidence of file manufacturers in the reliability of the results produced by file-testing machines.

There is, however, a real demand for a mechanical file test, notwithstanding the opposition of file manufacturers and others. The file-testing machine, in one form or another, has come to stay, and it will sooner or later be recognized as a necessity in the domain of engineering testing, where it will be used in connection with all large contracts for files. With this idea in mind, the subject of mechanical file-testing has been investigated during the past three or four years by Dr. W. Ripper and the writer in the laboratories of the Applied Science Department of the University of Sheffield, where a Herbert file-testing machine has been installed and thoroughly examined, together with the results which have been obtained from it. The method of procedure followed with this machine is briefly given: The file to be tested is held rigidly between two headstocks, which are carried on a reciprocating table. The test bar is supported on grooved rollers, in a horizontal position normal to the direction of motion of the table and file, and is pressed against the face of the file by means of a rope and weight. The movement of the file over the end of the bar causes a portion of the metal to be removed at each cutting stroke, the amount depending upon the composition of the material of the bar and the cutting power of the file under test. The file cuts on the forward stroke only. At the end of this stroke, the bar is drawn a short distance from the file by means of a clutch mechanism. This condition is maintained throughout the backward stroke, at the end of which the bar is released and allowed to come again into contact with the face of the file. The pressure of contact is 30 pounds per square inch, since the cross-sectional area of the bar is one square inch and the weight is one of 30 pounds. This pressure is maintained throughout the cutting stroke, the length of which can be varied to suit the conditions. To prevent chattering and jarring, and undue deflection of the file, heavy weights are supported on a rest which is carried by one of the reciprocating headstocks, these weights pressing on the back of the file. A recording apparatus is attached to the machine, the number of cutting strokes made and the number of cubic inches of the bar filed away, up to any time after the beginning of the test, being instantly obtainable from the curve which is automatically produced.

Cause of Errors in Mechanical File Tests

The early experiences of Dr. Ripper and the writer led them to believe that this machine possessed one or two defects, to determine the exact character of which, repeated and extended experiments were made. In the first series of experiments, only the best files of well-known makers were tested, the object being to eliminate, as far as possible, all outside influences upon the results of the tests. The results of the tests were quite normal in some cases, but in the majority of the cases, extraordinary and unaccountable differences of effectiveness or cutting power appeared to exist, both between files of the same batch and between the two sides of the same file. On examining the diagrams obtained from the machine during the tests, and also diagrams obtained from other machines, it was impossible to fail to notice at least two points in regard to their unusual character. The first point to be observed was the peculiar shape of each curve, this giving no evidence of the existence of an operating law. Two general forms of diagram or curve were discovered. The first, examples of which are shown in Fig. 2, is the more usual; the lower section is practically a straight inclined line, with a very slight curve at its upper end turning it into the horizontal. The other form is a zigzag line, examples of which are represented in Fig. 3; these diagrams show no signs of regularity and appear to contradict every mechanical law likely to operate in such a case as this. The second point to be observed was the great apparent difference in cutting capacities, which were found by means of this machine to exist between files belonging to the same batch, and between the two sides of the same file. In regard to the first point, we shall have to consider the nature of the file, and

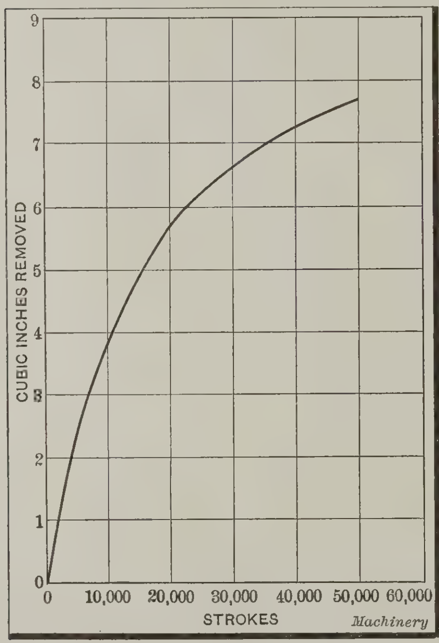

Fig. 4. Diagram showing Gradual Blunting of Files

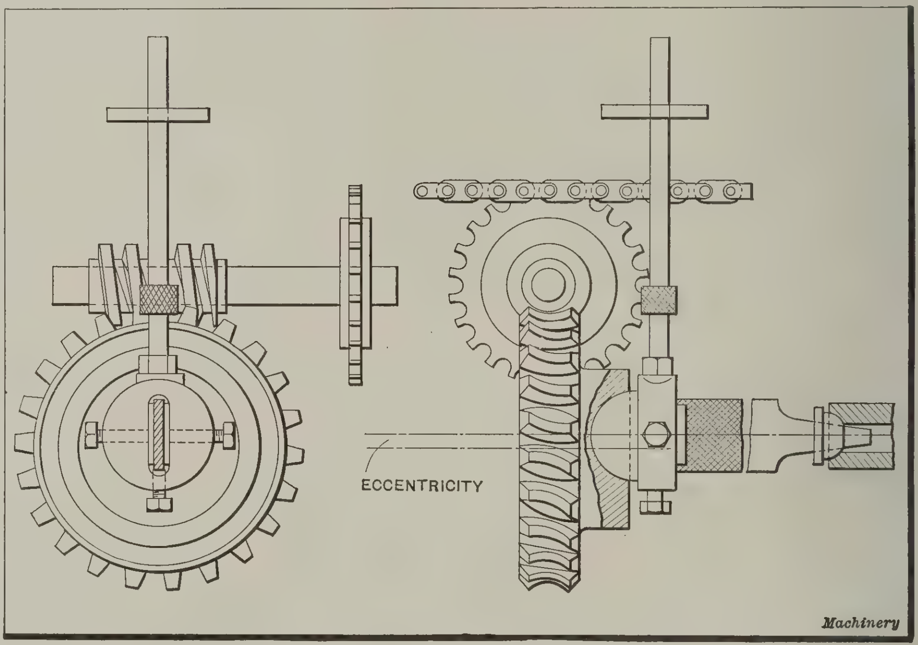

Fig. 5. Mechanism for changing Relative Position of File and Work

the action of the machine upon it, to discover whether such curves are reasonable or not. In some quarters, the file is regarded as a cutting tool which works on the wedge principle, though in essence, its action is more like that of a scraper. Its teeth are small projections, which in the case of a new file, should have sharp edges. These teeth are capable of being pressed more or less into the end of the test bar under the influence of the weight of 30 pounds. The initial cutting capacities of these teeth depend almost entirely —other things being equal—upon their sharpness, and the depth that they are caused to penetrate in the end of the bar. From the very beginning of the test, the influence of the bar upon the teeth of the file is in the direction of blunting them, so that as the test proceeds, the teeth become blunter and blunter. Accompanying this condition, there is a reduction in the depth of penetration of the teeth in the bar, although the pressure upon the file per square inch of bar surface remains constant. This reduction is due to the increase in the area of the flats on the teeth.

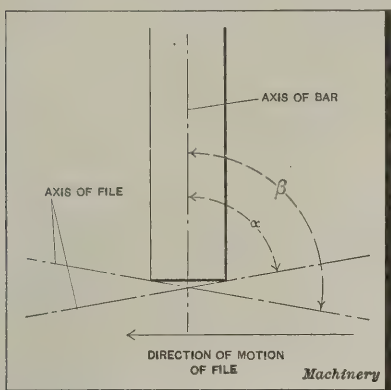

Fig. 6. Diagram showing Influence of Position of File on its Ability to cut

From the foregoing, it would seem to be fairly obvious that as the test proceeds, the rate of cutting should show signs of falling off, this being indicated in the diagram Fig. 4 by a curve, having a tangential tendency towards the horizontal which increases as the test proceeds. Under these circumstances, it is almost impossible to conceive the teeth of such a tool as the file retaining their original sharpness until the end of the test is nearly reached, and then suddenly ceasing to cut without any intermediate condition of cumulative bluntness. The irregular curves appear to be entirely beyond the ingenuity of man to explain in any reasonable and acceptable manner. In the course of the experiments already referred to, it was discovered that the cutting power of the side of a file, as indicated on the chart of the machine, was affected in no inconsiderable manner by the position of the file between the headstock, and by the relation of the axis of the file to the axis of the test bar. Thus, in practically every case which came under the notice of the writer in making these tests, the file would not cut at all if it was presented to the bar so that the angle between the axes of the file and the test bar on the leading side of the latter, as indicated by β in Fig. 6, was greater than 90 degrees; if the angle was reduced so as to be less than 90 degrees, as shown at a in Fig. 6, it would generally commence to cut. It was also discovered that the exact value of the angle between the two axes determined the rate of cutting, to a certain extent, the angle corresponding to the best position of cutting for one file not, necessarily, being the same as the corresponding angle for another file, although in most of the cases the differences were very slight. These differences, however, were sufficient to affect the results materially. It was found that the limiting angular positions of the file, for maximum cutting powers, were those in which the point end of the file axis was 1/32 inch and 5/32 inch, respectively, beyond the heel end, these measurements being made in a direction parallel to the axis of the bar and normal to the direction of motion of the file.

From a consideration of this subject, it will be seen at once that since there is such a wide diversity, it is impossible to select the best cutting position of the file in any particular case; it can only be accomplished by sheer accident. This partly accounts for the wide apparent differences in the cutting capabilities of approximately equal files. As the result of a further examination of the machine, it appeared that the mechanical action differed materially from the action of hand filing. The machine, as originally designed, holds the file so rigidly that it moves across the end of the test bar in an absolutely constant and unchanging path, while in the case of hand filing, the path of the file is changed more or less at every stroke. Therefore, the conditions of a mechanical test made on this machine differ from those which obtain when the file is used in actual practice, the result of maintaining a constant direction of motion being the formation of grooves in the end of the bar, the glazing of the face of the file, and the refusal of the latter to cut, even though it may not be worn out. To eliminate these defects in the action of the machine, Dr. Ripper and the writer designed and constructed a mechanism which, when added to the machine, removes the condition of constancy in the direction of motion of the file and its attendant influence upon the results, and causes the file to pass through a number of different angular positions with respect to the test bar, between the two extreme best cutting positions for all files as referred to above. At the same time, files of the same kind and size are treated in exactly the same way, so that the conditions of the test are maintained constant. By this means, the grooving of the end of the test bar by the teeth of the file is prevented, and each file is caused to give an average result for all the positions occupied. There are forty-eight of these positions in a complete cycle; at least one of these, and in the majority of cases two, is the best cutting position. The result obtained by the improved machine is the average cutting power of the file, and not its

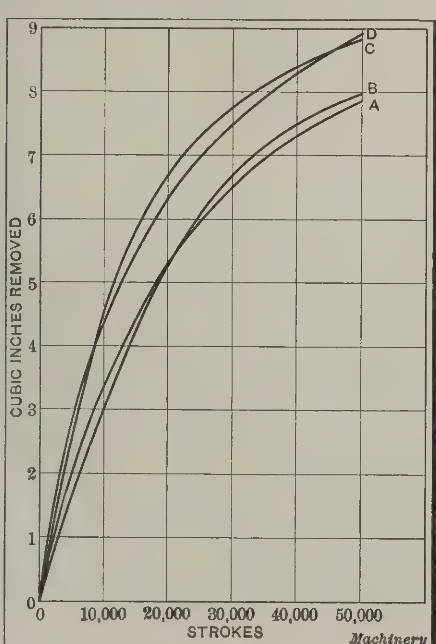

Fig. 7. Curves for Sides of Two Files of the Same Make

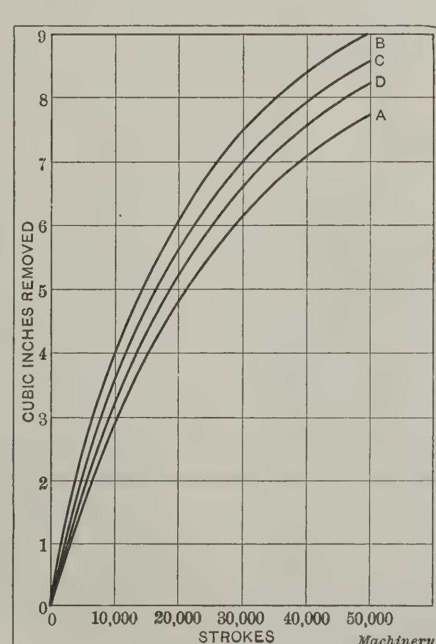

Fig. 8. Curves for Sides of Two Files that are all of the Same General Order

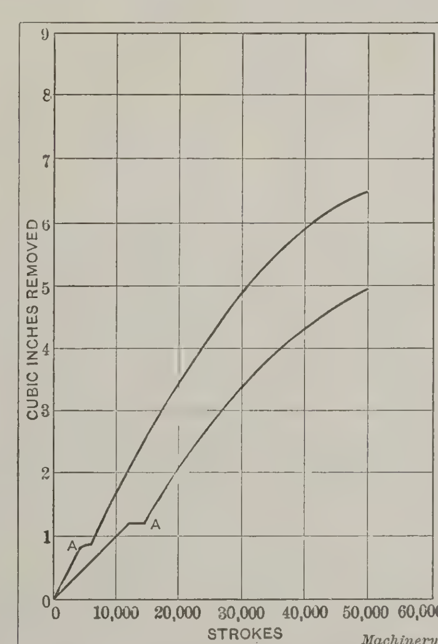

Fig. 9. Effect of changing Position on Durability of File

best or worst cutting power. Thus the results of all tests when this mechanism is used—provided, of course, that the other conditions of the test are maintained constant—are comparable with each other.

Mechanism of the Improved File Testing Machine

The mechanism by means of which this movement of the file is accomplished, is shown in Fig. 5. It consists of two ball-and-socket connections between the two ends of the file and the headstocks. The socket at the heel and tang end of the file is fixed in its headstock, while the other socket is arranged so that its center has a slight rotary movement, which is transmitted through the ball to the point end of the file. In this circular path, there are forty-eight different positions which are equally spaced, and these positions are occupied by the point end of the file during successive cutting strokes. The radius of the circular movement at this end of the file is 1/16 inch. The rotating socket is formed in the boss of a worm-wheel, which is mounted on the headstock, but set eccentric with it, as shown, the eccentricity being 1/16 inch. The worm-wheel is driven by a worm that is mounted on a plain shaft, the outer end of which carries a free sprocket wheel. The chain which meshes with this wheel is fastened to two fixed points on the frame of the machine. By this means, the sprocket wheel, having the same reciprocating motion as the table and file, is caused to rotate through its engagement with the fixed chain. This rotation is transmitted to the worm-wheel and ball-socket during the return or non-cutting stroke. During the cutting stroke, the sprocket wheel is traveling in the other direction and rotates quite freely on its hub, which is keyed to the worm-shaft; during this stroke the worm-wheel and socket are stationary, and the position of the file is not changed. Consequently, a change in the position of the file is made for each double stroke, and during each cutting stroke the file is presented to the end of the bar in a slightly different position from that occupied by it during the preceding strokes. There are forty-eight different positions in a complete cycle and the time required to complete a cycle is just under one minute, since the machine makes fifty double strokes per minute in its original form.

The point of the file is secured in the ball-holder by means of four set-screws and two small steel wedges. One of these set-screws is extended and attached to a bent arm, which rests on the reciprocating table and travels with it. This prevents the file from rotating on its own axis, as it would have a tendency to do if secured too firmly between the two headstocks. The wedges were found necessary to bring the point of the file exactly in the middle of the slot in the face of the ball. The tang of the file is inserted in a small ball holder which rests in the cupped end of adjusting screw of the headstock. This screw is longer than the one which is usually supplied with the machine, an additional nut being used on the other side of the headstock boss to get delicate adjustment of the file between the two headstocks. For files of different lengths, eccentricities of different amounts may be used, but this is hardly necessary—though some regard it so—because, in practice, it is not generally required to compare files of different lengths, so much as different files of the same length and grade. If desired, the pitch of the worm and wheel could be made different from that selected in connection with the original design, so as to obtain a cycle of positions of greater or less duration than one minute. It should be observed that the face of the file presented to the bar is not, except in two positions at the most, vertical; these two are the extreme inner and outer positions. In all other positions, the face of the file is more or less inclined to the vertical, the inclination being in one direction for half of the positions and in the other direction for the other half.

Conclusion Drawn from Carefully Conducted Mechanical Tests

A very large number of tests have been made with this apparatus on all makes and sizes of files. The majority of the results have shown that the defects found in files by the ordinary method of testing do not exist, while in no case do they exist to anything like the same extent that the ordinary test results suggest. The curves obtained by means of this apparatus are of the general character of the representative standard curve shown in Fig. 4. They show the gradual reduction in the cutting capabilities of files during the progress of the test, which can reasonably be expected. Figs. 7 and 8 show representative curves obtained by this method. The curves *A* and *B*, in each figure, represent the two sides of one file, the curves *C* and *D* representing those of another file of the same make. The two figures represent two different makes. It will be observed in Fig. 7 that there is very little difference between the two sides of each file, in a test whose length is 50,000 strokes, although it will be seen that in neither case are the two curves of exactly the same order, since they intersect, the first in one place, and the second in two. In Fig. 8, all the curves are of somewhat the same order there being no intersection of the pairs. There is, however, a greater difference between curves *A* and *B* than between curves *C* and *D*, based on a test of 50,000 strokes. On the other hand, the difference between the two files represented by Fig. 7 is greater than that represented in Fig. 8.

The results of tests extending over a very long period indicate that such differences as 30 to 1, or 10 to 1, or even 4 to 1 do not exist. The ratios commonly found range from 1 to 1 to 1.20 to 1. Other experiments with this method of testing have produced results which show conclusively that, in the case of a new file, every one of the forty-eight positions of the file has a corresponding cutting power. This cutting power is usually different for each position, so that the test invariably gives an average result, which is a much fairer result than any other. A number of experiments have also been made to determine the effect of the application of this varying position principle in cases where, according to the ordinary test, files were worn out—that is, had ceased to cut in the machine. The result was conclusive in every case; at the same time, it was astounding. Fig. 9 represents the results graphically. In the case of each curve, the point *A* is the break-down point, where, in the ordinary test, the file ceases to cut. By putting the position-changing apparatus into action, each side was caused to start cutting, and to continue cutting so that the file did not actually give out at the end of 50,000 strokes. From the results of many tests, of which the above are samples, it is felt that this apparatus supplies a much needed element to the test, and enables both file manufacturers and users to repose greater confidence in the results of the tests than has hitherto been the case.

In conclusion, and as an apposite addendum to the above, it may be pointed out that the exact chemical composition and physical properties of the test bar have a considerable influence upon the results of the tests. As there does not appear to be a test bar which is universally recognized and employed as *the* standard, it cannot be said that the conditions of file-testing are in a very healthy state. To demonstrate the fact that the influence of the physical properties of the test bar is no inconsiderable factor in the problem of file-testing, some tests were made with two similar files from the same batch on two test bars, one having a Brinell hardness numeral of 241 and the other of 186. Each file made 20,000 strokes, in which only 2.75 cubic inches of the hard bar was removed by one as against 6.25 cubic inches of the other. This is conclusive evidence that for a *standard* test there should be a *standard* test bar.

* * *

Near the old sun temple at Baalbec, in Syria, there is an enormous cut stone, probably the largest cut and finished piece of stone in the world. It is about 72 feet long, 13 feet wide, and 16.5 feet high. It is believed that the stone was intended for the sun temple which is now in ruins. There are still in the heavy walls of this temple stones of similar dimensions. Several that have been measured are about 66 feet long. These stones are placed in the wall at a height of nearly 20 feet above the ground. No indication of mortar can be detected, but the stones are so carefully cut and polished on the surface that it is only with difficulty that the joints can be detected. In fact they join so closely that a thin knife edge will not enter between them. How these blocks of stone could be lifted to such a height, and how buildings of this type could be erected, is one of the secrets of a past age of engineering.

SOME GOOD RESULTS OBTAINED BY THE BONUS PLAN

BY W. L. MYLES*

Much has been said and written regarding the advantages and disadvantages to both employer and employe of the bonus or premium plan of pay. Men who have given this plan a fair trial have attributed credit to it for obtaining lower manufacturing costs and higher factory efficiency for the employer, and higher wages for the employe. On the other hand, the bonus plan has been subjected to some hard criticism, principally by those who have never seen it in operation, or by those who are entirely unacquainted with its fundamental principles and ability to produce results.

Speaking from an experience of five years with the bonus plan, the writer believes that it is one of the best systems,

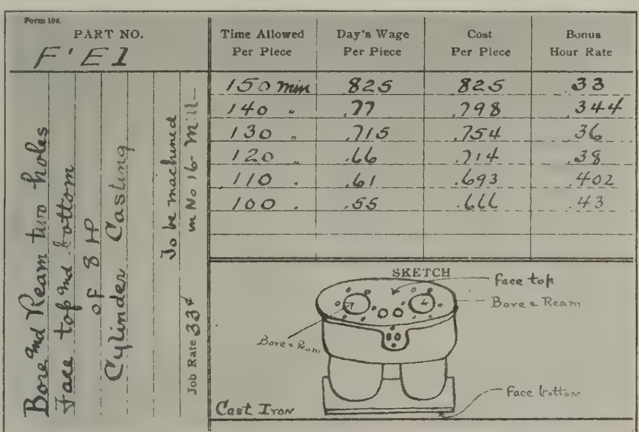

Fig. 1. Rate Card, showing Time allowed per Piece and Rate paid per Hour—4 by 6 inches

if not the best system, now in vogue, for justly compensating the workman for the extra effort he puts forth. This plan is also instrumental in obtaining those results so earnestly sought by the manufacturer or employer, *viz:* lower costs and greater efficiency of production. One of the advantages of the bonus plan is that it justly rewards the mechanic for extra effort; it creates a spirit of cooperation which would not exist under other conditions, and lifts the mechanic and the shop to a higher plane of efficiency. This will amply repay

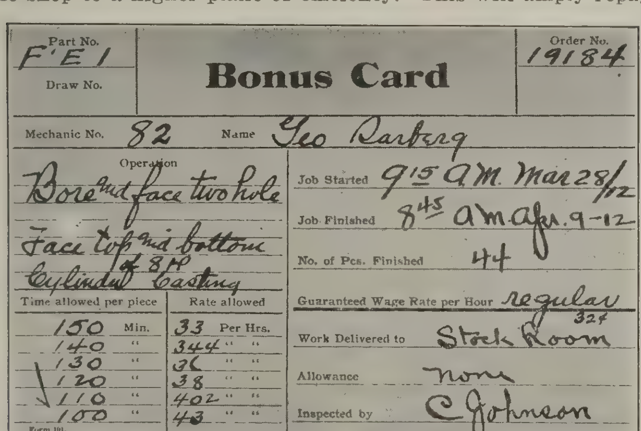

Fig. 3. Bonus Card, showing Time allowed per Piece, Rate per Hour, and what Operations to perform—4 by 6 inches

the employer for its installation. Under the bonus plan, the mechanic realizes that the management is interested in him, and he knows that if he gives an honest day's work he will receive an honest day's pay. The amount of that day's pay is entirely in his own hands, for the more work he turns out in a given time, the more pay he receives. This system teaches him that the ability to turn out more work in a day does not require a greater amount of physical exertion, but less, for by following the methods outlined on his instruction card, he uses a little more brain energy and less physical energy to produce the same amount of work. Some of the critics of this system have claimed that it is unfair to the mechanic, as it makes a mechanical tool out of him, rendering him an object for the scrap pile in a short time. It has been proved, however, to the satisfaction of these critics, that this is entirely wrong. The tendency of this system is to awaken the mechanic out of that dreamy mechanical state in which many of our workmen are today, into new, energetic men; for, in order to earn their bonuses, they realize that they have to use their brains and hands at the same time, thereby avoiding many mistakes and accidents. The reward of extra compensation is sufficient to repay the mechanic for his extra effort which, in a great majority of cases, is but a matter of giving a little more thought and attention to his work, reducing instead of increasing the physical effort formerly employed. It is a known fact that 90 per cent of the workmen of this country are accomplishing less than 60 per cent of what they might do without physical injury or over-exertion.

Under the bonus system, in one shop the writer has in

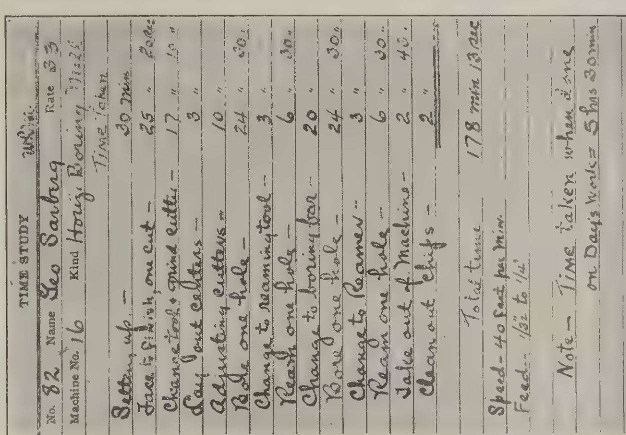

Fig. 2. Detailed Record of Results of a Typical Time Study, on Back of Rate Card

mind, the men are doing 40 per cent more work with about 25 per cent less physical effort. Why is this? Partly because the management has standardized the tools and equipment, and provided the mechanics with instruction cards which show exactly how the work should be done, thus eliminating many unnecessary moves. But it is mainly because the bonus offered is large enough to supply the needed incentive. Many have asked the question, "Do the majority of those working under the bonus plan earn bonuses, or is it only those who

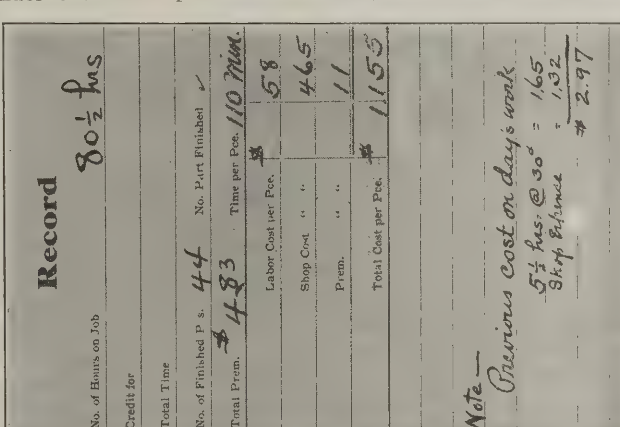

Fig. 4. Cost Record of the Operation, on Back of Card, filed for Future Reference

are most rapid and experienced in their particular line?" The writer can readily answer this question by referring to a chart kept by him, which shows the percentage of each class of workmen that earned bonuses. For the first three months of the present year, over 75 per cent of the men earned bonuses which gave them an average increase of 8.5 cents per hour, or about 30 per cent higher wages. Through the opportunities offered by this system for men to show their ability in mechanical lines, laborers and helpers have turned out to be good mechanics, and mechanics have become functional foremen, thereby increasing their earning power and adding materially to the efficiency of the plant.

The following is a general outline of the procedure followed in making time studies, setting rates, and issuing bonus cards, together with forms used by one of the leading manufacturing

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concerns of New Jersey, which has operated this plan successfully for some years. In order to correctly set a time and price on a piece of work, it is necessary to know each operation and move needed to complete the work in the shortest and best way. When a job is to be put on bonus, a detailed time study is made; the machine best suited for the operation is next decided upon, correct tools are supplied, and belts and equipment are brought up to proper speed. Each operation is timed separately with a stop watch; then an overall time is taken to verify it, a fair amount of time being allowed for grinding tools, etc. Fig. 1 shows a form of rate card, giving the time allowed per piece and the rate paid per hour. On the back of the rate card, there is a record of the detailed time study. It will be seen that decreasing the time per piece increases the rate paid per hour. After the time study is complete, a bonus card is issued to the mechanic to start with the work. This form includes the time allowed per piece and the rate paid per hour, also what operations to perform, the time of starting and finishing job, the part number, etc. A cost record of the operation is kept on the back of the bonus card, which is filed away for future reference.

The men are guaranteed their regular day's pay, whether they make the pieces in the allotted time or not. When the job is finished, the time of finishing is stamped on the card and the number of pieces is recorded; the card is then taken to the foreman, who verifies the number of pieces and inspects the work, if no regular inspector is employed. The finishing time of the last job is always the starting time of the next job, except where special time is allowed for repairs or some other necessary work, other than the general up-keep of the machine. This eliminates a large amount of time that was formerly lost between jobs, when done under the old day-work system. The foreman's task of answering a lot of unnecessary questions, and standing over a man in order to keep him at work is reduced 50 per cent, as the instruction card states plainly what is to be done and all other information that is required on the job. Needless to say, the men working under the bonus system require no watching; all their time and attention is required for their work, if they wish to earn their bonuses.

Some of the results obtained by working men on the bonus plan of pay can be summed up as follows: Higher wages and greater efficiency for the mechanic. A reduction of the number of accidents, for many an accident is caused by inattention to work. A method of showing the foremen who are the non-producers or "deadheads" in their departments. A reduction of the "overhead" expenses of the plant. Simplification of the method of keeping costs and the production of far more accurate cost records. A reduction in the cost of manufacturing, and a marked increase in output. In general, the bonus plan benefits all parties concerned and compensates the mechanic as no other system can. For the greater effort put forth by both employer and employe, a material increase in efficiency is seen throughout the whole plant, and in addition, there is that spirit of cooperation between both parties that is so essential to a successful business.

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IMPROVED TYPE OF COUPLING BOLTS

A recent number of *Page's Weekly* describes a practical type of coupling bolt which was designed to do away with the difficulty experienced in extracting the bolts when it is necessary to disconnect a shaft. The advantage of such a design will be apparent to any sea-going engineer who has had experience with broken shafts at sea. According to the writer the corrosive action of salt water upon ordinary steel is such that he has known it to take a week to get out twenty-four three-inch bolts, while the same work can be done in an hour where the improved type is in use. Figs. 2 and 3 show cross-section views of coupling flanges connected with the old style bolts. These two types are identical, with the exception that a head is provided on the bolt shown in Fig. 2, while the type shown in Fig. 3 depends entirely upon the taper for holding it in the flange. Both of these bolts are made of steel. Fig. 1 shows the improved type of bolt previously referred to. In this case it will be seen that the regular nut is provided at one end for tightening the bolt, while a similar nut is provided at the opposite end for drawing the bolt when it becomes necessary to disconnect the shaft. The nut *B* used to tighten the bolt, is best made of "Delta" metal or some similar tenacious metal of a non-corrosive nature, and washer *C* is of similar material. The nut *D* used for starting the bolt is made of non-corrosive "Sceptre" bronze with a washer of similar material. Before putting the bolt in place, it is thoroughly coated with a mixture of flake graphite and castor oil which further protects from corrosion.

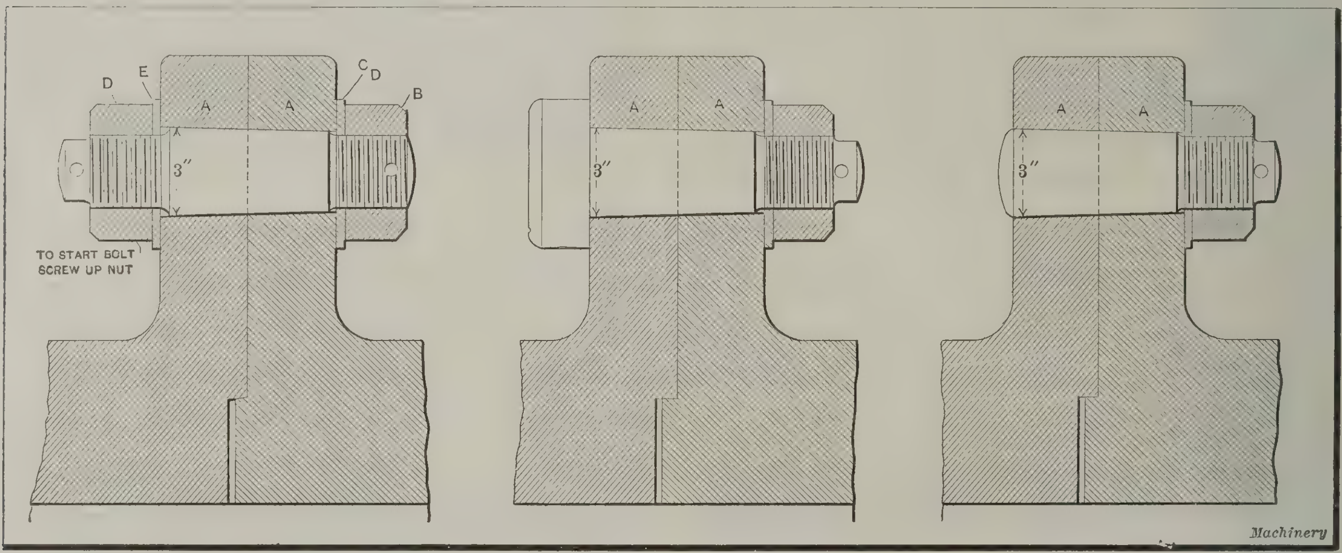

Fig. 1. New Style Bolt with Second Nut for Starting

Fig. 2. Old Style of Bolt shown in Fig. 3, with a Steel Head

Fig. 3. Old Style Bolt with Steel Nut, Washer and Pin

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"EXPLOSION-PROOF" ELECTRIC MOTORS

The United States Bureau of Mines, Washington, D. C., has issued a bulletin (No. 46) regarding the results of an investigation of explosion-proof electric motors. The term "explosion-proof" as applied to an electric motor refers to a motor enclosed by a casing so constructed that an explosion of a mixture of mine gas (methane) and air within the casing, will not ignite a mixture of the same gas surrounding the motor. There are two classes of motors so constructed: First a class totally enclosed and built strong enough to withstand internal explosion pressures and so designed that the efficiency of all the enclosing covers can be satisfactorily maintained; second, a class provided with relief openings or valves designed to cool any products of combustion discharged through the valves. The results of tests are given in detail in the bulletin. These tests are of interest to other than mine operators, as explosion-proof motors are desirable in situations such as flour mills and other plants in which explosive gases incident to the processes of manufacturing sometimes collect.

EVOLUTION OF A SKYSCRAPER

In a paper entitled the "Evolution of a Skyscraper," read before the American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., November 2, 1912, Mr. N. L. Malmros made reference to some antiquated provisions that are still part of the building laws of New York City, and which indicate how difficult it is for the law-making bodies to keep pace with the advances in science and engineering. The building law of New York City contains provisions which were unsuitable and unnecessary even twenty-five years ago. One of these provisions is that relating to wall thicknesses, which works a hardship and an actual disadvantage from all points of view in the erection of high buildings. The modern steel skeleton structure does not depend on the masonry walls for support; instead the steel frame supports and holds the masonry in position. The function of the walls is principally to afford protection against the weather and fire, and as the walls are carried entirely by the steel framing at every story, their thickness need be no greater at the bottom than at the top. Nevertheless, the building laws at present in force in New York City require as great a thickness of wall in the lower stories as though they actually carried the weight of the building. As an example, it may be mentioned that a building one thousand feet high would have walls six feet thick at the ground floor. The unpierced walls along the lot lines facing adjoining buildings would have to be solidly made of this thickness for several stories up. This involves not only a waste of rentable space but places an enormous dead load on the steel structure and on the foundations—a load which detracts rather than adds to the strength and safety of the building construction. Strong efforts have been made within the past two years to frame a suitable and sane building code, but these attempts have all failed by reason of the conflicting and warring interests within the building material industries.

Mr. Malmros mentioned that he expected to see still higher buildings in New York City than the Woolworth building now nearing completion, which is about 750 feet high. He mentioned that he had been connected with the design of a proposed building 1100 feet high, of about eighty stories, which careful calculations showed, would have proved a good investment. The limiting factor in high buildings is the transportation facilities within them, and the large space taken up for elevators, halls and stairways, which require a proportionately larger space the higher the building is made. As far as the steel construction is concerned, there is no reason why a building 2000 feet high could not be erected.

Reference was made to the Singer Building, of which Mr. Malmros, acting in a consulting capacity with Ernest Flagg, was the architect. As an interesting illustration of the great amount of work connected with the building of a skyscraper of this type, it may be mentioned that the specifications covered more than eight hundred typewritten pages, and that the number of trades employed in the building of this structure, for which separate contracts were let, numbered more than seventy-five. About 1500 drawings were made in the architect's office for this building, besides all the shop and construction drawings made by the various contractors, which were also checked and corrected in the architect's office. A peculiarity of the very high building is that on account of the enormous wind pressure to which it is exposed, and its proportionately small base, it must not merely be placed upon its foundation but must be actually anchored down very securely.

* * *

A pressure of from four to thirty-five pounds per square inch of surface on work being ground on a disk wheel is recommended by the Gardner Machine Co., which has experimented extensively in determining the proper pressures for grinding. A less pressure than four pounds per square inch results in polishing and burnishing the work. For this reason it is necessary, when grinding light pieces on a horizontal disk wheel, to load them with weights when the weight of the piece does not impose a pressure of more than four pounds per square inch.

TURNING ELLIPSES IN THE LATHE

BY GEORGE E. POPE*

The writer believes that the following method of turning an ellipse in a lathe has not found wide application for two reasons: it will be evident from the description that it has a rather limited scope, and the principle has probably never occurred to a great many men. The possibility of applying this method is controlled by several considerations, *i. e.*, the length of the ellipse to be turned must be comparatively short, it must be on the end of a shaft, pin, or similar part, and the ratio of the major to the minor axis must not be too great. These conditions are all met with in the case of the emergency brake cam shown in Fig. 1. The design of this cam was changed from one whose section is shown in Fig. 2; this illustration also shows the method of milling with a formed cutter, the cam being milled on one side and then turned over to have the other side formed.

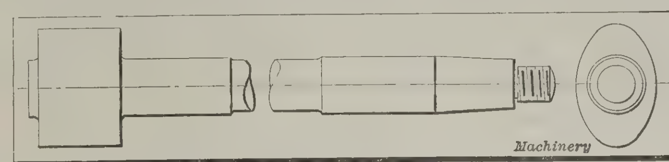

Fig. 1. Elliptical Emergency Brake Cam turned in a Lathe

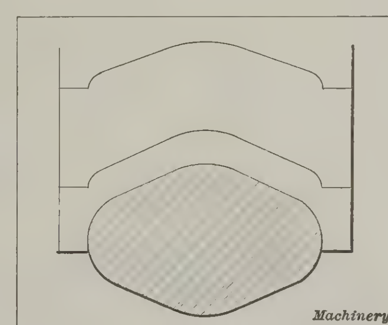

Fig. 2. Former Type of Cam produced by Formed Cutter

In Figs. 3 and 4 are shown a plan view, a partial side view, and sections of the device for turning this cam in a lathe, after changing its design to an elliptical section. Referring to Fig. 3, the device will be seen to consist in part of a square steel block *A*, that is tongued into and bolted to the faceplate and carries the fly-cutter *C*. The remainder of the device consists of the cast-iron block *B* which is tongued into and bolted to the upper surface of the compound rest of the lathe, as shown plainly in Fig. 4. A bushing *D* carries the cylindrical end of the work which has already been turned to size. This bushing is split through one side and is closed in firmly on the work by means of the bushing locks *L*; it is prevented from rotating by the pilot on set-screws *S*. This bushing can easily be replaced by others of different sizes, thus making the fixture adaptable for various sizes of work.

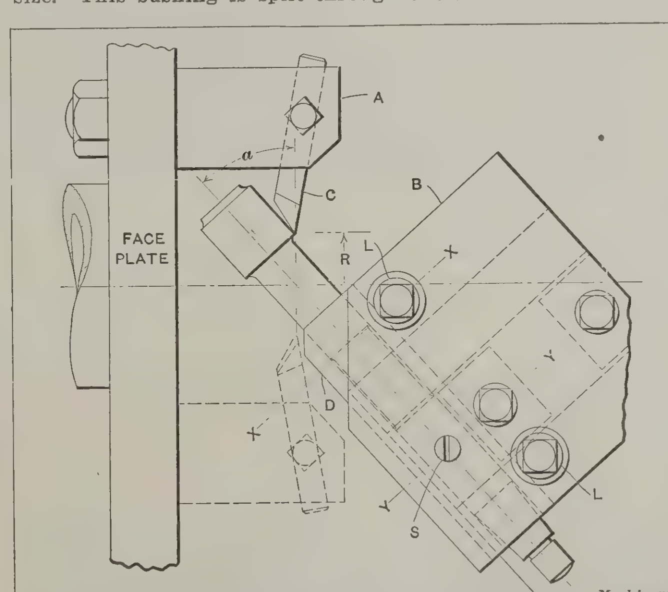

Fig. 3. Fixture for turning an Ellipse in a Lathe

It will be readily seen from Fig. 3 that in order for the elliptical section to be concentric with the shank, the axis

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must pass exactly through the center of the circle generated by the point of the fly-cutter C. This is accomplished by taking care that the height H in Fig. 4, from the surface of the compound rest to the center of the split bushing, corresponds closely to the height from the surface of the compound rest to the center of the lathe spindle, and by adjusting the longitudinal position of the carriage, taking light cuts over the cam and measuring for concentricity. A positive stop can then be clamped on the ways of the lathe to engage the forward end of the carriage, as the carriage must be moved away from the faceplate in order to remove the finished part.

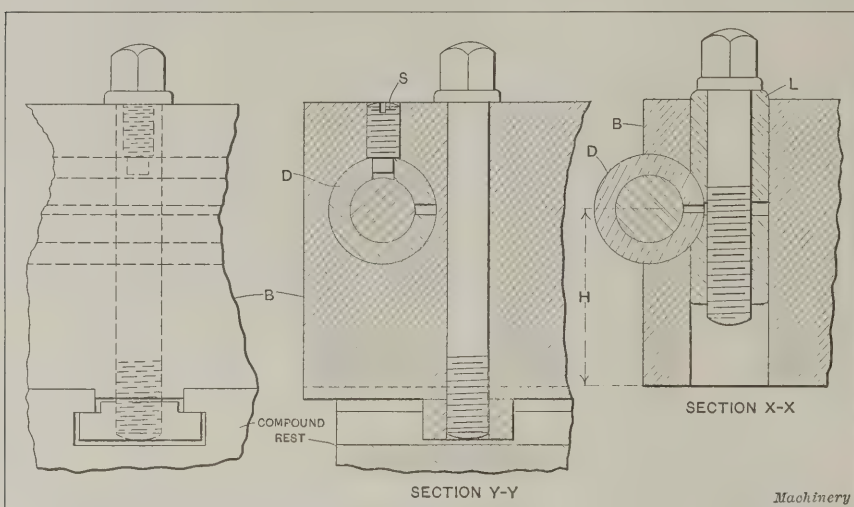

Fig. 4. Partial Side View and Sectional Views of Ellipse Turning Fixture

The compound rest is turned around to an angle a which determines the length of the minor axis of the ellipse, and is fed straight in on this angle in the operation of turning the cam. The major axis of the ellipse is determined by the diameter of the circle generated by the cutting point. The angle that determines the minor axis can be readily derived by the method shown in Fig. 5, which is merely the projection of a circle of diameter equal to the length of the major axis of the cam, at an angle sufficient to give an apparent width equal in length to the minor axis. In the triangle ABC,

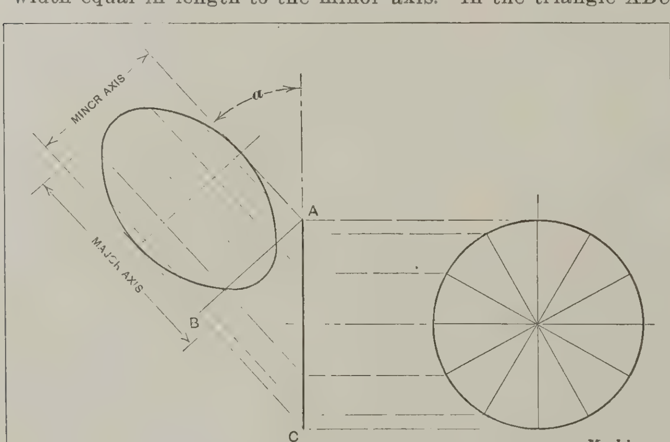

Fig. 5. Method of deriving Angle of Compound Rest

AC is equal to the major axis and AB is equal to the minor axis, and the angle BAC equals angle a. Then $\frac{AB}{AC}$ or $\frac{\text{Minor Axis}}{\text{Major Axis}}$ equals the cosine of the angle to which the compound rest must be revolved for the desired results. This method of turning ellipses could be successfully applied to the turning of the familiar oval locating plugs used in tool work, and for a variety of other classes of work.

* * *

The best all-around aluminum mixture, says a writer in the *Brass World*, is an alloy containing 92 per cent of aluminum and 8 per cent of copper. This mixture casts well, does not crystallize in service or crack in the mold, and has a fair tensile strength.

JOINT MEETING OF THE A. S. M. E. AND V. D. I. IN GERMANY

The plans for the meeting of the American Society of Mechanical Engineers with the Verein deutscher Ingenieure which have been nearly completed, promise the most remarkable tour of the industries in Germany ever offered to American engineers. Conrad Matschoss, Dozent of the Royal Polytechnic High School of Berlin, has been in the United States for several months as representative of the German Society, arranging the details of the tour. The engineers will sail for Germany June 11, and arrive in Hamburg or Bremen June 21, where they will be received by the municipal authorities and given opportunity to visit the great shipyards before going by special trains to Leipzig. There they will be welcomed by the King of Saxony and the municipal authorities of Leipzig.

The party will leave Leipzig June 25, for a tour of industrial Germany visiting the principal cities, such as Dresden, Berlin, Dusseldorf, Cologne, Frankfurt a/M, Nuremberg, Munich, etc. It is expected that the Krupp works will be thrown open to the party and that they will be received by Baroness von Bohler, daughter of the late Herr Krupp.

The final meeting will be held in Munich July 7 in connection with the Museum of Technical Arts of which Dr. von Miller is the director. The itinerary of the society in connection with the fifty-fourth annual meeting of the Verein deutscher Ingenieure, as arranged at present is as follows:

June 21.—Reception at the landing place by the local board.
June 22.—Leipzig, official reception by the Verein deutscher Ingenieure.
June 25.—Dresden.
June 27-28.—Berlin.
June 29.—Düsseldorf—Reception by the Rhine-Westphalian Section of the Verein.
June 30-July 2.—Various functions arranged by the Rhine-Westphalian section, including a trip to Cologne and Essen.
July 3.—Bonn—By boat up the Rhine with festival at Rüdesheim; by rail to Frankfurt a/M., arriving about 6 P. M.; evening reception of welcome at Frankfurt.
July 4.—Independence Day at Frankfurt.
July 5.—Nuremberg.
July 6.—Munich—Evening reception of welcome.
July 7.—Visit to the German Museum.
July 7.—Trip on the Starnberg Lake. Evening—Final exercises in the Pathaus.

* * *

EXPERIMENTAL WORK ON KEROSENE CARBURETERS

What promises to be an investigation of more than usual interest and utility is being conducted by the State Engineering Experiment Station at the Pennsylvania State College, State College, Pa., under the direction of Prof. J. A. Moyer of the mechanical engineering department. With the increase in the price of gasoline has come the demand for some cheaper fuel that will give as good results. Kerosene would meet the demands if a satisfactory carbureter could be designed, and it is with a view of determining the merits and defects of various types of carbureters that the investigation is being carried on. The price of gasoline has nearly doubled in this country in the past year, while in England the price has risen to fifty cents a gallon for "motor spirit." The use of a mixture of gasoline and kerosene has been advocated, but without an efficient carbureter no such mixture can be used. Prof. Moyer has installed at the college a motor built to utilize the energy from either of the two fuels mentioned and suitable for use on farms and country estates. Experiments will also be made on various mixtures, and a carbureter valve will be designed to shift the fuel supply automatically from a small gasoline tank, used only for starting, to the main kerosene tank.

THE ABBOTT BALL-BURNISHING PROCESS

A METHOD OF FINISHING POLISHED WORK BY TUMBLING

BY CHESTER L. LUCAS*

Burnishing, as used in the ordinary sense of the word, consists in finishing exterior surfaces of work by rubbing with a highly polished steel hand tool, which hardens and

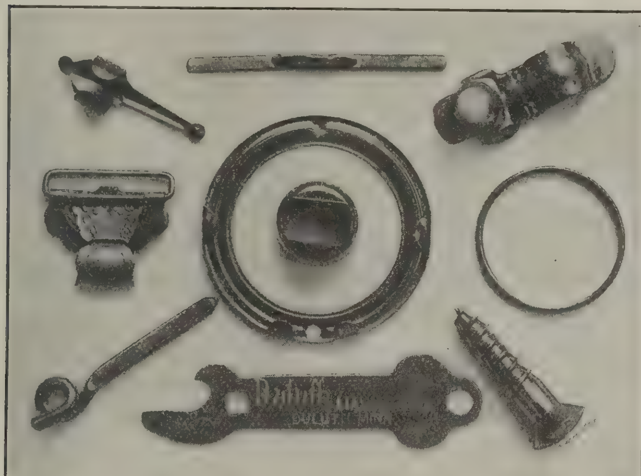

Fig. 1. Character of Work finished by Abbott Ball-burnishing Process

polishes the surface metal. The Abbott ball-burnishing process produces the same effect, but in an entirely different manner, employing quantities of hardened and polished steel

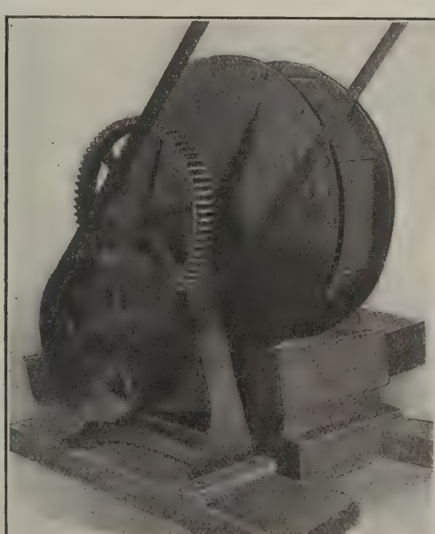

Fig. 2. Type of Burnishing Barrel used

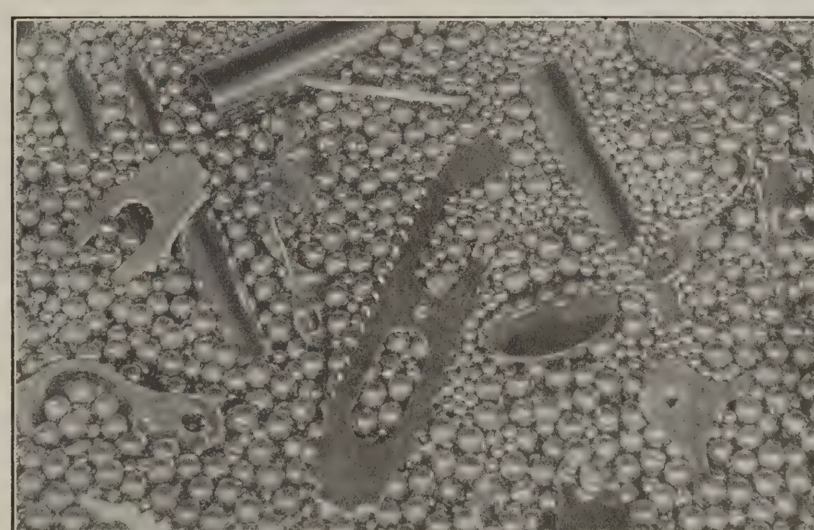

Fig. 3. View within the Barrel to show Burnishing Action of the Balls

balls which are caused to roll over the work while under pressure. This pressure is effected by the weight of the balls which are confined within a tumbling barrel like that shown in Fig. 2. Thus, each ball acts as an individual burnishing tool, and as it rolls over the work, pressed by the mass of balls and work above, it leaves a burnished path on the work. Fig. 1 shows some representative burnishing jobs which have been efficiently handled by this process. Some idea of the action which takes place within the tumbling barrel may be gathered by noticing the balls and work which are represented in Fig. 3.

Fig. 4 shows the general form of the ordinary tumbling barrel as contrasted with the Abbott burnishing barrel. From this it will be seen that in the Abbott barrel, the balls are confined in a deep narrow space so that the same amount of balls being restricted within a narrower space exert a heavier burnishing pressure upon the work. The Abbott ball-burnishing process cannot be used when any metal is to be removed or deep scratches are to be taken out. It is purely and simply a burnishing process for putting a high finish upon the work, and on work within its limitations is highly successful. Not only can a large amount of work be done in a short space of time, and in a very efficient manner, but many jobs which cannot be burnished by hand are efficiently finished by this process. Referring to Fig. 3 again, it will be seen that it is a simple matter for the balls to burnish the inside of a tube, the center of a deep depression, or the inside of a wire loop as shown in Fig. 1. Such pieces as these would be difficult to burnish in any other way. In order to burnish corners and depressions, it is necessary to employ balls small enough to come in contact with the surfaces of such places; therefore, on other than the very plainest of work, two sizes of balls are commonly used as shown in Fig. 3. Again, on work which is lettered, ordinary polishing processes "drag" the letters, but with the ball-burnishing process, this trouble is not experienced.

The balls used for this work are made of low carbon steel, by the heading process, carbonized and hardened clear through and then highly polished. The balls are not truly spherical, nor of an exact size, but they are highly finished and very hard. The barrels may be of the single or multiple type, having one or more compartments. The barrel shown in Fig. 7 has two sections, and gives a general idea of the construction. The compartments are octagonal in shape and are lined with maple wood so that the balls and work do not come in contact with any metal during the burnishing process. Two hand-holes are provided for each compartment with covers which may be clamped in place. The two hand-holes furnish a means for quickly removing the contents and washing out the barrel. A lubricant is employed in burnishing, which ordinarily consists of soapy water.

To burnish a quantity of work, the work and balls are

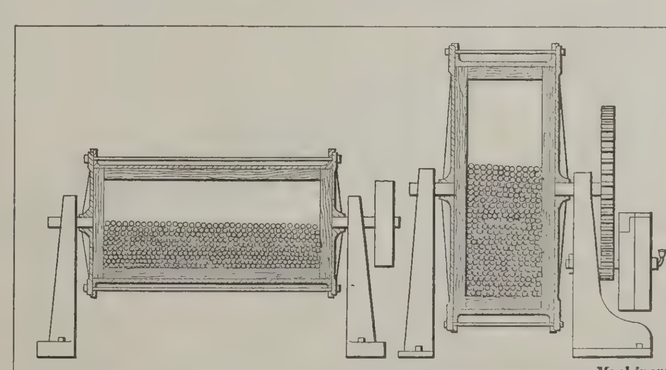

Fig. 4. Comparison of Old-style Barrel with Abbott Barrel

placed in the barrel in the proportion of one peck of work to two pecks of steel balls. Water is then added until it stands about one inch above the contents of the barrel. In this water, about four ounces of burnishing soap chips have pre-

* Associate Editor of MACHINERY.

viously been dissolved. The hand-hole covers are then clamped in place, and the mixture tumbled from one to five hours, depending upon the character of the work, metal, etc. The speed ordinarily employed for tumbling ranges from 10 to 30 R. P. M., the usual speed being 15 R. P. M. If after tumbling, the work has a dull or smutty appearance, the soap solution should be drained from the work and clean water substituted, to which should be added a piece of cyan-

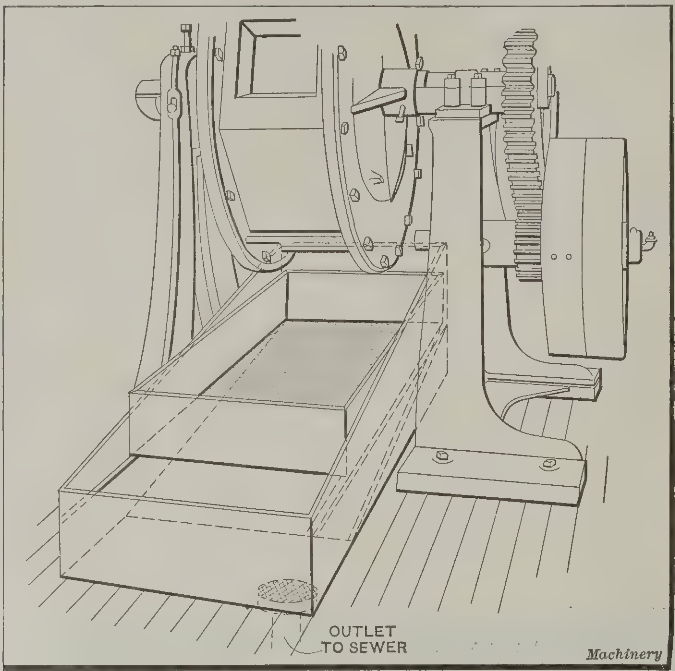

Fig. 5. Convenient Arrangement for Separating Balls and Work

ide of potassium about the size of a pea. It is highly important that the balls be kept from rusting, for rust, of course, destroys their burnishing qualities. The balls are easily kept in good condition by returning them to the barrel with the soap solution on them, but in no event should they be washed in clear water and allowed to stand. The burnishing operation is the same on all kinds of metal. After the work has been burnished sufficiently, it is separated from the balls by dumping the mixture into a screen of sufficiently coarse mesh to allow the balls to drop through. A convenient arrangement to use for separating the balls from the work is shown in the illustration Fig. 5.

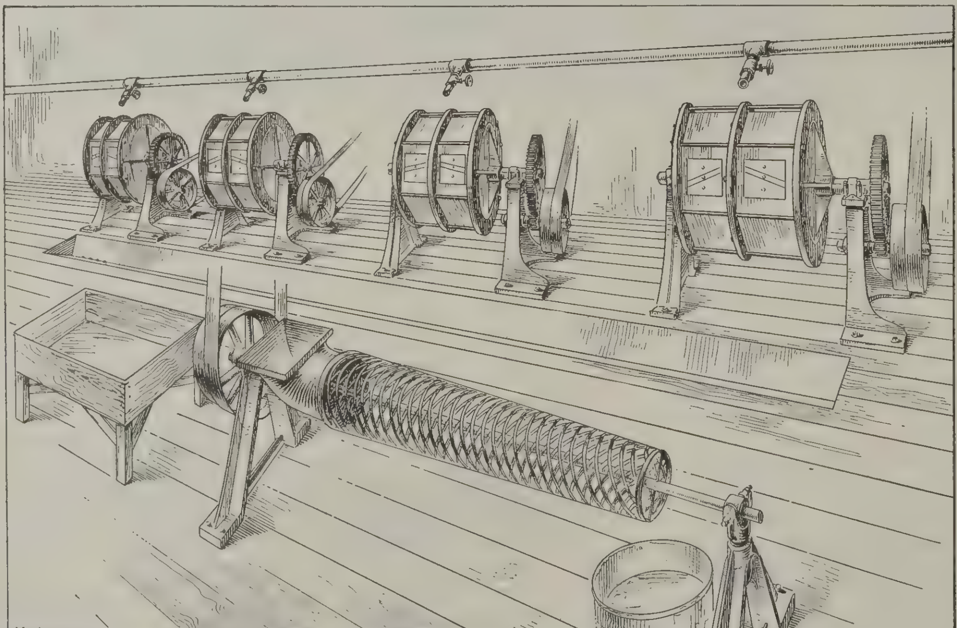

Fig. 6. Abbott Ball-burnishing Installation at Heron Mfg. Co.'s Plant

If the work is not to be plated, it is taken from the barrel and dried in sawdust, but if to be plated, it is cleaned in the usual manner and plated. The cleaning operation incident to plating is usually very troublesome on account of the rouge that is driven into corners of the work by the polishing wheels. No such trouble is experienced after ball-burnishing, as no rouge is used. It is only necessary to rinse off the soap solution, dip in potash and plate. After plating, the

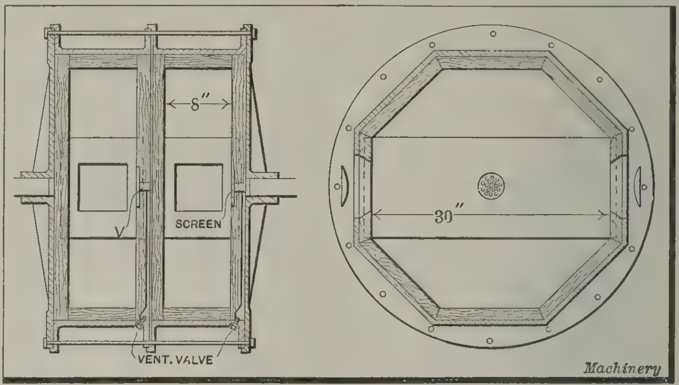

Fig. 7. Construction of Ball-burnishing Barrel

work is returned to the barrel and tumbled in a soap solution for a half hour to impart a high finish.

While most commonly used for small work, say under three inches in greatest dimension, larger work may be handled

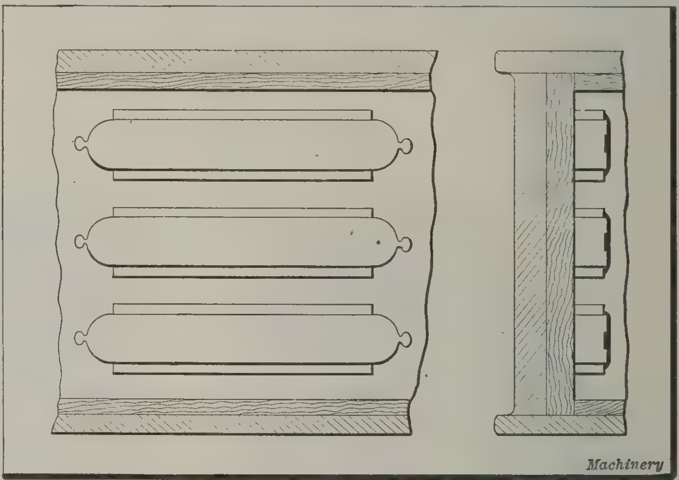

Fig. 8. Section of Barrel to show Method of Mounting Large Work

by a modification of the process. The difficulty in burnishing large work is due to the fact that the weight of the piece is often great enough to injure other pieces of work, and, of course, if the pieces are easily bent, there will be trouble from this source. Aside from the danger of bending large work in the burnishing barrel, a greater source of trouble is from scratches caused by the sharp edges of such pieces coming in contact with the finished faces of other pieces in the barrel. Referring to the illustration Fig. 8 a method of mounting pieces of this character is shown. Any convenient method of clamping is employed, depending, of course, on the shape of the pieces, but the fundamental idea is to support the pieces so that they cannot move in the barrel, and yet give the burnishing balls a chance to act upon the work exactly the same as though it was loose in the barrel. Mounted in this manner no possible injury can be done to the work and yet the balls have access to every part of the piece except the edge, even to the inside. It is apparent that this method cannot be used for all work, but a little ingenuity will often solve the problem without having to resort to hand polishing.

A typical installation of the Abbott ball burnishing process is found at the Heron Mfg. Co., Utica, N. Y. This installation

is represented by the illustration Fig. 6, in which are shown four double barrels driven from a common shaft. A line of piping extends over the four barrels, being connected with a hot water tank on the floor above. By means of outlets over the barrels, water may be admitted to the barrels for mixing the burnishing solutions, and for cleaning the barrels and their contents after the burnishing operation. A trolley system is arranged so that after the work has been dumped from a barrel into a basket, during which operation the suds and soap solution are carried away by means of the trough in front of the barrels, the work may be carried to the sawdust box for drying. This sawdust box is of the usual type and after the work has been sufficiently dried, it is shoveled into the chute shown at the right of the sawdust box, from which it enters the revolving conical screen cylinder and is separated from the sawdust, emerging from the small end of the screen, completely dried and ready for shipment.

By the use of this apparatus, the Heron Mfg. Co., who manufactures casters of all kinds, states that it is producing twice the number of parts at half the cost, and getting a better finish than when using hand polishers. Thus an expensive polishing and buffing equipment is eliminated, as well as the high priced labor formerly employed.

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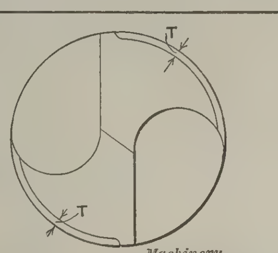
CLEARANCE ON TWIST DRILLS

In the June, 1911, number of MACHINERY an article was published entitled, "Data for Fluting and Relieving Twist Drills," which gave the dimensions of the fluting cutters used for grooving twist drills and also the thickness of the web and the width of the land (portion not relieved) on twist drills. The accompanying table gives the total amount of clearance, $2T$, for twist drills, as made by a prominent maker, the illustration showing how the dimension T is measured. The clearances given are for the finished drill sizes. Of course at the time the clearance is milled, the unrelieved portion of the drill is still a certain amount over the finished size. The amount of "oversize" must, of course, be added to the dimension T to determine the clearance in the unfinished drill. When measuring the depth of the clearance, the diameter is measured by micrometers over the relieved part. The dimension thus measured is the finished diameter of the drill less twice the dimension T. The thickness of the web as given in the June, 1911, number of MACHINERY is that at the point of the drill. Most makers groove their drills on a taper, which is so selected that the web is about forty per cent thicker at the upper end of the groove than at the point.



AMOUNT OF CLEARANCE ON TWIST DRILLS

Size of Drill, No.	Total Clearance, 2 T	Size of Drill, Inches	Total Clearance, 2 T	Size of Drill, Inches	Total Clearance, 2 T	Size of Drill, Inches	Total Clearance, 2 T
80–68	No Clearance	15/64	0.016	1/2	0.033	1 1/16	0.059
67–60	0.003	1/4	0.017	17/32	0.035	1 1/8	0.061
59–56	0.0035	17/64	0.018	9/16	0.037	1 3/16	0.063
55–52	0.004	9/32	0.019	19/32	0.039	1 1/4	0.065
51–48	0.0045	19/64	0.020	5/8	0.041	1 5/16	0.066
47–44	0.0055	5/16	0.021	21/32	0 043	1 3/8	0.067
43–40	0.0065	21/64	0.022	11/16	0.045	1 7/16	0.068
39–36	0.007	11/32	0.023	23/32	0.047	1 1/2	0.069
35–32	0.008	23/64	0.024	3/4	0.049	1 9/16	0.070
31–28	0.009	3/8	0.025	25/32	0.050	1 5/8	0.071
27–24	0.0095	25/64	0.026	13/16	0.051	1 11/16	0.072
23–20	0.0105	13/32	0.027	27/32	0.052	1 3/4	0.073
19–16	0.0115	27/64	0.028	7/8	0.053	1 7/8	0.075
15–12	0.0125	7/16	0.029	29/32	0.054	2	0.075
11– 8	0.0135	29/64	0.030	15/16	0.055	2 1/2	0.075
7– 4	0.014	15/32	0.031	31/32	0.056	3	0.085
3– 1	0.015	31/64	0.032	1	0.057	3 1/2	0.085

The allowance made for grinding varies with different manufacturers from about 0.010 to 0.015 inch. When high-speed steel is used, 0.025 inch is allowed for grinding on account of the scale produced in hardening. Straight drills smaller than from about 3/8 inch to 1/2 inch are not ground after hardening, as they are made from drill rod of the correct size. On the larger sizes, however, there is considerable decarbonization of the outer shell, and it is advisable to make an allowance for grinding on all drills larger than 3/8 inch diameter, which, in fact, is the practice of many of the twist drill makers.

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LIFE AND COST OF PATENTS

In an article in *Engineering* (London) of October 18, Mr. G. G. M. Hardingham gives a table stating the number of years during which patents are valid in various countries, and the total patent office fees paid for maintaining a patent during the specified number of years. It will be seen that in most countries the fees, which are given in the English monetary system the same as in the original table, are very much higher than those in the United States. It should be understood, however, that the large sums mentioned for some of the European countries are not payable in total at the time when the patent issues. In many countries yearly dues are payable in order to maintain a patent once issued. All these yearly dues have been added together so as to show the actual cost of a patent running for a specified term of years. Under the influence of the patent renewal fees in force in most European countries, a great many patents are annulled after they have been running only a few years, due to the fact that renewal fees are not being paid for them. In Great Britain, for example, statistics show that an average of 66.4 per cent of all the patents actually issued are annulled at the end of the fourth year, when renewal fees commence to become payable. Only 14.9 per cent of the total number of patents are renewed at the beginning of the eighth year; 7.6 per cent are renewed at the beginning of the eleventh year; and only 3.2 per cent run for the full term of fourteen years. It has been argued that patent renewal fees of some kind are desirable for the purpose of weeding out useless and unworked patents, but the correspondent of our contemporary, whose table is quoted, points out that there are two sides to this question. The table itself, however, is interesting as showing how cheaply a patent may be obtained and maintained for a period of seventeen years in the United States, as compared with the cost in the leading European countries. It also, probably, explains why the number of patents issued in the United States exceeds to such a large extent those issued in the other leading industrial countries.

TABLE SHOWING LENGTH OF TERM OF PATENTS AND TOTAL FEES IN VARIOUS COUNTRIES

Country	Term, Years	Total Patent Office Fees			Average Annual Cost of Entire Term of Patent		
		£	s.	d.	£	s.	d.
Germany	15	257	10	0	17	3	4
Russia	15	228	7	0	15	4	6
Austria	15	164	12	0	10	19	6
Hungary	15	118	0	0	7	17	4
Holland	15	113	13	0	7	11	6
Denmark	15	111	15	0	7	9	0
Great Britain	14	100	0	0	7	2	10
Brazil	15	98	9	0	6	11	3
Belgium	20	84	0	0	4	4	0
Spain	20	84	0	0	4	4	0
France	15	60	0	0	4	0	0
Italy	15	60	0	0	4	0	0
Norway	15	58	2	0	3	17	6
Transvaal	14	53	10	0	3	16	5
British India	14	52	13	0	3	15	3
Switzerland	15	54	16	0	3	13	0
Sweden	15	40	18	0	2	14	6
Argentine Republic	15	38	2	0	2	10	10
Japan	15	27	13	0	1	17	0
New Zealand	14	18	0	0	1	5	8
Australian Commonwealth	14	13	0	0	0	18	7
Canada	18	12	7	0	0	13	9 [illegible]
United States of America	17	7	4	0	0	8	6 [illegible]
Mexico	20	4	2	0	0	4	1 [illegible]
Average	15.6	77	1	6	5	1	1

Machinery

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

COMMENTS ON QUARTER-TURN BELTING ALIGNMENT

In reading Mr. M. H. Ball's article on quarter turn belting alignment in the September issue of MACHINERY, the writer is reminded of an incident which occurred some twenty-five years ago. A millwright was sent from a machine shop in central Massachusetts to install a water wheel and all of the power transmission equipment for a large mill in Maine. Included in the job there was a quarter-turn belt, 16 inches wide, that ran through five floors from the basement to the upper story. From the time he began the job, which was of some three months' duration, the quarter-turn belt was in the millwright's mind, as he had not the least idea how to install it. However, it was up to him to do it some way, and all his spare time was devoted to studying the matter. It may be said, in passing, that he had not a technical education, and therefore had no knowledge of descriptive geometry, but as the floors were all laid with hard pine tops, he did not want to cut belt holes big enough to let a wagon and oxen through. After studying the problem for some six weeks, the millwright went home for the express purpose of asking the boss how to lay out and cut the belt holes. The answer he received was, "If the pulleys were of the same size with only a single floor located midway between them, I could tell you; as it is, I don't know how." So the millwright returned to the job no more enlightened than when he left.

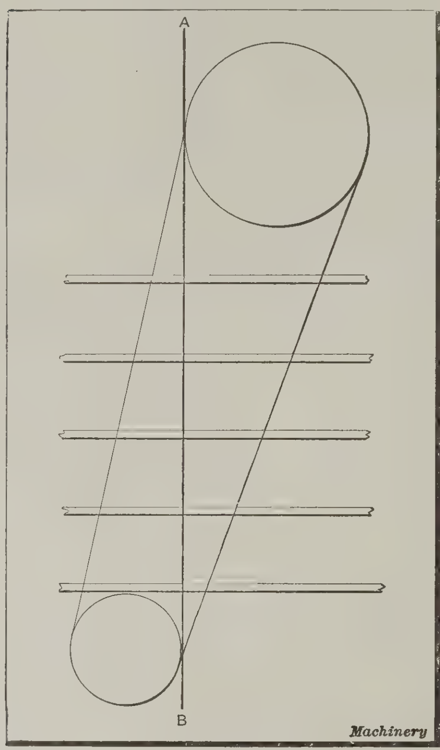


Diagram for laying out Belt Holes

One evening he took a compass and struck two circles to represent pulleys of different diameters, one above the other; he then drew lines representing an open belt from one pulley to the other, a line from the left of the upper pulley to the right side of the lower pulley, and lines to represent the five floors, as shown in the illustration. After studying over the sketch for some two hours or more the millwright was about to give it up for the night. He took up the paper and started to fold it on the line *AB*—purely mechanically—without any purpose whatever in doing so, but still thinking hard of the subject which had troubled him so long. He raised his hand to throw the paper into the fire, when it opened at an angle of about ninety degrees and caught his eye. He stopped and looked first at one side of the fold and then at the other, and was astonished as well as delighted to see that the solution of the whole problem was before him—perfectly plain and easy to understand. The line *AB* represented the plumb line through the floors, from the face of the upper to the face of the lower pulley, and the lines representing the belt showed the distances of the belt from the plumb line each way, and also the angle which the belt made in passing through the floors. The next morning the millwright made a drawing of the same thing to scale, and then to be absolutely sure, he made a model to the same scale, cutting all the belt holes, and putting on a model belt. He then laid out all the belt holes, allowing half an inch all around, and when the belt was put on it did not strike the side of any one of the holes. The writer believes that this incident shows what persistent thought and study will accomplish under most unfavorable circumstances.

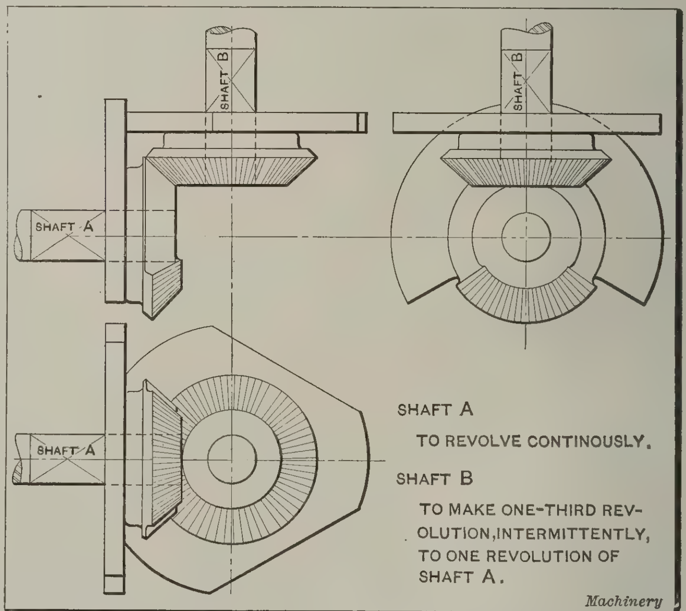
S. S. JENNISON

Cleveland, Ohio

AN INTERMITTENT MOTION

The feed rolls of machines for making cardboard fillers for egg boxes require an intermittent motion for their operation. They feed cardboard into the machine while in motion, and hold it for cutting while at rest. In one case a continuously running shaft was made to give this motion through an ordinary miter gear and a properly proportioned miter gear sector. This sector engaged and turned the miter gear during one-third of a revolution and then allowed it to remain idle during the remaining two-thirds. In the design of the machine no provision was made for keeping these ratios exact, further than by correctly proportioning the gears. As a consequence of slight variations, this combination gave much trouble through the gears not meshing correctly. This caused the gears to be broken, the timing of the feed to be destroyed, and the working of the machine to be generally deranged.

The illustration shows the method used for overcoming these defects and obtaining an accurate and sure-working feed



Mechanism for regulating Action of an Intermittent Motion

motion. It consists of a pair of flat plates attached to the shafts *A* and *B* behind the gears. The plate carried by shaft *B* is slabbed off on the three sides of an equilateral triangle. to give the correct dimension from center to edge, and the plate carried by shaft *A* is cut away to allow clearance for the plate on shaft *B* while turning. The mechanism acts exactly as before, except that when shaft *B* is idle, it is held in place by the bearing of one plate on the other. These plates limit the movement of shaft *B* to exactly one-third of a revolution for each revolution of shaft *A*. The former difficulties are thus remedied, and a smoothly running machine made possible.

MILES SAMPSON

Manchester, N. H.

ATTACHMENT FOR WINDING CLOSE COILS IN SPRINGS

The spring winding attachment shown in Fig. 1 is designed to fit on the back end of an ordinary lathe headstock. The attachment can be set to produce from one to two and one-half

close coils, at required intervals, so that a spring of the full length of the lathe can be wound and then cut up into lengths. This method of close coiling makes it possible to save the time that was formerly taken in closing the ends by hand or in heating the ends of larger springs before closing them up.

The attachment is driven by the screw cutting stud, through the regular change-gears, to the lead-screw, as in an ordinary screw cutting operation. The nut is kept in engagement with the screw all the time. The change-gear is loose on the screw cutting stud, but has a clutch member keyed to it; the other part of the clutch is keyed on the stud and has a spring to push it into engagement. When these two clutch members are in engagement the apron travels forward; when the clutch

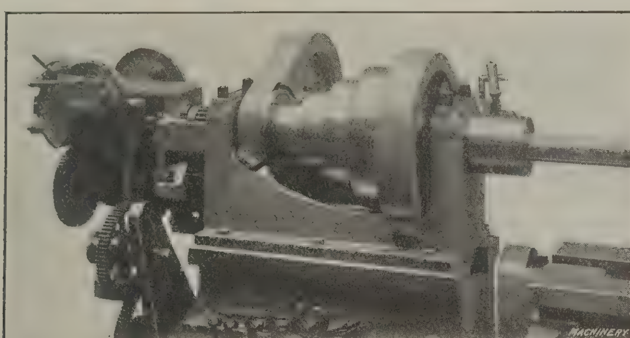


Fig. 1. A Lathe Attachment for winding Springs

is disengaged the apron stands still but the spindle continues to revolve.

The screw cutting stud is continued outward and drives a cam A by means of two gears, as shown in Fig. 2. This cam runs continuously and acts on a runner attached to the curved lever B which carries a spring plunger or pawl C. Each time the lever reaches the top of its stroke, the pawl carried by it acts on the ratchet wheel and picks one tooth. The ratio of the gearing which actuates the cam is such that it requires three strokes of the lever for each two coils of spring which are wound. The ratchet wheel is prevented from coming back by means of the fixed catch D at the top, which holds it against the weight and rope tending to pull it back. On the side face of the ratchet wheel there is a T-groove in which a dog is clamped. As soon as the ratchet wheel has been advanced through the required distance, this dog comes against a projection E on the inside of the ratchet mask; the ratchet and mask then travel together. The mask has a gap through which the pawl usually works; consequently it remains stationary until it is engaged by the dog on the ratchet wheel. This mask is rather larger than the ratchet wheel, the bottom of its teeth being slightly above the top of those on the ratchet, so that when it begins to move, the pawl C and fixed catch D are both lifted out of contact with the wheel and allow it to go back under the pull of the rope and weight.

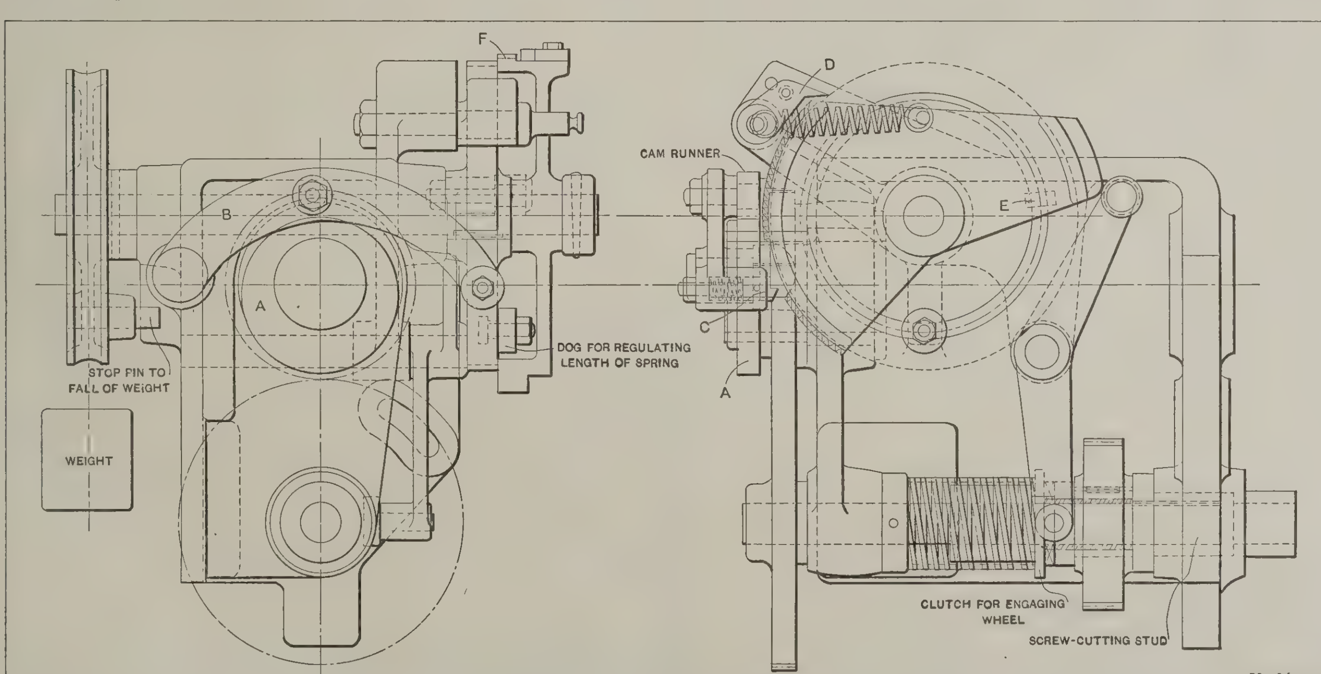


Fig. 2. Details of the Mechanism for producing the Close Coils

Shortly after the mask begins to move, its corner comes in contact with the cam runner on the lever which controls the stud clutch. This throws out the clutch and stops the travel of the apron. The mask continues to rotate through the action of the pawl until it has produced the required number of close coils. An adjustable dog for lifting the catch now comes into action and throws the catch out of engagement with the mask; the tension of a spring then returns the mask to its original position. This releases the clutch lever and allows the drive on the screw cutting stud to be reengaged. At this point, the apron continues its forward movement for the production of another section of the spring. When the mask is returned, the fixed dog, which it carries, pushes the retaining catch into engagement with the ratchet wheel, thus restarting the latter in rotation.

Means are provided to cushion the weight so that the full shock does not come on the attachment. Suitable means have been taken to adjust the ratchet pawl so that it takes only one tooth at a time, also to have it drop clear of the ratchet wheel in order that the latter may be given time to run back when the action of the weight becomes effective. The design of the teeth of the clutch on the screw cutting stud must be such that they will have plenty of clearance and not too strong a spring behind them, as this would make the return uncertain.

The pitch of the spring is obtained in exactly the same way as the pitch of a screw produced in the ordinary manner. The attachment merely determines the length of each section of the spring and the number of close coils that are to be produced.

Keighley, England W. Haggas

CASEHARDENING PRACTICE—A COMMENT

The writer would like to make a few friendly criticisms and comments on Mr. Robert Grant's article on "Casehardening and Casehardening Practice" in the October number of Machinery. In the first place, the general methods outlined are not entirely in accordance with the most modern practice. However, the article is good and in most cases it treats of the present methods practiced all over the country.

The statement is made that carburized steel should never be quenched at the carburizing heat, but should be cooled to the hardening heat, as the latter is much lower than the carburizing heat. This would make little improvement, for the grain of the steel would be about the same as if it had been quenched at the highest temperature attained while

carburizing. It is necessary to cool the steel below its lowest critical point (about 1275 degrees F.) and then reheat it to the hardening temperature, thus quenching on a rising heat, in order to secure a refined grain. Steel should never be quenched on a falling heat.

Mr. Grant's method of local hardening is not the most modern, and it is expensive and troublesome. He shows a cup-shaped piece in Fig. 6, which was only hardened at the interior of the cup, using another cup-shaped piece to prevent the outside from hardening. There is now a prepared fire paint on the market which works admirably when painted on parts of steel that are not to be hardened. This paint is in the form of a powder and is mixed up with water to the consistency of paste; it is then ready to be applied. The steel can be painted before or after carburizing. If painted before, the part of the steel which it covers will not be carburized, and consequently it will not harden. If the paint is applied after carburizing, the painted steel will not harden, although it is carburized, because the paint forms a shield which does not let the water come in contact with the steel. This makes local hardening a simple proposition, and is superior to copper coating. The use of the mandrels shown in Fig. 5, for preventing the hardening of the inside of rings, could be done away with by using this fire paint. The fire paint is also useful in corners where a thin part joins a thick part in the steel, the paint forming a fillet that leaves the corner soft after hardening and prevents breakage.

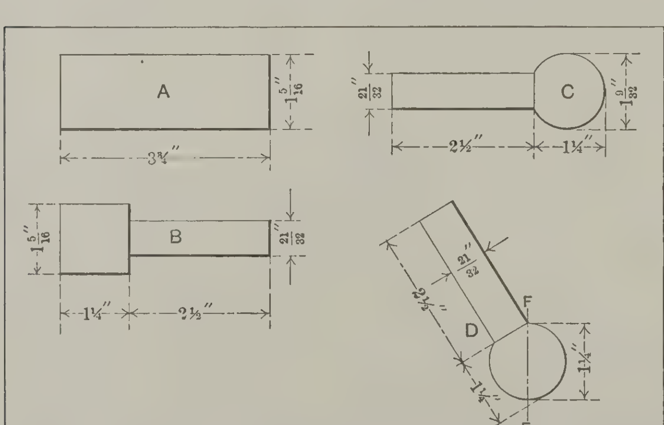
Mr. Grant says that small pieces packed in a box for carburizing may touch each other without detriment. It is hardly possible that this would be true in actual practice, because the surfaces in contact would prevent direct contact of the carburizing material; therefore these spots would get little or no carbon, and the steel would either have soft spots after quenching or the depth of case would be irregular.

The method of drawing the temper of hardened steel by heating it in a muffle is not nearly so reliable as drawing it in oil, where the temperature can be accurately gaged with a thermometer. Drawing in oil is a more rapid and accurate method. Mr. Grant says that large articles require a higher carburizing heat than small ones. The writer does not see the reason for this. Of course it takes a higher heat to penetrate a large piece in the same time as a small one, but it seems that if two pieces of steel—one small and one large—are held at the same uniform heat for the same interval of time, they will each receive the same depth of case.

Cleveland, Ohio J. E. WASHBURN

TURNING SPHERICAL SHAPES BY HAND

Special fixtures and methods for ball turning have been shown and described in recent issues of MACHINERY. The accompanying illustration shows a method which the writer



Successive Operations in Turning Ball-shaped Parts by Hand

recently used in a job shop where no ball turning device or lathe with a compound rest was at hand. The pieces to be turned up are stub ends to be welded onto the steering arms of automobiles for repairs. After cutting off the pieces, as shown at *A*, they were faced to the proper length and centered, and were then caught in a three-jaw universal chuck and one end was turned down, as shown at *B*. The pieces were then reversed in the chuck and the ball shape was roughed out by hand as accurately as practicable, as indicated at *C*. They were then caught in the chuck in the position shown at *D*, on the points of the chuck jaws, so that a circle could be turned to 1¼ inch diameter along line *EF*. Preferably, this should be done in an independent jaw chuck so that the circle turned in this position will agree as nearly as possible with the diameter marked 1 9/32 inch, previously turned. The pieces are then returned to the position shown at *C*, and the ball is finished, the circle turned to 1¼ inch diameter being used as a "witness" mark. H. W. RICKS

Santa Ana, Cal.

TURNING A BALL WITHOUT CENTERS

It was required to turn the brass ball shown in Fig. 2 without the use of centers, and in performing this operation the following method was used. A 4-inch bar was chucked in the lathe and the ball roughed out. The compound rest was next set with the pivot directly beneath the center of the ball and slowly swung around to form the work. The tool was fed in until the caliper showed that the ball had been reduced to

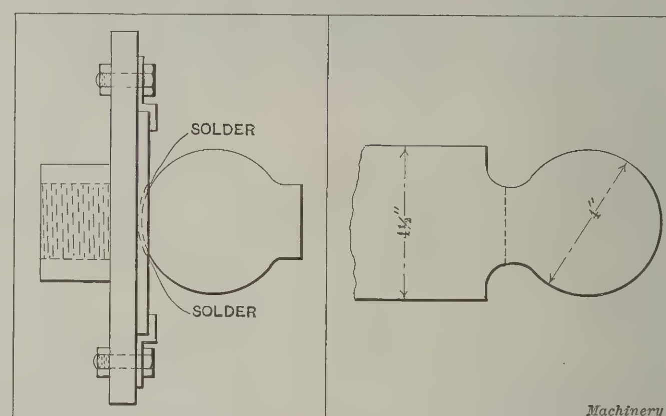


Fig. 1. Method of securing Ball to Faceplate Fig. 2. Ball ready to be cut from Bar

the required diameter of 4 inches. This turning operation was continued until the work had been brought to the form shown in Fig. 2. The ball was then cut off along the dotted line leaving sufficient stock to finish.

The chuck was next removed and a faceplate mounted on the lathe spindle in its place. A brass plate was then strapped to the faceplate and a hollow was turned in it with the tool in the compound rest. The same radius was used for this purpose and, consequently, the hollow formed was of exactly the right size to hold the ball. The work was then mounted in the position shown in Fig. 1 and the tailstock brought up against it to secure it in place. Soft solder was now melted into the joint between the ball and disk, a blow torch being used for this purpose. This method of fastening proved entirely adequate to hold the work in place after the tailstock had been removed. The remaining surface of the ball was then finished. In performing this operation, it was necessary to maintain exactly the same radius on the compound rest, but this did not interfere with the possibility of moving the rest along the lathe bed to bring it into position for completing the ball.

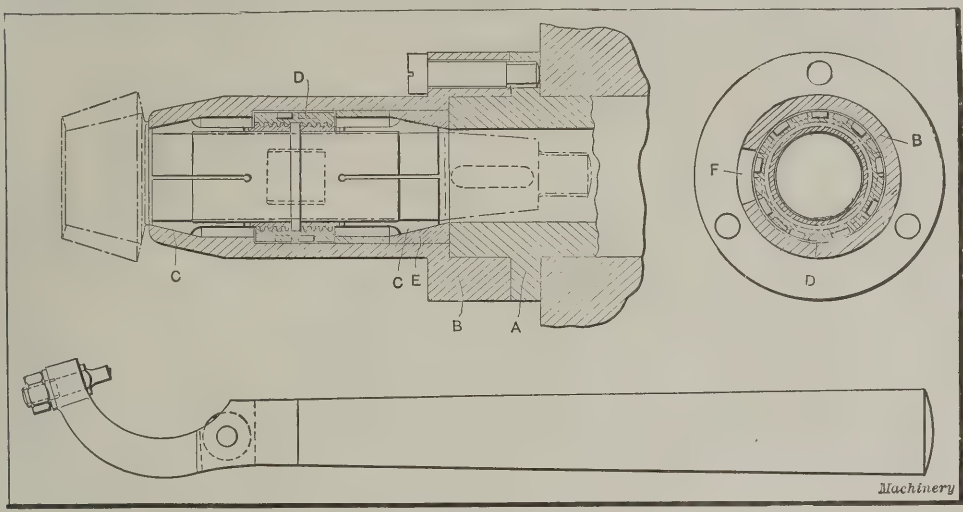
The advisability of turning balls in this way may be questioned, as some may regard the method of turning them between centers and then grinding off a more rapid process. This is true in some cases, but for the operation described in this article it was necessary to have the ball accurate to 0.0001 inch, and the method described enabled the work to be produced to meet this requirement.

New Britain, Conn. J. M. HENRY

DOUBLE GRIPPING CHUCK

In the shops where the writer is employed we had to rough out some very hard nickel steel miter gears on a spur and bevel gear cutting machine. The usual chucking devices at our disposal failed to do their duty, as we could not possibly take the heavy cuts without moving the work.

The double gripping chuck shown in the accompanying engraving was, therefore, designed and proved quite effective. At *A* is shown the machine spindle; *B* is the chuck which is firmly fastened to the spindle by means of three screws. At *C* are shown two conical split collets which are fitted on the inside of the chuck, the front one resting in a taper seat, while the rear one rests in a ring *E* held against the front of the machine spindle. Both collets are threaded on the outside with a right- and left-hand thread, respectively, and are screwed into a ring *D* which holds them together. The ring has, on the outside surface, spanner holes so arranged in two rows around the circumference, that when the ring is rotated they alternately pass in front of a rectangular opening *F*.



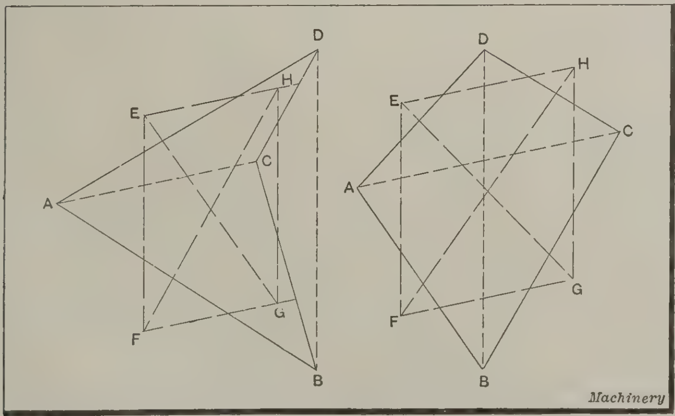
A Special Double-gripping Chuck

Through this opening the tooth of the spanner shown in the lower part of the engraving is inserted. Ring *D* is thus rotated, and the two collets *C* operated against the taper surfaces, so as to clamp the work firmly in position.

Turin, Italy. G. Boella

FINDING THE CENTER OF GRAVITY OF ANY FOUR-SIDED FIGURE

In many calculations pertaining to the design of machinery, it is necessary to find the center of gravity of irregular polygons, and the following is a simple method of obtaining the center of gravity of any four-sided figure. Two cases are possible, as shown in the illustration. To find the center of gravity of the four-sided figure *ABCD*, each of the sides is



Method of finding the Center of Gravity of any Four-sided Figure

divided into three equal parts. A line is then drawn through each pair of division points next to the points of intersection *ABCD* of the sides of the figure. These lines form a parallelogram *EFGH;* the intersection of the diagonals *EG* and *FH* locates the required center of gravity.

McKees Rocks, Pa. August H. Anger

[To prove that *EFGH* is a parallelogram, a line is drawn connecting points *B* and *D*. This forms two triangles *BCD* and *BAD* having the common base *BD*. It can be shown that a line which subdivides any two sides of a triangle proportionately is parallel to the third side. The line *EF* divides the sides *BA* and *DA* in the ratio of 2 to 1, and so it is parallel with *BD*. The line *GH* divides sides *BC* and *DC* in the ratio of 2 to 1, and so it is parallel with *BD*. Hence the lines *GH* and *EF* are parallel to the common line *BD* and with one another. To prove the sides *EH* and *FG* parallel with one another, a line is drawn connecting points *A* and *C*. The same method will then show that the lines *EH* and *FG* are parallel to the common base line *AC* and, consequently, to one another. Hence *EFGH* is a parallelogram.—Editor.]

ERASING INK MARKS FROM TRACINGS

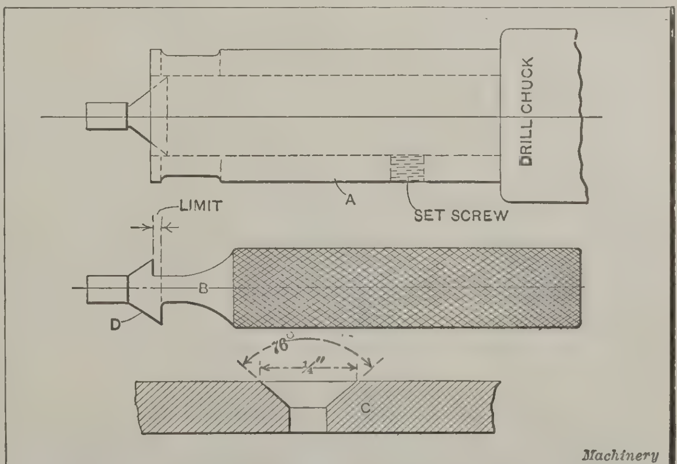
The writer, a draftsman of twelve years experience, has read many articles on the well worn subject of "Erasing Ink Marks from Tracings," but has seen nothing that agrees entirely with what he has found to be the most satisfactory method. To begin with, an ink line is one of considerable breadth and thickness. When an eraser is applied it grinds the ink up into minute particles, which are worked into the cloth as soon as the glaze is broken; these particles of ink are only removed by much unnecessary rubbing. The following is a more satisfactory method:

Place a triangle or other hard, smooth surface beneath the line or spot that is to be erased from the tracing cloth; then with a very sharp knife remove the ink which lies on top of the cloth. This means the ink which has not actually sunk into the cloth; do not scratch into the cloth. If sufficient care is exercised, the knife need scarcely break the glaze. Then, still keeping the triangle under the tracing and using a hard pencil eraser—do not use an ink eraser—it will be found that the remainder of the ink can be completely removed with little injury to the cloth. By this method, the troublesome grit coming from an ink eraser is avoided, and by applying a small amount of soapstone, the surface of the cloth is renewed sufficiently to prevent the pores filling up with dust and becoming unsightly. As a general thing, a knife is tabooed as an eraser, and with good reason, but when used according to the method outlined, the writer has found it far superior to an ink eraser.

Auburn, N. Y. Raymond H. Farwell

STOP-SLEEVE AND GAGE FOR COUNTERSINKING

The writer has had considerable difficulty in accurately countersinking holes in thin sheet metal; hence, a gage or stop-sleeve was finally devised which answered the purpose



Stop-sleeve and Gage for Countersunk Holes

so well that a description of it may be of interest to others who may have met with trouble of the same kind. The countersinking of holes in sheet metal to a uniform depth com-

bines the difficulties of ordinary countersinking with the additional difficulty that the sheet metal is apt to spring away somewhat from the tool. Trouble is also met with on account of slight bends in the sheet.

The stop shown at *A* in the accompanying illustration is a sleeve which is placed over the countersink. The top of the sleeve fits against the face of the drill chuck and is prevented from falling off the tool by a set-screw. Openings near the bottom provide an outlet for the chips. The bottom face of the sleeve is hardened and slightly drawn. It is then polished as smoothly as possible with fine emery so that it will not mark the stock. When the countersink has reached the proper depth, the face of the stop will revolve on the stock and thus prevent the tool from entering further. The pressure on the sleeve will tend to straighten out any bends in the sheet metal and make certain that every hole will be countersunk to a uniform depth.

A test gage for countersunk holes which may be of interest is shown at *B*. It is provided with a pilot for entering the drilled hole. One side of the gage proper is ground away, as indicated, to a level lower than that of the other side. In this way, the allowable limit of variation in depth of the countersunk hole is given on the gage in a very convenient way. The part *D* is ground and by using Prussian blue or red lead in gaging, the angle of the countersunk hole can be easily tested.

Many draftsmen when dimensioning a countersunk hole give its depth. This is not a convenient dimension for the shop men to work from, as it is practically impossible to measure the depth accurately without a gage; hence, countersunk holes should be dimensioned as shown at *C*, the diameter at the top and the angle being given. F. A. PARSONS

Milwaukee, Wis.

JIG FOR DRILLING HOLES CLOSE TO A SHOULDER IN SCREWS

A jig for drilling holes close to a shoulder in a screw is shown in Fig. 2. The hole to be drilled is for the threading tool to run into, when cutting threads up to the shoulder on

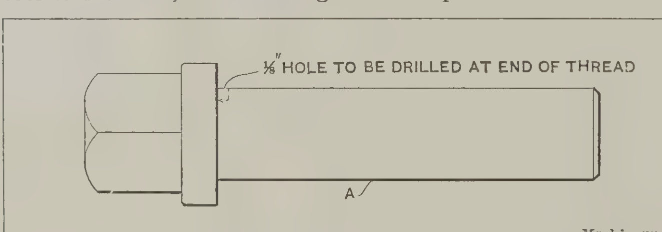


Fig. 1. Screw to be drilled

the screw shown in Fig. 1. The jig is placed in the tailstock of a lathe, and the drill is held in a chuck in the headstock.

In operation, the body *A* of the screw, Fig. 1, is held with the left hand in the V-part of the jig, with the shoulder against the

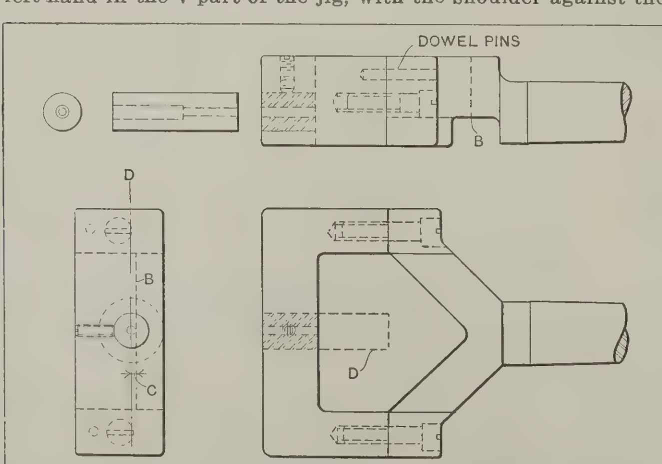


Fig. 2. Jig used for drilling Holes close to Shoulders in Screws

cut-away portion *B* (the face *B* is equal to the radius of the drill or the distance *C* from the center), while the right hand is used to run the tailstock spindle out, or, in other words, to feed the work against the drill.

In this jig the work is quickly done with a sufficient degree of accuracy, and if the drill used is ⅛ inch in diameter, screws of ⅛ inch pitch or less and of various diameters can be drilled, which makes this a handy jig for drilling odd half-dozen lots, as well as a greater number of pieces.

The long bushing *D*, shown in Fig. 2, is for supporting the drill on small diameters, as it projects further through the cap, as shown by the dotted lines. M. F.

A SWAGING OPERATION

In swaging the piece *A* to the shape *B*, Fig. 1, and in other similar work, trouble is often experienced in obtaining a satisfactory means of locating the work, owing to the flash which spreads entirely around the piece. In Fig. 2 is shown

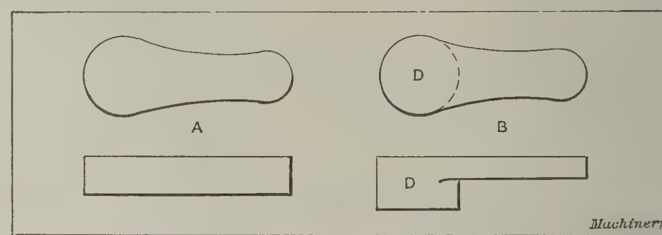


Fig. 1. Piece of Work before and after Swaging

a punch and die for swaging this part. The work is located between the spring-operated holders *A* and directly over the die, which has a hole *B*, 3/32 inch deep, in it. The small end of ejector pin *C* forms the bottom of the hole in the die. When the piece is swaged into the die, this pin compresses

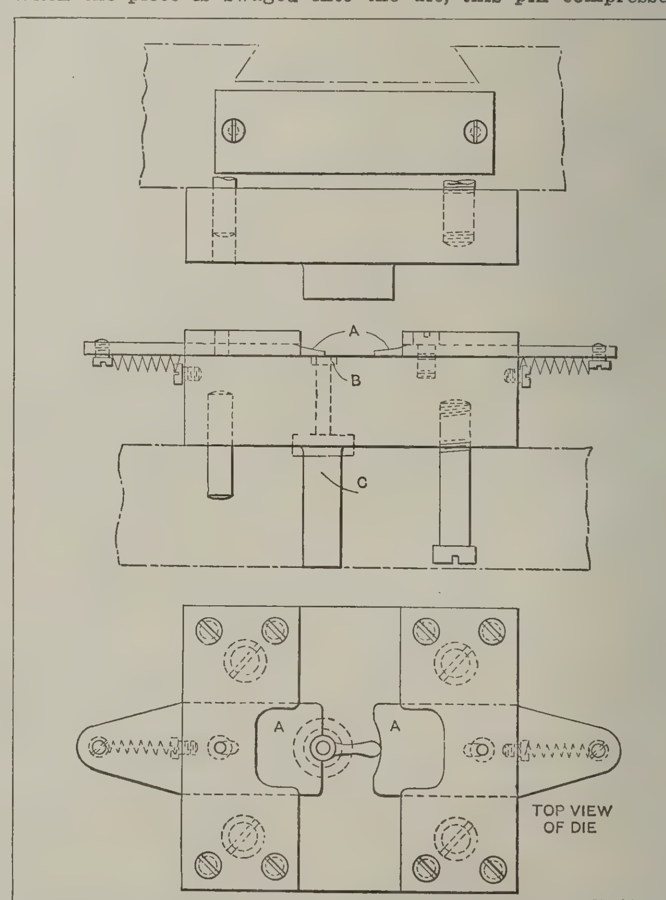


Fig. 2. Punch and Die for Swaging Operation

the rubber pad which is used for ejecting. A small ring is formed on the work by the hole through which this ejector slides; this is afterwards removed by a drilling and reaming operation through boss *D*, Fig. 1. BACON

MACHINING AN AUTOMOBILE SPIDER

The piece shown at *B* in Fig. 1 is known as an automobile spider. It has four arms which are finished on the outside, and a hole bored through the center. The machining operations on the spider are carried out as follows: In the first operation the spider is gripped in a three-jaw chuck, as shown in Fig. 1, one jaw being cut out to allow one of the arms of

the spider to set into it, thus furnishing a drive. While the hole through the spider is being bored and reamed with tools held in the turret, one side of the spider is faced with a back facer bar which is operated through the spindle, and the side next to the turret is faced with tools held on the cross-slide. In this operation the ends of the arms of the spider at *A* are also turned.

Before the second operation on this spider is done it is necessary to drill a small hole *A*, Fig. 2, which is used to locate the spider on the turret for the second operation. This hole is drilled in a jig as shown, which consists of a base on which the spider is set and an upper half which locates the

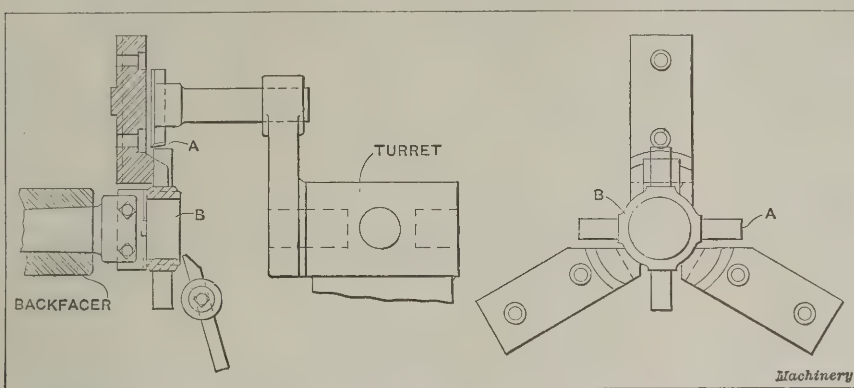


Fig. 1. First Operation—Turning, Boring and Facing

hole. Fig. 3 illustrates the method of machining the arms in the second operation, this being quite a departure from ordinary turret lathe practice, in that the tools are held in the headstock spindle, and the work on the turret. In place of the regular turret a special turret is used for holding the spiders, each spider being located in the same position as the preceding one by means of the hole mentioned above and the pin *A*, Fig. 3.

It is obvious that if there are four turret faces on the regular turret, the same will be true of the special turret, and each indexing of the turret brings another arm in line with the spindle, where it is operated upon. When the four arms are finished the machine is stopped and another spider put

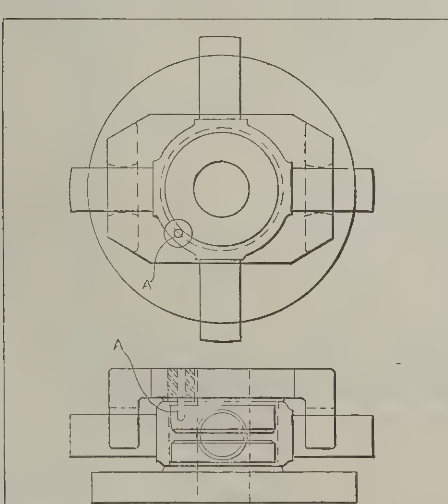


Fig. 2. Jig for Drilling Locating Hole

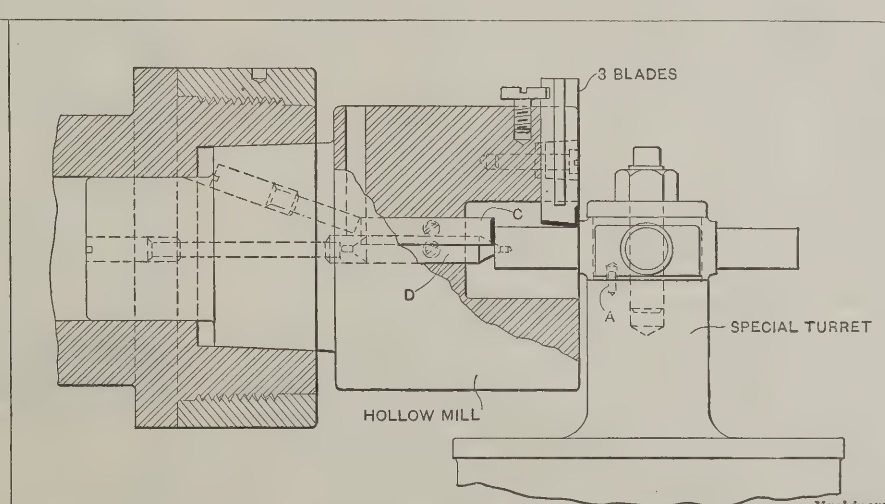


Fig. 3. Turning and Facing the Spider Arms

on. The machining on the arms of the spider is done with a hollow mill held in the spindle. In this mill there are three blades for turning, one facing blade *C*, which faces the end of the arms, and a small combination center-drill *D* which centers each arm. As the arms on the spider are opposite, they can be set between centers and ground, a pin being used to drive them by simply coming in contact with one of the arms not being ground; this saves the necessity of using a dog and is much quicker. F. Server

A COMPARISON OF SELLING METHODS

Some time ago we were in the market for a machine tool and wrote to two manufacturers who advertise in these columns. The selling methods of these two companies differed sufficiently to cause comment. Our letter asked for information regarding prices, the type of equipment that would be best suited to our requirements and the correct method of installation. The replies came promptly but the difference can be noted from the following: Firm No. 1 enclosed a blueprint photo of machine and a printed pamphlet of general information on the method of installation, etc. Their letter made no mention of the special information we asked for and appeared to be a stereotyped form. Nor was this information included in the pamphlet, and to complete a poor argument, the letter was signed in typewritten characters, no writer's name appearing. Firm No. 2 sent an attractive catalogue with prices—which, by the way, were higher than those submitted by firm No. 1—and a three page letter *fully* answering all of our requests, and calling attention to a few salient points not mentioned in the catalogue. They advised that their salesman would reach us within three days to enter into the matter still more fully. In conclusion, the letter was personally signed by the head of the firm, thus giving that touch of individuality which means so much. The salesman arrived on time, explained some minor points—the letter had covered nearly everything—closed the order, and the machine was shipped in three weeks. Although we would have paid for it on delivery, the builder insisted that we take up the thirty day trial offer, which was done. Needless to say, the machine is still in use and further purchases are now contemplated.

The reason for asking the special question concerning installation and equipment was that remodeling was necessary to accommodate the machine. It was necessary to start this work at once, in order to be ready when the machine arrived; consequently it was a matter of absolute necessity for us to have these questions answered. We notified firm No. 1 that the order had been placed, but received a stereotyped "follow up letter"—signed in typewritten characters as before. While merits, of course, were the final considerations governing our selection, the first impressions made by the letters went a long way in making the decision. It does seem as though some firms should adopt twentieth-century methods of selling their goods. One thing more; these firms were located in the same town and manufactured the same line of machines, so that both had equal opportunities of securing the business.

New Britain, Conn. J. M. Henry

PUBLISHING TECHNICAL INFORMATION

In the September issue of Machinery, appeared an editorial comment on an article recently published in *Canadian Machinery*. The article in question spoke of the selfishness of some engineers who refrained from giving out useful technical

information which was the result of personal research. Modern methods and ways of thinking are making this type of men a thing of the past.

There are, of course, various reasons for this policy, one of which was brought out by an experience which the writer recently had. The superintendent of a certain factory, having noted one of the writer's articles on a method of performing an important operation, came to him and said, "I don't believe in this sort of thing and the president also expresses himself as being against it." Upon being asked for the reason he replied, "Simply because we do not believe in the general education of the masses.". The writer refrained from making any comment, but to him it surely seems a narrow-minded view. The article did not reveal any trade secrets or information of that nature, being merely a description of a short cut in machine production.

Some people appreciate the publicity which comes from advertising, etc., but fail to appreciate the publicity value of giving out their methods of manufacture to the trade. Competition makes it necessary for every short cut to be applied, but does not, in the writer's opinion, require withholding information that would be helpful to a great many mechanics. This only refers to information that could be made public without loss to the works where the method originated.

It will generally be observed that the shops which guard their fancied secrets so jealously are the ones in which time, money and energy are wasted most freely. The reason for this is that their narrow-mindedness prevents them from accepting other known and tried methods of improving their working conditions. Perhaps they are ashamed of their methods. If this narrow view were broadened, it would clear away much of the mystery which surrounds the intelligent use of modern machine tools and appliances, and the benefits received would fully repay manufacturers for giving out information which is at their disposal. J. M. H.

DRAWINGS AND THE EYE-SIGHT

There is altogether too much unnecessary eye-strain among draftsmen that is weakening their sight. This is not brought on entirely by the continuous use of the eyes; other causes of eye-strain are making and reading drawings with lines of inadequate thickness, using lead pencils that are too hard, and making tracings from pencilings whose lines are barely distinguishable through the cloth.

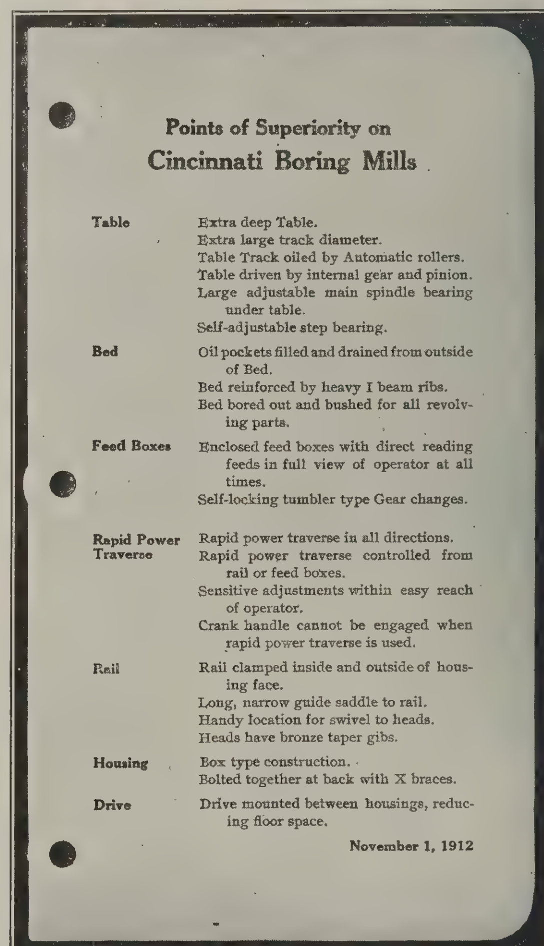
The exercise of a little discretion in selecting drawing materials and in drafting-room practice may be made the means of saving both the draftsmen and those who use their drawings from eye-strain. It is more difficult to trace a penciled drawing made on buff or cream colored paper than one made on white paper. Many draftsmen use but one degree of hardness in lead pencils—generally a 5–H or 6–H on all shades and grades of drawing paper. They do not appear to realize that there is a proper degree of hardness of lead for different papers, that will make a drawing "seeable" and "readable" through tracing cloth in all conditions of light, whether the day is stormy or bright. In most drafting-rooms, the papers used have a coarse-grained surface and are either white, buff or cream colored. Experience has shown that on white drawing paper, a 5–H pencil makes lines of sufficient weight, on the buff color a 4-H should be used, and on the deeper shades a 3–H is desirable. Since a much greater pressure can be secured in making lines with a lead pencil than with a pencil compass, the lead in the compass should always be one degree softer than the pencil. If this method is followed, all drawings will have good black lines, which will lessen the strain on the eyes, especially when making tracings.

Another means of relieving eye-strain is to make the light and shade lines thicker. The day of elaborate drawings for shop use has passed. Plainness and simplicity in drawings is both required and appreciated by workmen. It is better to use a drawing pencil having too blunt a point and make thick lines, than to use one filed down to a point like a needle. In making tracings, plenty of ink should be used. The lines that were formerly made for shade lines should now be the light lines, and the shade lines should be made just double the thickness. The lettering and figures on the drawing should be made with a coarse pen, and at least 5/16 inch high and 3/16 inch wide. Blueprints taken from such tracings are far more useful in the shop than many of the ones with sight destroying hair-lines, dwarfed letters and figures, and feeble looking arrow-heads that are now in use. All this may seem a radical change from the present method, but its general adoption would be a change in the right direction, as it would enable those with dimmed eyesight to read drawings more easily and prevent damage to the sight of those whose eyes are still good. JAMES E. COOLEY

Hartford, Conn.

PRICE SHEETS FOR SALESMEN

On page 235 of the November issue, engineering edition, attention is called to the loose-leaf price books that are now generally used by machinery salesmen. We have been sending out our price lists in this form for the past six years, the size of the sheet being 7¼ by 4 inches, suitable for the Morden No. 6 loose-leaf binder. All information which we issue for



Points of Superiority on
Cincinnati Boring Mills

Table	Extra deep Table. Extra large track diameter. Table Track oiled by Automatic rollers. Table driven by internal gear and pinion. Large adjustable main spindle bearing under table. Self-adjustable step bearing.
Bed	Oil pockets filled and drained from outside of Bed. Bed reinforced by heavy I beam ribs. Bed bored out and bushed for all revolving parts.
Feed Boxes	Enclosed feed boxes with direct reading feeds in full view of operator at all times. Self-locking tumbler type Gear changes.
Rapid Power Traverse	Rapid power traverse in all directions. Rapid power traverse controlled from rail or feed boxes. Sensitive adjustments within easy reach of operator. Crank handle cannot be engaged when rapid power traverse is used.
Rail	Rail clamped inside and outside of housing face. Long, narrow guide saddle to rail. Handy location for swivel to heads. Heads have bronze taper gibs.
Housing	Box type construction. Bolted together at back with X braces.
Drive	Drive mounted between housings, reducing floor space.

November 1, 1912

Morden Price List Sheet with Reinforced Holes

the use of salesmen, such as dimensions, talking points, motor information, etc., is printed on sheets of this size, and we have just adopted a scheme of reinforcing the holes as shown by the sample sheets enclosed. These price lists are referred to constantly by the salesmen, and unless some provision of this kind is made, the holes are soon torn through and new sheets must be supplied.

Cincinnati, Ohio CINCINNATI PLANER CO.

REFITTING A WORN STRAP ON AN ENGINE CONNECTING-ROD

The writer read with considerable interest an account in the August number of MACHINERY of how a number of rings that had been bored out too large were saved by shrinking and reboring them. This recalled to his mind a job of a somewhat similar nature which he saw done while an apprentice. A large engine was being repaired and generally overhauled. The strap for the connecting-rod required re-

fitting, but instead of making an entirely new strap, the old one was heated to a red heat across the end and immersed in cold water for about one-half the thickness of the stock; thus the outside portion contracted and compressed the inner portion in a manner similar to that explained in the article referred to. This method might be used to advantage in many cases, if it were better known.

Los Angeles, Cal. JOHN A. WOOD

EFFICIENCY OF WORM GEARING

We have read with much interest the article published in the September issue of MACHINERY entitled "Efficiency of Worm Gearing for Automobile Transmission." We have made a large number of tests on worm gearing in these works and our results do not confirm the results given in the article in question. We should be glad, therefore, to have certain points explained. The general trend of the tests given in Tables I to V shows that the efficiency decreases with decreasing load, which is entirely opposite to our results.

It appears to us that the loss in friction is proportional to the working pressure between the teeth, and, therefore, when the working pressure is less, the loss in friction is less. However, in Table III, "Second Speed" test, the loss at 36.95 H. P. is 0.84 H. P., and at 19.12 H. P., 1.14 H. P.; also, in the same table on the "Direct Speed" the loss at 49.35 H. P. is 1.21 H. P., and at 30.73 H. P., 1.89 H. P. We cannot see how these figures—and there are several similar cases in the other tables—can be substantiated.

We also note that later in the article appears the following remark: "The higher loads indicated were abnormal for the gears under consideration, and would not occur in any use to which the gears would normally be put." A consideration of the tables shows that as the highest efficiencies are always obtained at these abnormal loads the gear should surely be taken to be correctly rated for these loads, and a *smaller* and (according to these results) *more efficient* gear should be designed for the *normal* working load required. It also appears from the tables that if the load were still further increased, an efficiency of 100 per cent might readily be obtained.

In conclusion, we may say that our experience gives the following general results, *viz:* that the efficiency of a correctly designed gear increases considerably under light load and decreases under overload, and that the temperature rise of the oil is an exact measure of power loss in the gear.

Manchester, England. HENRY WALLWORK & CO., LTD.

I have read with much interest the comments made by Henry Wallwork & Co., Ltd., Manchester, England. In drawing the efficiency curves in Fig. 11 (September number) no attempt was made to smooth out the curves and so eliminate any inconsistencies which appeared. In the very nature of things it is impossible to obtain absolute accuracy in results where it is necessary to measure small differences of power, as in this case, especially when the speed of the instrument measuring input varies from that of the one measuring output.

I note that Henry Wallwork & Co. questions the decrease of the efficiency with decreasing load, and that their tests show entirely opposite results. It is certain that the friction of the gears does not vary directly with the tooth pressure. In other words, in wide variations of tooth pressure the friction does not vary widely. This being the case, the efficiency must increase with the load. Take an extreme case as an example: Assume that the friction does not vary at all, and is, in a given case, let us say, one horsepower. If, under these conditions the gear transmits two horsepower the efficiency would be 50 per cent. If the same gear transmitted 100 horsepower the efficiency would be 99 per cent. Of course, this is not intended to apply to any actual gear system, but is merely mentioned to illustrate the point that, in general, it should be expected that the efficiency would increase with the load until the breaking down point of the gear surface is reached.

In reference to the statement that the loads indicated were abnormal for the gears under consideration, this statement merely refers to the load to which the gears will be subjected when placed in an automobile transmission. It would be perfectly proper and normal to transmit the higher loads by means of these gears, but they are certainly in excess of what would occur in an automobile.

Providence, R. I. WILLIAM H. KENERSON

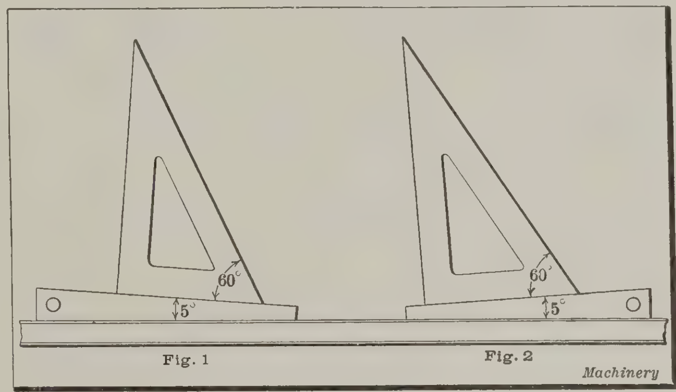
"DEVICE FOR DRAWING DOTTED LINES"

On page 215 of the November, 1912, issue of MACHINERY, engineering edition, I note an article entitled "Device for Drawing Dotted Lines." As the device referred to in said article is the subject of a patent granted to the writer (965,-945, dated August 2, 1910) please print this notice in the December issue to inform your readers accordingly, so that they may avoid infringement thereof. It is the intention of the writer, who is a patent attorney, to prosecute any form of infringement of said patent to the fullest extent.

13-21 Park Row, New York BENJAMIN ROMAN

SUPPLEMENTARY ANGLE FOR DRAFTSMEN

The supplementary angle shown beneath the triangles in the accompanying illustration consists of a piece of celluloid with two of its sides or edges at an angle of five degrees to each other. With one of these angles, and the regular 45 or 30—60-degree triangles, all angles at intervals of five degrees from 0 to 360 degrees can be drawn. Fig. 1 shows the 60-degree angle combined with a 5-degree angle in such a way as to make it possible to draw an angle of 65 degrees. In



Method of using the Supplementary Five-degree Angle

Fig. 2 the 5-degree angle is reversed, making it possible to draw an angle of 55 degrees. DRAFTING ROOM

[A device of a somewhat similar nature has been invented and patented by James Dangerfield, and was described in the August, 1903, number of MACHINERY. The difference between the device here mentioned and that of Mr. Dangerfield's is that the latter consists of a set of ten angles from 1 to 10 degrees. This makes it possible to obtain accurately every whole-degree angle from 0 to 360 degrees. Sets are also made with two additional ¼- and ½-degree angles, making them practically as universal as the regular draftsman's protractor. —EDITOR.]

DRILLING HOLES IN GLASS

Occasionally we are called upon to do small jobs of drilling holes in glass. The common method known to the writer is a long and tedious process, *viz:* placing a short piece of brass tubing the diameter of the hole desired in the drill chuck and grinding the hole through the glass with powdered emery and oil. A more effective and simpler way is to take a rat-tail file about the size of the hole to be drilled and break it at about the middle so that while drilling it will not wedge the hole. Place the tang end of the file in the drill press chuck and run at high speed. Place the glass under the rapidly revolving file and let the file come gently in contact with the glass by moving the handle up and down. For a lubricant use turpentine. In this way holes are drilled in one-fourth the time required by the old method.

Chicago, Ill. O. M. HANCE

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

ACTION OF BELTS WHEN THE SHAFTS ARE OUT OF PARALLEL

The answer in the October number to the inquiry regarding the action of belts on pulleys is correct in part only. The crowning of the pulley faces causes the belt to run to the "high side," that is, crowd to the center where the diameters are largest, as you state. But when the shafts are out of parallel the belt runs to the "low side," and if the shafts are badly out, the belt will run off from the low side. In other words, a high side made with a "monkeywrench" (shafts out of parallel) does not act like a crowned face. I have had many years' experience with pulleys and belts and have never known them to act in the contrary way, as described in your answer.

Amherst, Nova Scotia B. G. Cox

DIES FOR NAIL-MAKING MACHINERY

G. W. E.—I would like to obtain information on the making and tempering of dies used in nail-making machinery. At present we have to anneal, redress and temper the dies whenever they become worn, having for this purpose a gas stove with pyrometer for hardening and an oil bath with thermometers for tempering. We feel, however, that our practice is defective in comparison with that of some American firms, who we believe, regrind the cutters several times without drawing the temper. We have tried grinding the vees inside to about a fifty-degree angle, but encountered the difficulty that carborundum wheels will not keep the necessary sharp edge. Apparently it would be necessary to use a steel disk studded with diamond dust to secure the desired result by grinding.

A.—The subject is of sufficient importance to make a full reply from any reader having had general experience on the maintenance of nail-making machinery, of general interest. We will be glad to receive contributions on the subject.

STRAIGHT FACE VS. CROWN FACE IDLER PULLEYS

W. M. F.—Are idler pulleys which run on the outside of opposite side of the belts on transmission pulleys usually made with straight or crown face—and why?

A.—Practice differs. The H. W. Caldwell & Son Co. furnishes straight face pulleys for idlers. The reason given is that the driving and driven pulleys having crown faces, of course, the belt is kept in the center of these pulleys by the crowning. If the intermediate idler pulleys are also made with a crown face, and if the crown is not exactly in line with the crown of the driving and driven pulleys, there will be an objectionable moving back and forth of the belt. The Dodge Mfg. Co. makes idler pulleys both crown and straight face, depending upon the condition, but the greater part of its product is made with the crown face, and crown face pulleys are furnished when not otherwise specified. The reason given for preferring the crown face idler pulley is that it is often necessary to "lead" the belt slightly and a crown face idler assists in doing this. No objection, however, is offered to the straight face idler, and either type is furnished when specified.

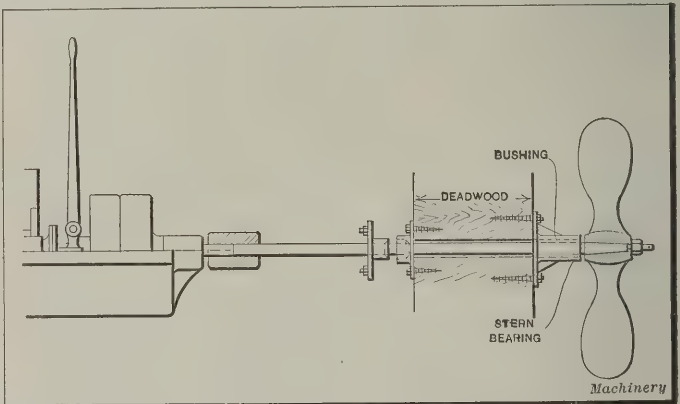
TOOLING FOR INTERCHANGEABLE MANUFACTURE

A. L. B. Co.—The question has arisen in our factory as to whether or not it is necessary to build a model machine to construct the tools, jigs and fixtures for same, provided the machine is known to be practically correct from a manufacturing standpoint, but not mathematically correct in all its parts. The machines were originally built without drawings and little by little were improved until we have a practically standard machine. About two years ago one was disassembled and drawings of the parts made, no assembly of the machine having been made or any methods used to check the accuracy of the parts. We attempted to use these drawings in conjunction with parts of the machine in making jigs and fixtures, but found that it was not feasible to proceed in this manner because of variations in dimensions of parts. The question is, how should we proceed? Do you think it necessary to build a sample machine first to check the drawings for accuracy and then make the tools and jigs to manufacture the parts?

A.—The exact procedure in tooling for manufacturing is something on which probably there would be no general agreement among toolmakers and manufacturing experts who were given the problem to solve. It would depend very largely on the type of machine, size of parts and the degree of accuracy required. In general, we would say that the handmade machine should be disassembled and accurate drawings made of every part. No changes whatever should be made in dimensions or shapes except in those parts immaterial to the working of the machine. Having made the drawings, jigs should be made for each part using the part to get the shape, distance between holes, etc. Where great accuracy of related parts is required, and trouble in the functioning of the machine is anticipated, the jigs for the parts should be made simultaneously, and changes made if required to secure closer adjustments. Having proved the dimensions and shapes of these parts satisfactory, the drawings should be changed and corrected when necessary to agree. The work should be laid out so that the machine can be assembled, and each part checked by the pieces produced in the jigs. When the work has proceeded to the finished stage, a complete manufactured machine will have been produced from the jigs, each jig having been proved as the work proceeded. It cannot be said that this procedure would invariably result in an absolutely perfect machine, but the probabilities are that the change required would be of an insignificant character, not expensive to make. Suggestions from readers who have had experience in tooling for interchangeable manufacturing are invited.

HOW TO FIX A BUSHING ON A PROPELLER SHAFT

S. H. S.—Will you kindly advise me if there are any effective methods of fixing bushings on propeller shafts where they bear in the stern bearing of a boat? The illustration shows the manner of installation. The shafts are tobin bronze and the bushings are bronze, being from ¼ inch to ⅜ inch thick, 8 inches long on a 2½-inch diameter shaft. I have shrunk and pinned the bushings on and have sweated them on, but they all work loose sooner or later. The bushings run in lignum vitæ lined bearings or bronze bearings.



The reason I have deduced for the peculiar loosening up of the bushings is that, being under water, more or less sand and dirt get into the stern bearing and quickly wear it so as to let the shaft pound or hammer, which causes the bushing to stretch and loosen on the shaft. The harder and thicker the bushings are made, the longer they last, but all of them loosen if used long enough.

A.—The oxy-acetylene process might be used to secure a sectional bushing which could be applied as a series of narrow rings and successively welded to the shaft. This method is slow and rather expensive and perhaps the readers can suggest simpler and more effective methods.

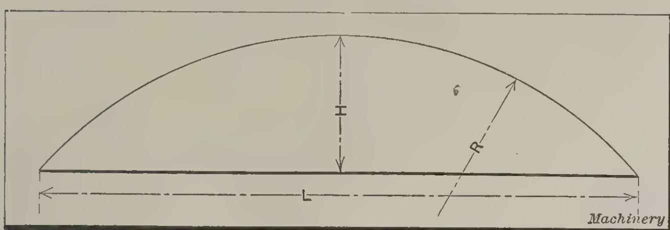
TO FIND RADIUS OF ARC WHEN LENGTH OF CHORD AND HEIGHT OF ARC ARE GIVEN

J. E. H.—Kindly give me a formula for finding the radius of a circular arc when the length of the chord and the height of the arc or segment of the circle are given, as indicated in the accompanying illustration.

A.—A formula for obtaining the radius of a segment, when the data mentioned above are given, was published in MACHINERY in November, 1906; this formula may also be found in the engineering handbooks. If L is the length of the chord; H the height of the arc; and R the radius to be found, then:

$$R = \frac{\frac{(\frac{1}{2} L)^2}{H} + H}{2}$$

This formula looks rather cumbersome and could be some-



what simplified so as to take the form:

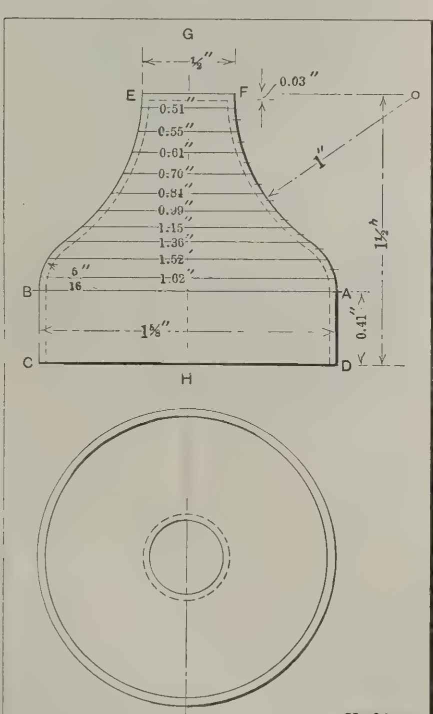
$$R = \frac{(\frac{1}{2} L)^2 + H^2}{2H}$$

The second form of the formula, however, requires more numerical calculation than does the first, which, therefore, is preferable.

TO FIND THE AREA OF A SURFACE OF REVOLUTION

R. B. H.—I would like to see a formula published for finding the outside area of sheet metal cups. An example of the kind of cups referred to is shown in the accompanying illustration.

A.—No general formula can be given for obtaining the area of a symmetrical body of the form shown in the illustration. However, the approximate area can be found by a comparatively simple method. In the illustration, the dimensions written in common fractions are the given dimensions. Those written in decimals are found by actual measurement on a figure drawn to scale. The method of finding the area is as follows: First separate such areas as are cylindrical, conical or spherical, as these can be found directly by exact formulas found in all engineering handbooks. In the example shown, $ABCD$ is a cylinder, the area of the surface of which can be easily found. The top area EF is simply a circular area, and can thus be computed separately. The remainder of the surface generated by rotating line AF about the axis GH is found by the approximate method to be explained. From point A, set off equal distances on line AF. In the present case each division indicated is ⅛ inch long. From the central or middle point of each of these parts draw a line at right angles to the axis of rotation GH, measure the length of these lines or diameters (the length of each is given in decimals), add all these lengths together and multiply the sum by the length of one division set off on line AF (in this case, ⅛ inch), and multiply this product by π. This gives the approximate area of the surface of revolution.



In setting off divisions ⅛ inch long along line AF, the last division does not reach exactly to point F, but only to a point 0.03 inch below it. The part 0.03 inch high at the top of the cup can be considered as a cylinder of ½ inch diameter and 0.03 inch height, the area of the cylindrical surface of which is easily computed. By adding the various surfaces together we get the total surface of the cup as below:

Cylinder, 1⅝ inch diameter, 0.41 inch high,	2.093 square inches
Circle, ½ inch diameter,	0.196 square inches
Cylinder, ½ inch diameter, 0.03 inch high,	0.047 square inches
Irregular surface,	3.868 square inches
Total,	6.204 square inches

The method used in finding the area of the irregular shaped part of the cup is based on the Pappus or Guldinus rule, which states that the area of a surface generated by the revolution of a line about a central axis equals the length of the line, multiplied by the path of its center of gravity, the line being considered as a fine wire. As it is a matter of considerable difficulty to find the center of gravity of an irregularly curved wire, the simplest way in which this method can be applied is to divide the irregular shaped line into a number of parts, each one of which can be considered as a straight line, having its center of gravity at the middle of the line. In this way we find the area of each one of the divisions by multiplying the length of the division by the circumference of the circle which passes through its center of gravity. As all the divisions, in our case, were made of equal length, the simplest method was to add the lengths of all the diameters of these circles together, and then multiply by π and by the length of each division, ⅛ inch.

In testing out the accuracy of this method, the surface of a half-sphere 6 inches in diameter was found by dividing a great circle into parts ¼ inch long and finding the area by this graphical method. The exact area of this half-sphere is 56.55 square inches. The graphical method, using only an ordinary draftsman's scale, compass and triangle, gave an area of 55.28 square inches, which may be considered fairly accurate for an approximate method. The half-sphere was selected for the test case because it presents one of the difficult shapes for the application of this method, as the curved outline merges from a vertical into a horizontal direction; the surface being convex throughout, the errors are also likely to be all in one direction. A more accurate result may be expected when part of the surface is convex and part concave.

* * *

NEW ALUMINUM REDUCTION PLANT

The General Electric Co., Schenectady, N. Y., is building seven vertical water wheel type direct-current electric generators for the new plant of the Southern Aluminum Co., at Whitney, N. C. Each machine will have a rating of 5000 K. W., delivering 20,000 amperes at 250 volts at a speed of 170 R. P. M. They will be the largest direct-current machines built. Two similar direct-current generators of the same type rated at 2500 K. W. and two 1250 K. V. A. alternators will be also installed. The Southern Aluminum Co. is capitalized at $8,000,000 and will become an important factor in the production of aluminum. The plant will be in operation about the middle of 1914, and will rank among the greatest and best equipped for the manufacture of aluminum in the United States. In the complement of buildings are nine furnace rooms, wherein the aluminum will undergo the various processes incident to conversion into aluminum. Each of these structures measures 60 by 500 feet and one electrode factory of similar dimensions is also included in the group. Aluminum, because of its lightness and toughness, is becoming of more and more importance in many lines of industry. Aluminum wire and cable are displacing copper for the transmission of high tension electric energy. It is made from a clay known as bauxite, found extensively in Georgia and the Middle West. The Southern Aluminum Co. will treat only alumina which has been made from bauxite. The engineering work is in charge of Dr. Paul Heroult, a prominent French engineer.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

AMERICAN HIGH-SPEED SENSITIVE RADIAL DRILL

The American Tool Works Co., Cincinnati, Ohio, has added to its line the high-speed sensitive radial drill illustrated herewith. This machine is designed for drilling and tapping small holes at high speed. It is said to combine the high-speed efficiency of the plain sensitive drill with the productive capacity of the radial drill. Convenience in operating a machine of this type is an essential feature, as the actual time consumed in drilling a hole is often very small as compared with the time which elapses before the machine is set to drill the next hole. The importance of this consideration has been kept in mind in designing the present machine, and all levers and other operating members have been conveniently located for the workman, in order to simplify the operation of the machine as much as possible.

The feed lever is located on the head within easy reach of the workman's right hand, affording a convenient means of operation and obviating any possibility of interference with the work set up on the table. Another advantage of the ratchet lever feed used on the American sensitive radial drill lies in the fact that the lever is automatically disengaged from the rack pinion shaft when it is placed in its vertical position, so that the spindle can be quickly adjusted up and down by means of a small star knob on the end of the rack pinion shaft. This affords a rapid and convenient method of bringing the drill to and from the work.

The head is accurately balanced and can be moved rapidly along the arm by means of a rack and pinion operated by a handwheel. This handwheel is located on the front of the head on the operator's left-hand side, enabling him to swing the arm with his right hand and at the same time adjust the head along the arm with his left hand. The arm binding lever is located on the column end of the arm, where it is always within easy reach of the operator. The head is of very simple design, consisting of a main saddle which has a bearing on the arm and carries an auxiliary head upon a vertical dovetail. The sliding head is so arranged that it can be moved to or from the table, thus affording accommodation for quite a wide range of work. The auxiliary head can be securely clamped at any point along the dovetail by means of a lever conveniently located on the front of the saddle, while the head proper can be firmly bound to the arm by a lever on the back of the saddle which is within easy reach of the operator when he stands at the front of the machine.

In the elevating table type of machine shown in Fig. 1, the table is of semi-box construction, affording a large working surface. It has a bearing of ample width on the face of the column which insures a high degree of rigidity, and is equipped with a gib adjustment and two binders for locking it securely in position. The vertical movement of the table is accomplished from the front by means of a crank which imparts motion to the elevating screw through a pair of miter gears located under the table. The arm is of the American parabolic beam and tube section which has proved itself to be exceptionally rigid on the larger sizes of radial drills. Its construction is such that the lower line is parallel with the table, thus enabling the full capacity of the drill to be utilized at any point along the arm. It swings easily on the column and may be securely clamped in any position by means of a convenient binding lever. The arm does not move vertically; therefore provision is made on the head for variable heights of work.

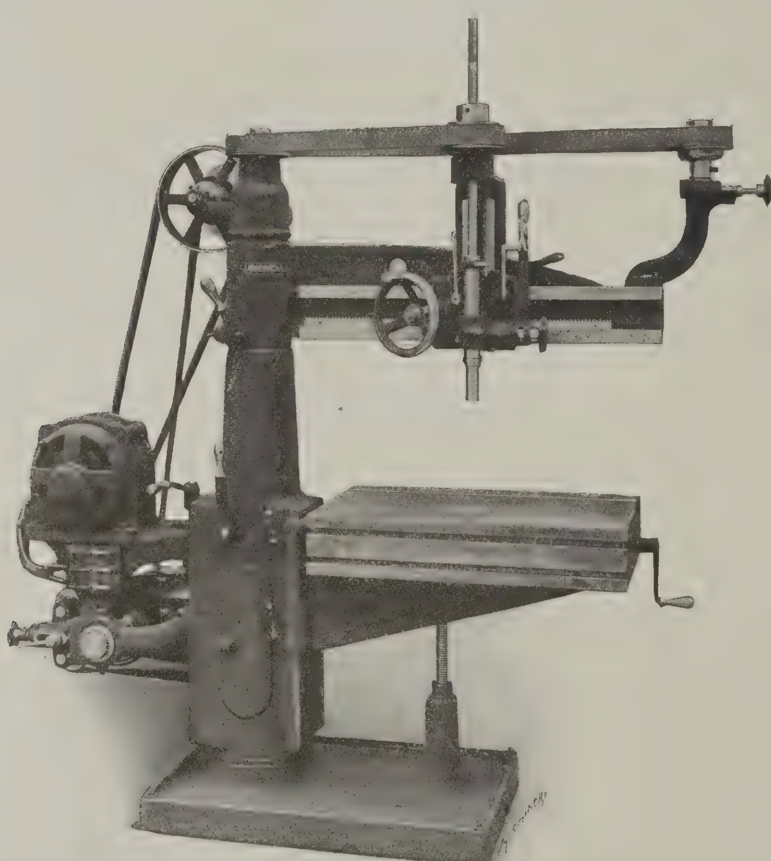


Fig. 1. Motor-driven Radial Drill equipped with Elevating Table and Tapping Attachment

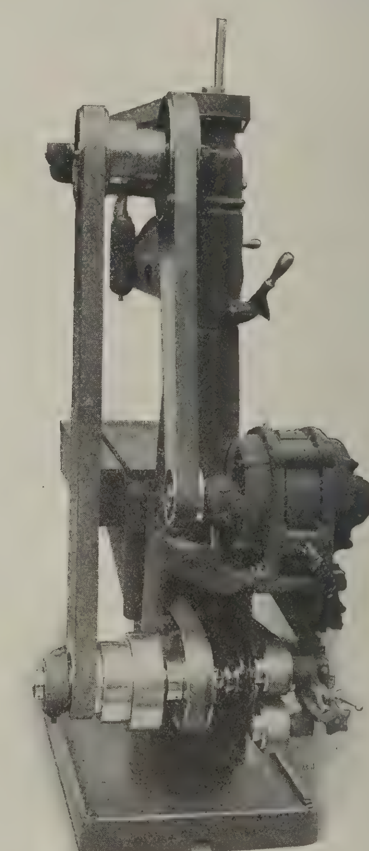


Fig. 2. Arrangement of the Drive

There are no gears in the driving mechanism of this drill from the countershaft to the main spindle, the drive being effected by means of a two-inch double belt running at high speed. This drive transmits an abundance of power directly to the spindle of the drill, the spindle belt being kept at the proper tension by turning the star knob located on the arm bracket. All of the driving and idler pulleys are equipped with special ball bearings which consist of a double set of hardened and ground ball races and cones; one set is located at each end of the pulley journals. These bearings are so

constructed that they are dustproof and form a retainer for the lubricant; vaseline or graphite is preferable for this purpose and need only be renewed at long intervals. The countershaft is especially designed for high-speed work and provides for two speeds. The hanger boxes are of an improved gravity and wick oiling type, taking their supply from large oil reservoirs and only needing attention at long intervals. The countershaft carries a three-step cone pulley with a pair of friction pulleys 10 inches in diameter and 3 inches face, and should run at 310 and 387 R. P. M.

This machine may be equipped with a tapping attachment, and with belt-driven machines so equipped a single-speed countershaft is furnished with six spindle speeds which are obtained through a three-step cone pulley and a pair of friction pulleys of different diameters located on the rear of the machine.

The spindle is of high-carbon crucible steel, accurately ground and provided with a dustproof self-lubricating ball thrust bearing. It has six changes of speed ranging from 300 to 900 R. P. M. in geometric progression, and is provided on the top with an adjustable stop-collar which may be used as a depth gage. The column is of tubular section, ribbed internally to provide the necessary rigidity. In addition to the type of machine illustrated, this radial drill is built with a stationary table, or with a pedestal base which makes it especially suited for large sizes of work. The regular equipment includes a countershaft and belts, no wrenches being required. All of the motor-driven machines are regularly equipped with a tapping attachment.

BILLINGS & SPENCER SAFETY LATHE DOG

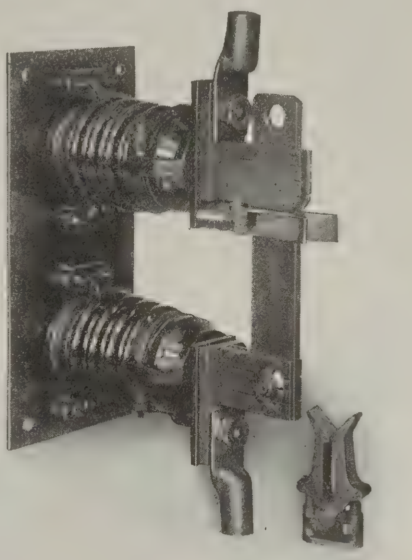
The safety lathe dog illustrated herewith is the product of the Billings & Spencer Co., Hartford, Conn. This form of dog embodies the simplicity, strength and convenience of the ordinary dog with the additional advantage of safety. The essential parts are the same as the design which is universally used, including the regular square head, so that no special tool is required for adjustment. The guard consists of a cover for the screw which is easily manipulated, being merely pushed to one side when it is required to uncover the screw head. The guard is then sprung back into position forming perfect protection for the operator. This dog has been thoroughly tested in the manufacturers' shops and has proved efficient under all conditions.

Billings & Spencer Safety Lathe Dog

LOCKING DEVICE FOR ELECTRIC SWITCHES

The locking device for electric switches here illustrated has recently been developed by the General Electric Co., Schenectady, N. Y., to eliminate the delays which are frequently caused by having machinery shut down through interruption of the power service. This device prevents the blade of a disconnecting switch from opening except where it is intentionally pulled by the operator. Instances are on record where the blades of a disconnecting switch, not protected by this device, have been thrown open or partially open by magnetic repulsion and destroyed when a short circuit has occurred on the line. In such a case, the destruction of the switch means that the circuit will be put out of commission while a new switch is being installed, unless there are duplicate circuits.

This safety locking device is a unit in itself and can be easily applied to any G. E. type L, Form G6 switch by merely clamping it to a support placed between the clip block and the insulator cap. It is designed to be operated with a switch hook and consists essentially of two brass bell cranks, hinged together at the ends of two shorter arms and held closed by compression springs. The projections or jaws in the outer ends of the two longer arms close in front of the blade, thus preventing the latter from coming out of the clips. Each bell crank is provided with a dog which moves in a slot in the bell crank elbow, the dog being hinged at this point. Two compression springs, one pressing outward from the switch base against the elbow of each crank and also against the dog, keep the bell cranks closed and the dogs pressed against the back of the switch blades.



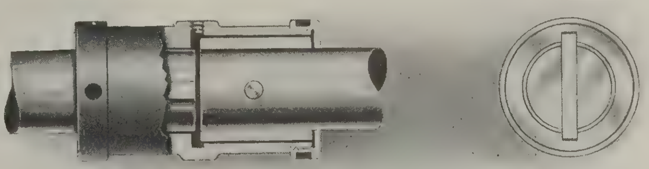
Locking Device to prevent Electric Switches from being accidentally opened

To open the switch, the outer ends of the bell crank are pressed back away from the blades, allowing the dogs to come forward and rest upon the sides of the blades; in this position they hold the jaws apart in front of the blade and allow the switch to be opened. Withdrawing the blade of the switch from between the dogs causes the jaws to automatically close against the sides of the blades and to snap shut as soon as the blade is completely withdrawn. As the outer edges of the jaws are beveled, the switch blade can be readily pressed back to the closed position between the clips, when the jaws close automatically in front of the blade, locking the latter in the closed position. The operator cannot forget to lock the switch closed because it automatically locks itself. This device is made in standard sizes to fit 300, 600, 800 and 1200 ampere switches, and can also be furnished for a switch of any other capacity.

MC EWEN IMPROVED STEEL COUPLING

A new form of flexible coupling, constructed entirely of crucible steel, has recently been introduced by McEwen Bros., Wellsville, N. Y. It is known as the McEwen coupling, and being small and consequently light in weight, it is particularly suited for classes of service in which it is necessary to reduce inertia as far as possible.

The keys extend right through the shafts and are set at right angles; provision is made to take care of a reasonable amount of non-alignment, but the ample key bearing surface and exceptionally good lubrication does away with any noise or tendency towards serious wear. This type of coupling was first used on McEwen Bros.' pumps, direct-connected to steam turbines, where it was kept in continuous service for several months at a time. The ability of the coupling to stand up under such a severe test appears to demonstrate its fitness for a variety of classes of service; such as reversible motor drive for machine tools, blowers, rotary pumps, and a variety



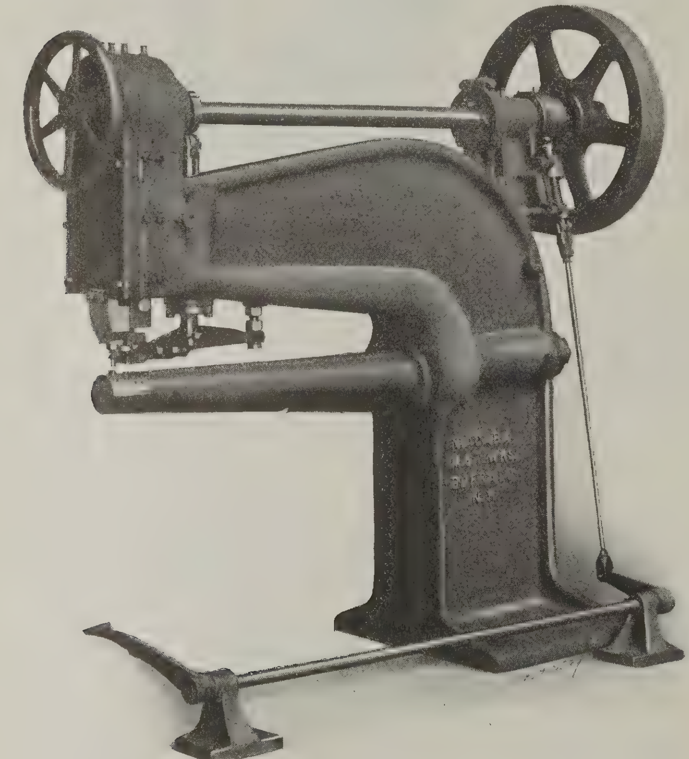
McEwen Improved Steel Coupling

of other cases where high speeds make the conditions of service particularly trying.

NIAGARA PUNCHING AND RIVETING PRESS

The Niagara Machine & Tool Works, Buffalo, N. Y., has recently added to its line the punching and riveting press illustrated below. This machine is designed to handle punching and riveting work in the manufacture of pipe, culverts, etc. Two thicknesses of material are punched and, at the same time, a rivet put in the hole punched on the previous stroke is headed, the rivet being inserted with the head upward. This method of combining riveting and punching in one operation, saves time, but is only applicable when the rivets are uniformly spaced. The distance between rivets can be varied from 1 5/16 to 2 3/4 inches.

The rivet header and punch are mounted in adjustable holders fastened to separate slides; these slides are actuated



Niagara Punching and Riveting Press

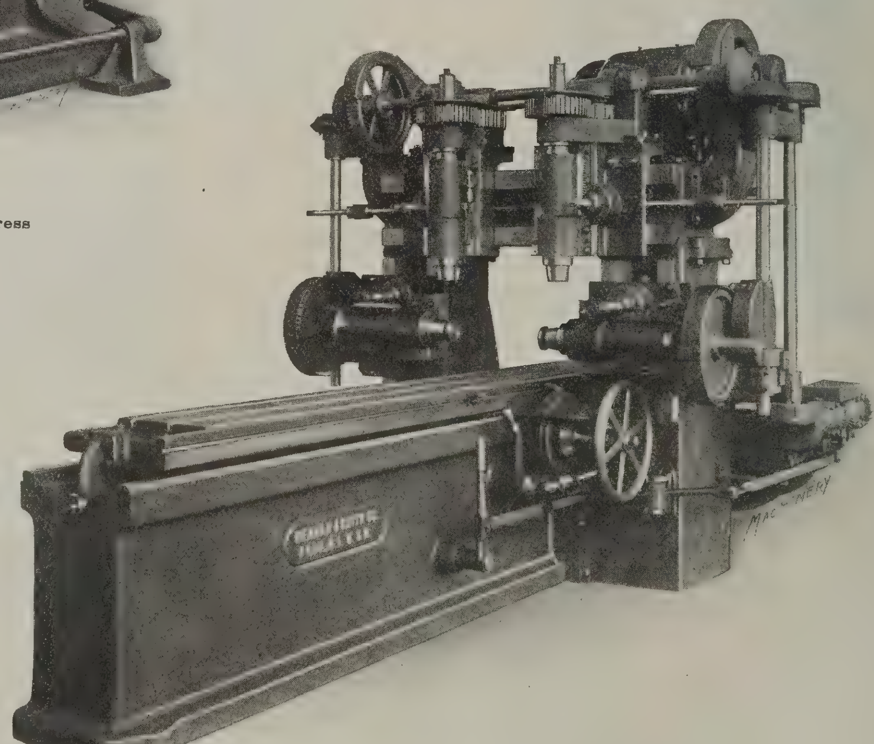
by two eccentrics and pitmans from the main shaft. It is also possible to use this machine entirely for punching holes or for riveting, or it may be used for punching and riveting alternately. When it is desired to use the machine entirely for riveting, the operator can quickly put the punch out of operation by means of a gag. When it is desired to punch without riveting, the rivet punch will run idle. The stripper or hold-down, which is actuated by a cam, clinches the material while it is being operated upon, and then strips the stock from the punch on the up stroke. The press is provided with an automatic jaw clutch and the motion of the slides can be started either by means of a hand-lever or a foot treadle. When the lever and treadle are released, the slides stop automatically at the top of the upward stroke. The machine has a throat 36 inches deep and the horn is a steel forging 5 inches in diameter at the outer end and 7 inches in diameter at the inner end. The press will upset a rivet cold up to ¼ inch in diameter, and will punch a hole ⅜ inch in diameter through ¼-inch iron or its equivalent. The gross weight of the machine is about 3600 pounds.

BEAMAN & SMITH FOUR-SPINDLE MILLING MACHINE

The four-spindle milling machine illustrated herewith is a recent design built by the Beaman & Smith Co., Providence, R. I. Reference to the illustration will show that there are two horizontal and two vertical spindles, the former having a vertical movement on the uprights and the latter a horizontal movement on the cross-rail. The table has a working surface 17 inches wide by 10 feet long; it has three T-slots finished from the solid metal and two rows of holes for stop-pins. The movement of the table on the bed is 10 feet 9 inches, and it is provided with a power traverse of 10 feet per minute in either direction. The automatic stop and feeds are arranged to maintain the desired rate at any spindle speed, which is a very important feature, as the rate of feed determines the quantity of work produced. The table is operated by a screw revolving in a bronze nut, the thrust being taken by ball bearings. Positive feeds for the table are provided by means of a geared feed-box which is conveniently located, and the change from one rate to another can be quickly obtained. There are nine changes ranging from 1 inch to 12.3 inches per minute at a driving-shaft speed of 500 R. P. M.

The spindles are of crucible steel and run in boxes of hardened bronze. They have a 6-inch independent adjustment and the ends are tapered to 3¼ inches in diameter for face milling cutters; No. 12 Brown & Sharpe taper holes are provided for cutter shanks and arbors. Each spindle has a hole through its center for the retaining bolt. The front bearings are 3⅞ inches in diameter by 5 inches in length, and are provided with means to compensate for wear. The rear bearings are 2¾ inches in diameter by 4¾ inches in length. All of the spindles are driven in unison. The gearing for the vertical spindles has a ratio of 7¾ to 1 and gives a spindle speed of 66 R. P. M. For the horizontal spindles, the gearing ratio is 21¾ to 1 and gives a speed of 23 R. P. M.

The machine is driven by a variable speed, 10-horsepower motor, geared to the driving shaft in the ratio of 3 to 1; the motor speed ranges from 500 to 1500 R. P. M. This machine



Beaman & Smith Four-spindle Milling Machine

can also be arranged to be driven by a 5-inch belt on a three-section cone with steps ranging from 11½ to 16 inches in diameter. When belt driven, the countershaft has tight and loose pulleys 14 inches in diameter and runs at 360 R. P. M.

The construction of the machine is in accordance with the latest practice. The quick running shafts are mounted in

bronze lined boxes; the bearings are finished by grinding; all sliding surfaces are scraped to an accurate fit; all gears are cut from the solid, the bevel gears being made by the Bilgram process; and many of the gears are of steel. The distance between the uprights is 30 inches; and from the ends of the vertical spindles to the top of the table, the least distance is 9 inches and the greatest distance, 15 inches; the least distance between centers is 10⅝ inches and the greatest distance, 30 inches. From the center of the horizontal spindles to the center of the table, the least distance is 4 inches and the greatest distance, 10 inches; between the ends, the least distance is 6 inches and the greatest distance, 18 inches. The weight of the machine is approximately 20,000 pounds.

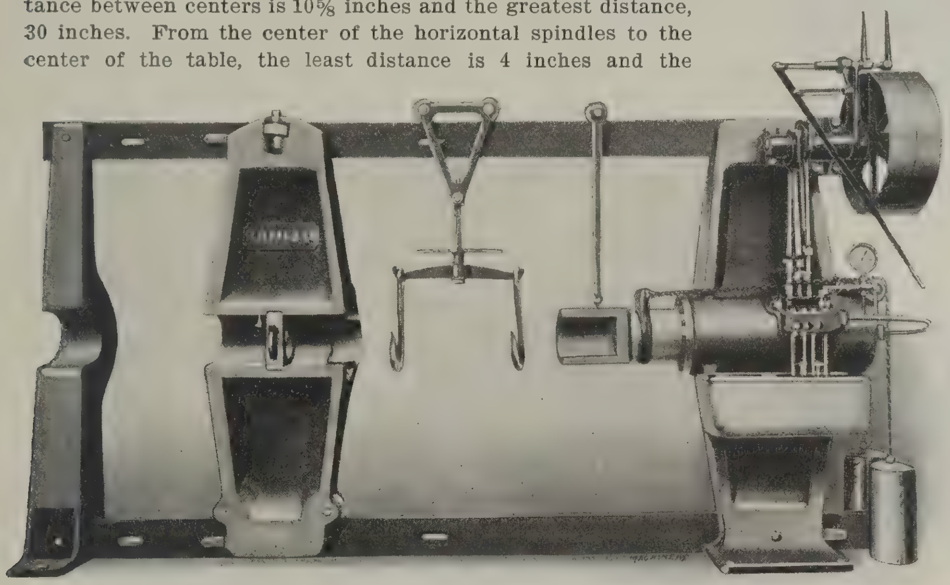


Fig. 1. Press for forcing Railway-car Wheels on and off Axles

THREE HYDRAULIC PRESSES

The Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio, has recently placed upon the market three hydraulic presses which are illustrated in Figs. 1, 2 and 3. The press shown in Fig. 1 is designed for forcing railway-car wheels on and off the axles, and delivers a firm steady pressure that will seat the wheel securely. Strength in all parts is obtained by the use of steel instead of iron or semi-steel. The steel cylinder is much lighter than when made of cheaper material, and is also far more dependable in service. Pressures up to 2500 pounds per square inch are available, and this is quite sufficient for the work done by this machine.

The ram has a long bearing in the cylinder which insures freedom from binding. As soon as the pressure is released, the ram is drawn back by weights and chains, and in order to enable it to withstand heavy pressure, the ram is faced with a hardened steel bearing. The resistance head is provided with a throat which serves the double purpose of a guide and stop. The parallel bars are slotted and provided with keys for shifting the resistance head to the right distance from the ram. This resistance head, in addition to the adjustable lifting hooks and hollow pressure block, shifts on the parallel bars by means of rollers. The press is operated by a motor drive or by a power attachment, with tight and loose pulleys for operating with a belt. It is equipped with from one to four pump plungers which can be arranged to drive the ram at any desired speed. The bronze pump flanges are driven by eccentrics and knockout attachments control the speed of the pump without stopping it.

The portable inverted press illustrated in Fig. 2 was built for the U. S. Government for forcing and general purposes; it is to be used at the Purdue University Experiment Station. One of its striking features is the unobstructed daylight space which makes it possible to place the press in contact with all sizes of machinery. By simply boring a hole in the platen, the press can be used for forcing wheels on and off shafts. The ram is returned by a rack and pinion which is placed back of the cylinder to be out of the way. The parts of the press taking stress are constructed of steel, the cylinder being made separate from the beam. The wheels have roller bearings which make the movement of the press from place to place an easy matter. The pump is small and compact, having a ⅝ inch piston with a 3½-inch stroke; the piston guide is made in one piece and serves the double purpose of guide and fulcrum for the pump handle. A safety valve in connection with the pump protects the frame against overload.

Fig. 3 illustrates a forming press which could also be applied to a variety of general classes of heavy work. The press is entirely above the floor line and can be easily installed. The speed of the ram in starting is increased by placing two pumps on the press. The platen, pressure head and strain rods are of steel, and are designed to withstand the great stress to which they are subjected in operation. A maximum stress of one hundred tons will seldom be exceeded in the general run of work, but a safety valve and pressure gage are provided to

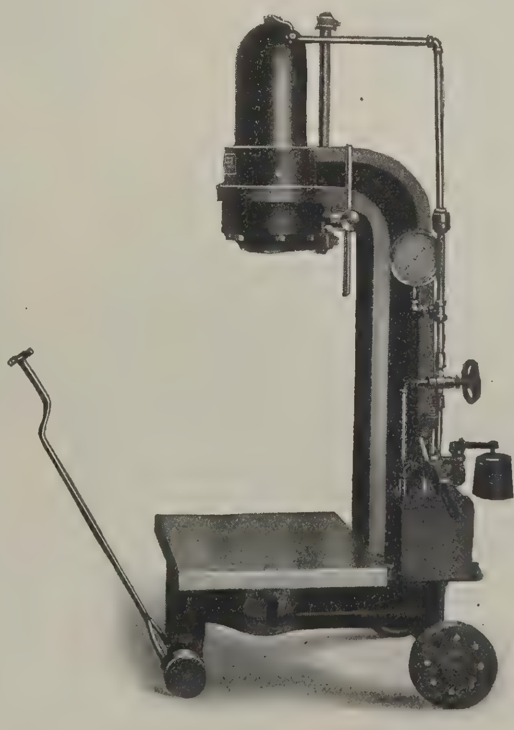


Fig. 2. Forcing Press built for Purdue University Experiment Station

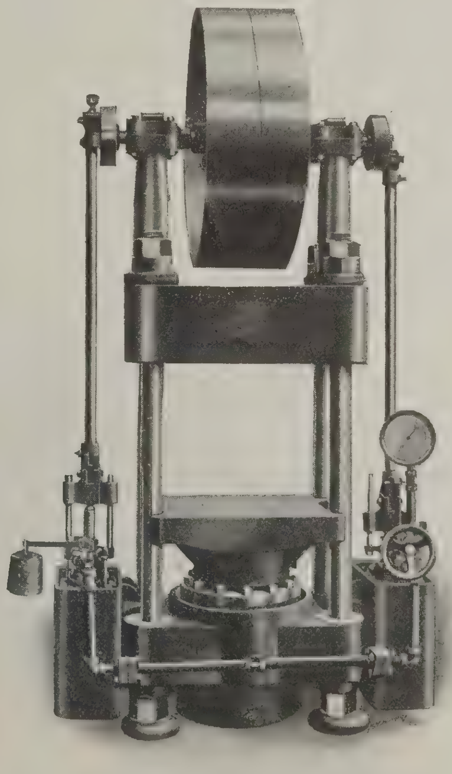


Fig. 3. Forming Press designed for Heavy Work

guard against overload. The power attachment is very simple and is located where it will not interfere with the operation of the press in any way.

EDGEMONT PLATE-TYPE FRICTION CLUTCH

The plate-type of friction clutch shown in Figs. 1 and 2 is an addition to the line of friction clutches manufactured by the Edgemont Machine Co., Dayton, Ohio. This friction clutch consists principally of three disks, enclosed in an outer casing provided with a hub on which the pulley or pulleys are held. (A two-piece sheet steel pulley is shown in place in Fig. 1). As shown in Fig. 2, the outer casing is provided with an internal rib, slotted to fit two keys formed on the "floating" disk which is faced on both sides with "burn-proof" brake lining. This central disk is free to "float," but cannot rotate independently of the outer casing.

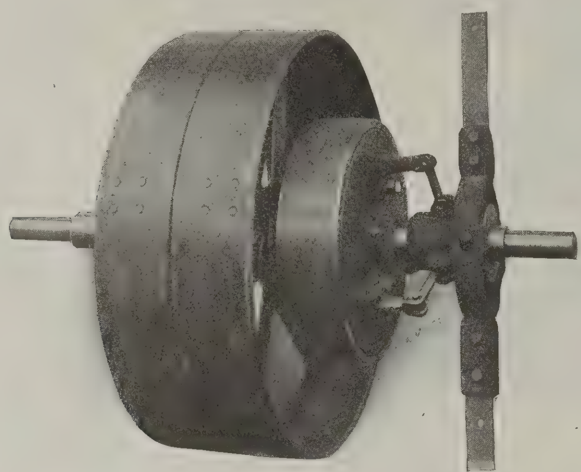


Fig. 1. Edgemont Friction Clutch with Pulley attached

The lever plate to the right (see Fig. 2), is provided with lugs, and is also furnished with a hub to which the plate to the left, is keyed, but is free to slide laterally when operated by the studs and levers shown. These two plates form the outer friction members of the clutch, and when brought into contact with the friction surfaces of the "floating" disk, rotate the outer casing and consequently the pulleys which are held on it. The lever plate which is held to the countershaft by a set-screw or key is drilled to receive three studs, provided with adjusting nuts, and held in the plate to the left. These studs are pulled out by the shoe ends of the levers. which are held in the lever plate and operated by the other three levers, sliding sleeve and shifter.

Now, when the shifter rod is forced to the left, it forces the sliding sleeve inward "expanding" the levers, and through the medium of the cam ends of the levers in the lever plate, pulls out the studs, drawing the plate in and exerting a friction between the three surfaces. Then as the lever plate is held to the countershaft, it follows that all the members of the friction clutch rotate when held together by the friction exerted between their surfaces. When the shifter rod is forced to the right, the action on the levers is just the reverse of that described, and as coil springs are interposed between the inner surfaces of the two outer plates, they are automatically separated when the studs are allowed to go back. The adjusting nuts on the studs are used to give the desired amount of friction required for driving.

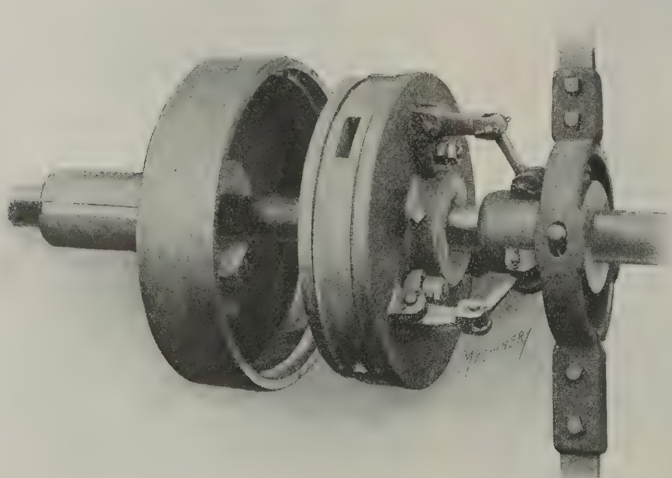
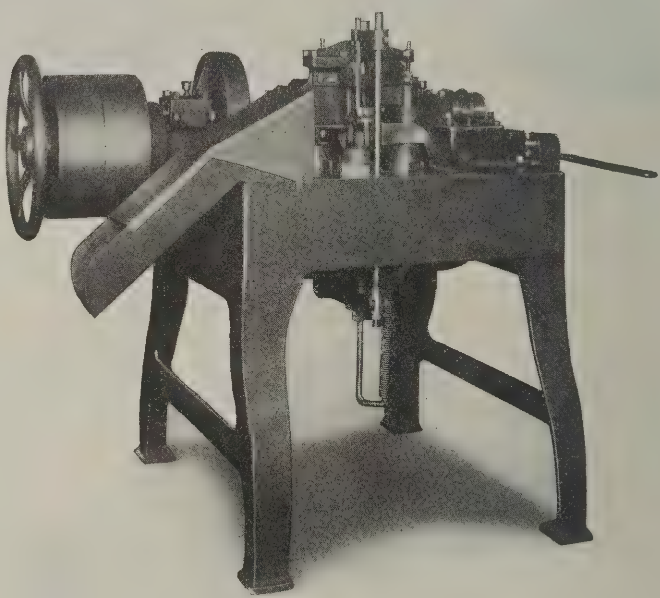


Fig. 2. Details of the Clutch Mechanism

One feature of this clutch, which is especially commendable, is that its friction plates do not require oiling. The friction lining can also be renewed without removing the clutch from the shaft. This clutch can be operated at high speeds, and is suitable for very heavy duty. It can be applied to line-shafting, countershafts, etc., and is furnished in either the extended sleeve type (shown in Fig. 2), or with the cut-off coupling; this type is used for connecting two line-shafts, and enables one section of the "line" to run while the other shaft is stationary, or when the clutch is "connected" both shafts can be rotated.

BLISS AUTOMATIC TRIMMING AND CURLING MACHINE

A special machine recently designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., for trimming and curling the flanges of drawn cups, is shown in the accompanying illustration. The machine consists of a vertical turret with six spindles, each of which is equipped with a chuck. The spindles are revolved continuously by spur gearing, and the turrets intermittently by a Geneva movement. The operator places a cup on the chuck as it appears in front of him; the chuck then moves in position for the trimming cutters. There are two rotary cutters which are mounted in a slide and driven by a chain and sprockets. The slide moves by cam action in toward the chuck and the flange on the cup is trimmed. The scrap is discharged through the machine.



Bliss Automatic Trimming and Curling Machine

The curling of the edge is done at the two succeeding positions. When the first of these positions is reached, the edge is started, and at the next position, it is finished. For all three positions, the blank is held onto the chuck by an upper spindle which descends and clamps the blank after it has been placed in position. The discharge of the blank is effected by means of two fingers. These fingers descend on the cup, gripping it at the edge and lifting it up until a third finger strikes it; this throws the cup in a horizontal direction into the discharge chute.

The machine is semi-automatic, as the operator simply places the cup on the chuck and the machine does the rest. The capacity is about 30,000 cups in ten hours, and it will take either straight, taper, or spherical shells up to 3 inches diameter by 1½ inch high.

BRADFORD HEAVY PATTERN LATHE

The Bradford Machine Tool Co., Cincinnati, Ohio, is building a new 18-inch heavy pattern, quick change gear lathe. One of the interesting features of this lathe (a general view of which is shown in Fig. 1) is the back-gear speed-changing mechanism. In previous designs, two friction clutches for engaging the medium and large back-gears, were placed directly on the back-gear sleeve. In this design, only one friction clutch is required, which has the advantage of engaging the higher speed of the cone, as well as giving two gear reductions for driving the lathe spindle when taking heavy cuts.

With the two-speed countershaft which is regularly furnished with the lathe, eighteen spindle speeds are available. The six fast speeds are obtained by locking the cone to the face gear and disengaging the back-gear in the usual manner. The method of obtaining the remaining twelve speeds will be more clearly understood by referring to the detail view of the headstock, Fig. 2. The cone pulley, by means of an expanding clutch ring in the left end, drives double cone gears with which the back-gears *A* and *B* are in driving connection. These latter gears afford two distinct drives for the lathe spindle, the drive being in each case through the clutch member *C*, the back-gear sleeve and pinion meshing with the regular face gear *G*. The clutch member *C* and the friction clutch member *D*, are engaged and moved simultaneously by the steel cross-piece *E*, which is caused to slide on a cylindrical

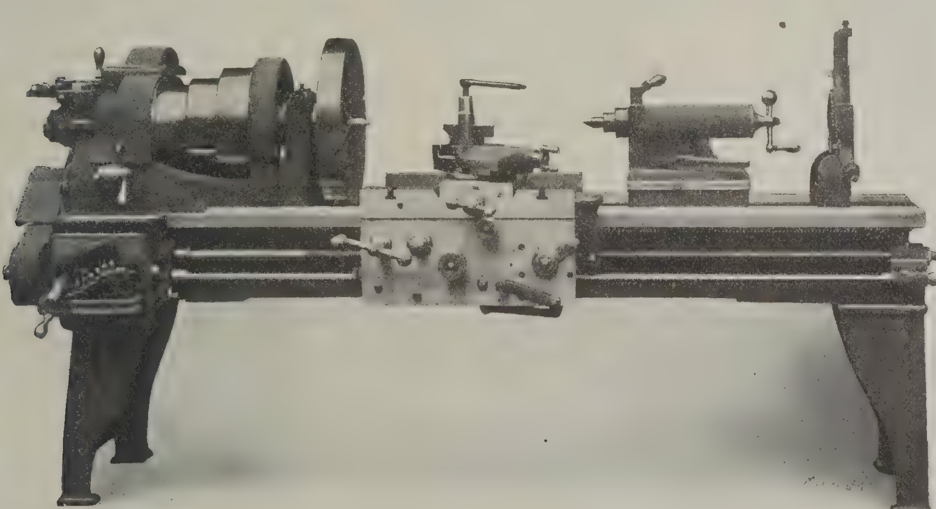


Fig. 1. Bradford 18-inch Lathe with Friction Double Back-gears

stud by handle *F*, and the connecting link shown. A movement to the right or left of clutch members *C* and *D*, causes the former to clutch first with either of the gears *A* or *B*, respectively, and, in both instances, the driving cone pulley is engaged in sequence by the friction clutch ring in the end of the pulley. The two back-gear speeds are available at all times without stopping the lathe. Lever *F* is provided with stop pins which prevent the action of this lever from subjecting any of the bearings or rotating parts of the lathe to end thrust.

Aside from the back-gear mechanism, this lathe is similar in its general construction to designs previously built by this company. The swing over the bed is 20¼ inches; over the rest, 11⅝ inches; and over the carriage, 13¼ inches. The size of the front spindle bearing is 3 1/4 by 5 1/16 inches, and the rear bearing, 2½ by 3¾ inches. The back-gear ratios are 10.95 to 1 and 3.31 to 1. The lathe will cut threads ranging from 3 to 46 per inch, including 11½ pipe threads. The spindle is made of high-carbon crucible steel and is mounted in adjustable taper bronze bearings. It extends through the hood,

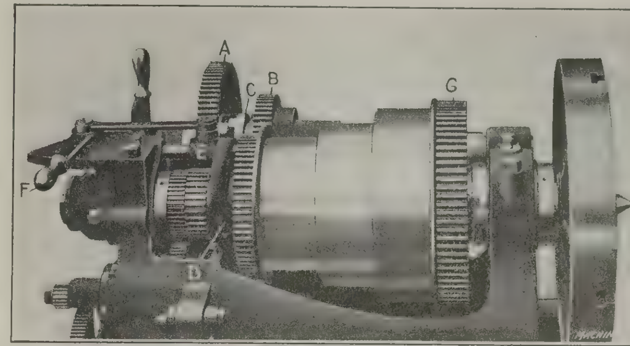


Fig. 2. Headstock of Bradford Lathe

allowing the use of draw bars and tubes for drawing attachments. The bed is of extra weight and depth and is webbed in two-foot sections, which gives great rigidity.

LA SALLE COMPENSATING QUADRANT CRANE

A one-ton "compensating quadrant crane" now being built by the La Salle Machine & Tool Co., La Salle, Ill., is shown in Figs. 1 and 2. This crane was designed for service on trucks and, at the present time, is made without a turntable; that is, the crane cannot be swung horizontally. A turntable, however, which will swing from 180 to 360 degrees, can be supplied. The lower end of the boom of this crane is segment shaped and has shrouded teeth which engage corresponding rack teeth on the base. These gear teeth are shrouded to the pitch line, not so much for strength, as to provide a rolling bearing for taking the vertical thrust due to the weight of the boom and load. The shrouding is machined on the outer surface, and the gear teeth are relieved of all vertical bearing stresses.

The position of the boom is changed by turning the crank and pilot wheel shown. The motion of the crank is transmitted to the screw through gunmetal bevel gears having a ratio of

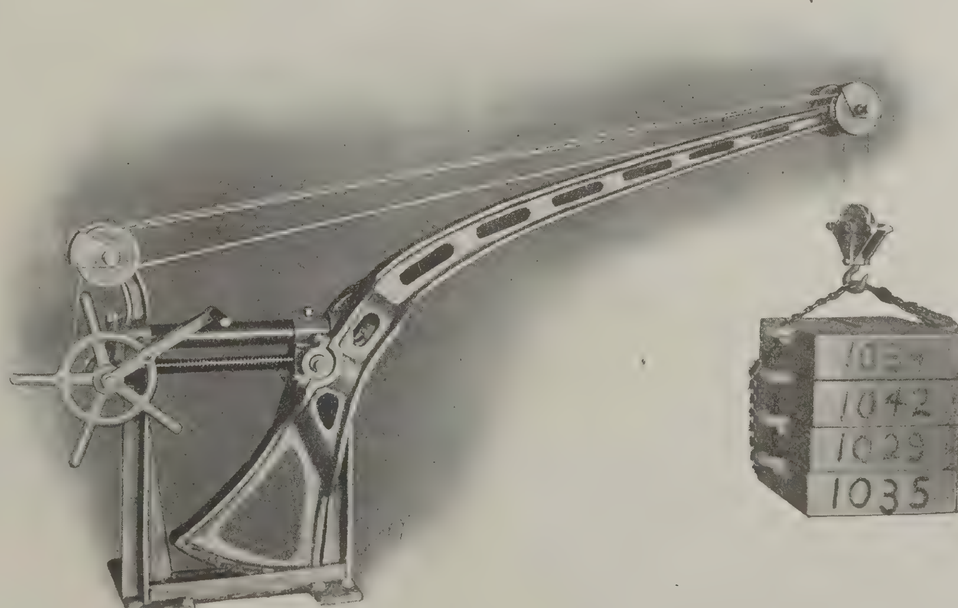


Fig. 1. La Salle One-ton Crane with Boom lowered

$1\frac{1}{2}$ to 1. The screw, in turn, engages a nut that is trunnioned in the boom and slides along a cylindrical rod above the screw. With this construction, one man can raise a load of one ton from the lowest to the highest position in thirty seconds.

Because of the compensating feature of the crane, the thrust on the screw is very slight and in some positions of the boom, the thrust is practically eliminated. The load also remains at about the same level whether the boom is in its lowest or highest position. The hoisting cable can be operated either by an electric hoist, in case the crane is mounted on an electric truck, or by a hoist designed to be driven directly from the transmission of a gasoline truck.

The frame, boom and nut are made of open-hearth steel castings. The tie-rod upon which the nut slides is made of cold-rolled steel covered with brass tubing. The screw is made of

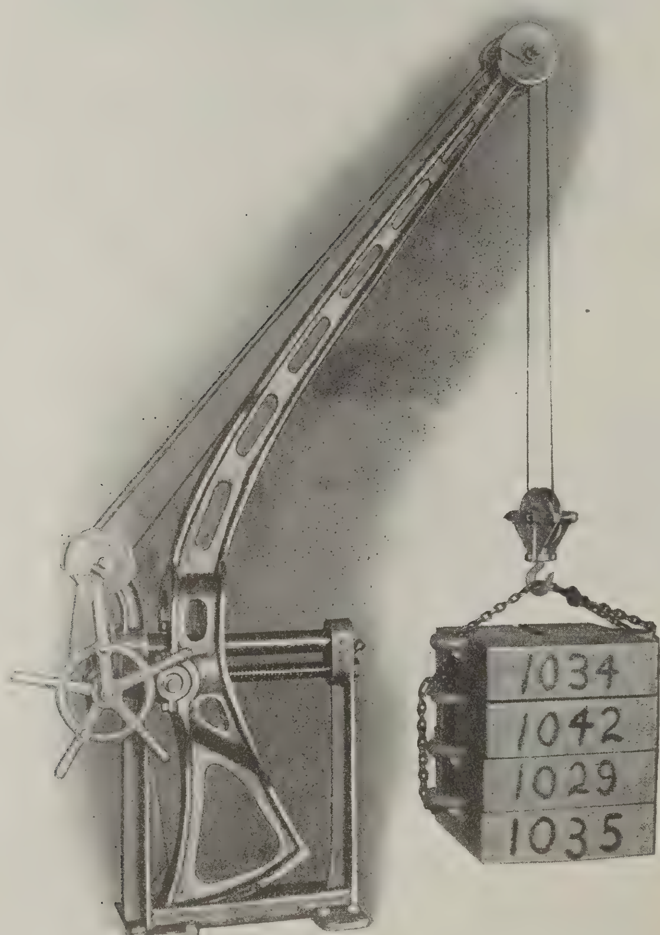


Fig. 2. La Salle Crane with Boom raised

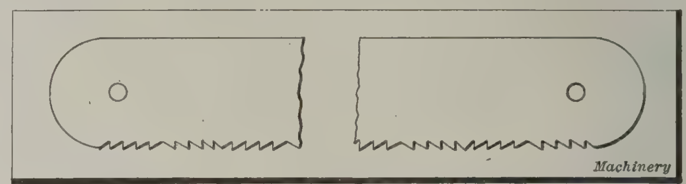
30 per cent nickel steel to avoid corrosion and is mounted in self-aligning radial and ball thrust bearings. The nut is lined with phosphor-bronze.

The figures on the weights (see illustrations) show the test load used on this crane. With this load, it is possible for one man, by means of the crank, to raise the boom from the lowest to the highest position without over-exertion. This crane has a maximum reach from the front of the frame, of 7 feet, and a minimum reach of 2 feet. The maximum and minimum heights are 9 feet 10 inches and 6 feet 2 inches, respectively.

REITLINGER DOUBLE-ACTION HACKSAW BLADE

A new type of hacksaw blade, recently placed on the market by Alex. Reitlinger, 201 William St., New York, is shown in the accompanying illustration. The design of this saw is decidedly novel. The teeth are arranged in groups of four, the teeth of each group being set in the opposite direction to those of the adjacent groups. The idea of this design is that the saw may be made to cut on both forward and return strokes. It will, of course, be evident that this type of saw is driven by a machine which is not equipped with means for lifting it out of engagement with the work on the return stroke.

It is claimed that the ability to cut on both the forward and return strokes gives this saw a materially increased cutting capacity. An idea of the capacity may be gathered from the fact that, in a recent test, a piece of $1\frac{1}{2}$-inch steel shafting was

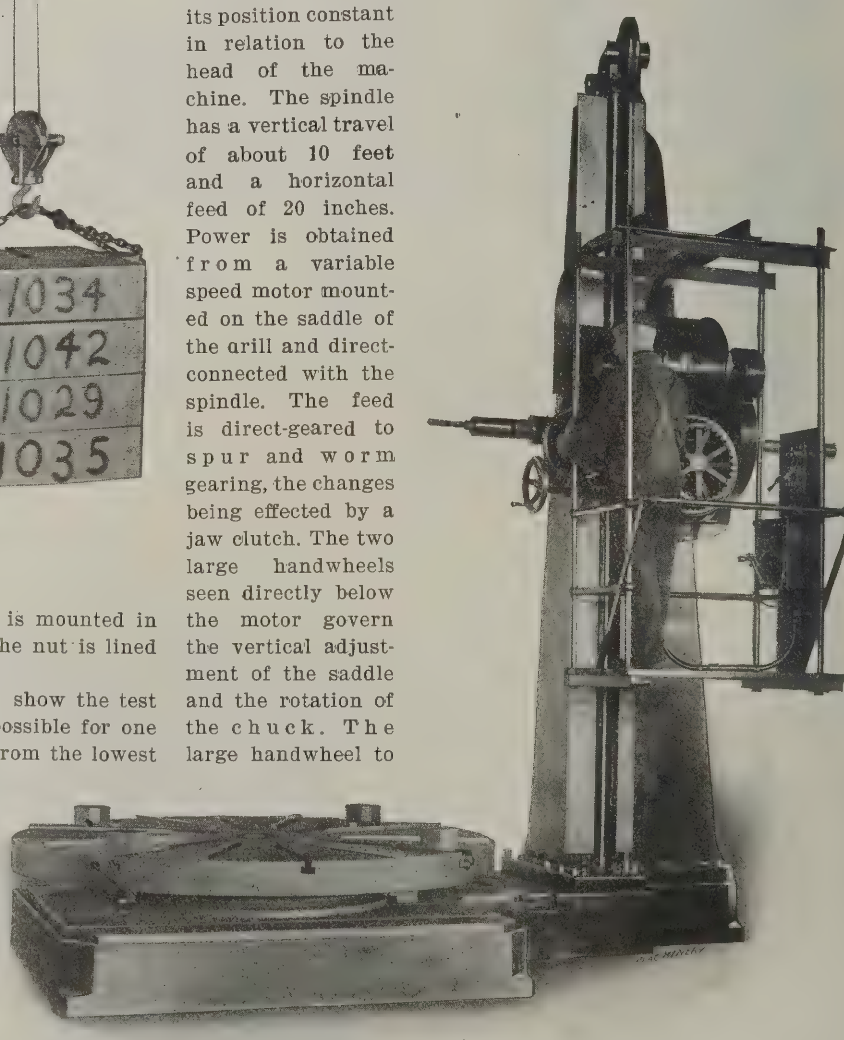


Hacksaw designed to cut on Both Forward and Return Strokes

cut in three minutes and thirty-three seconds. These saw blades are now being made $\frac{1}{2}$ inch in width with 16 teeth to the inch. It is also intended to make saws of this design having 11, 24 and 32 teeth to the inch; this range will provide for making saws of all necessary sizes for different classes of work.

BAUSH BOILER SHELL DRILLING MACHINE

A boiler shell drilling machine, in which the shell is held in a four-jaw universal chuck after being rolled and may be rotated from the operating position of the drill, is one of the latest products of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. The operator stands in a cage (see accompanying illustration) which moves on the column to keep its position constant in relation to the head of the machine. The spindle has a vertical travel of about 10 feet and a horizontal feed of 20 inches. Power is obtained from a variable speed motor mounted on the saddle of the drill and direct-connected with the spindle. The feed is direct-geared to spur and worm gearing, the changes being effected by a jaw clutch. The two large handwheels seen directly below the motor govern the vertical adjustment of the saddle and the rotation of the chuck. The large handwheel to the left controls the quick adjustment of the spindle and the small one in front of it governs the clutch. The handwheel on the shaft parallel with the spindle provides for a hand feed for hand drilling or facing.



Baush Boiler Shell Drilling Machine

The machine is provided with roller and ball bearings

throughout so that its operation is extremely light and sensitive, although the machine itself is of extremely massive construction, having a gross weight of approximately 30,000 pounds. The saddle is accurately counterbalanced and is raised and lowered by means of a screw which precludes the possibility of its dropping. The chuck has a capacity for shells ranging from 36 inches to 72 inches in diameter and up to ten feet in length; by reversing the work end for end, the capacity of the machine may be increased for work 20 feet in length. The chuck and its operating mechanism is a self-contained unit, so that the chuck may be lifted off the table and replaced again without the necessity of adjusting any gearing. The screws are equipped with ball thrust bearings which makes them easy to operate. The table is provided with T-slots so that it may be used for strapping down ordinary pieces to be drilled.

The machine stands 16 feet 1½ inch in height and the overall length is 14 feet. The top working surface and bed is approximately 7 feet square.

SHAW FIXED-TONGUE SWITCHES FOR MONORAIL CRANE SYSTEMS

An important improvement in the construction of monorail crane systems, in the form of a fixed-tongue track switch, has recently been made by the Shaw Electric Crane Co., Muskegon, Mich. The advantage of this fixed-tongue switch over the old-fashioned moving-tongue type, lies in the fact that it does not have to be set for the desired direction of travel. As the name implies, there are no moving parts to this switch, but it is still possible for the operator to select his route.

As the fixed-tongue switch does not have to be set for a change of direction, there is neither delay nor expenditure of effort for this purpose. Trolleys run through the track switch in all directions without stopping, and as there are no open ends of track, a serious source of danger has been eliminated. Reference to Fig. 1 will show that the two I-beams constituting the main or straight-through track and the third I-beam constituting the spur or curved track, terminate near the point of tangency of their center lines, and have a cast-steel extension piece or tongue rigidly secured to them. The projecting portion of this tongue is on the same level with the bottom flange of the I-beam and is a continuation of it. The tongues are so shaped that open slots are left between them through which the truck sides of the trolley pass in moving over the switch.

When the operator approaches the track switch at which he desires to run from the main line to a spur track, he pulls the steering lever which is located on the trolley near the controllers. This raises a horizontal roller to a position in which it engages a curved rib on the under side of the central tongue switch; the leading truck then swivels and is diverted onto the spur track. The trailing truck is guided onto the spur track by a positive and very simple means which is not dependent upon any action taken by the operator. No steering is necessary to return from the spur to the main line or to run through a switch on the main track in either direction.

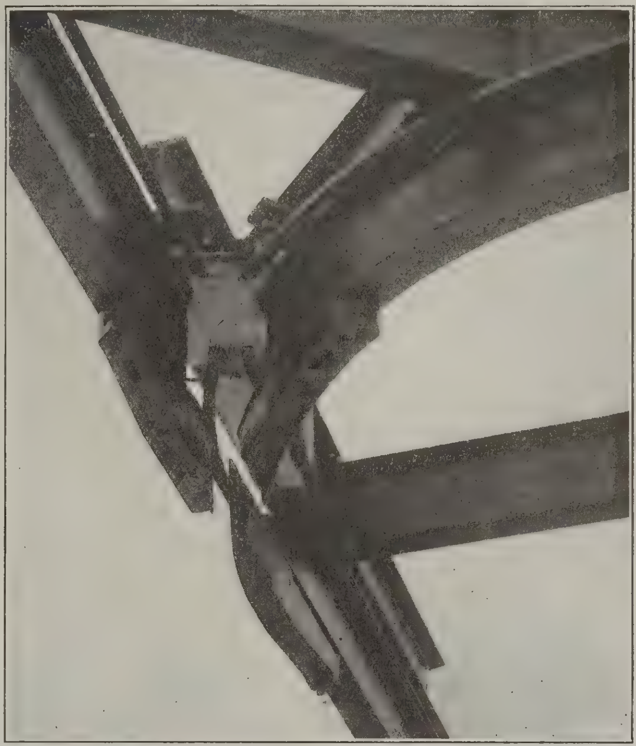


Fig. 1. Arrangement of the Shaw Fixed-tongue Track Switch

The details of the trolley design have been carefully worked out to secure a maximum efficiency of operation. Steel is employed in the construction of the main frame, the truck sides, the gears, and in all other parts where the weight of the load becomes effective, except in the rope drum and other compression members. The sizes of wire rope employed are especially liberal in proportion to the load, and the hook is a steel drop-forging which swivels on a ball bearing. Convenient

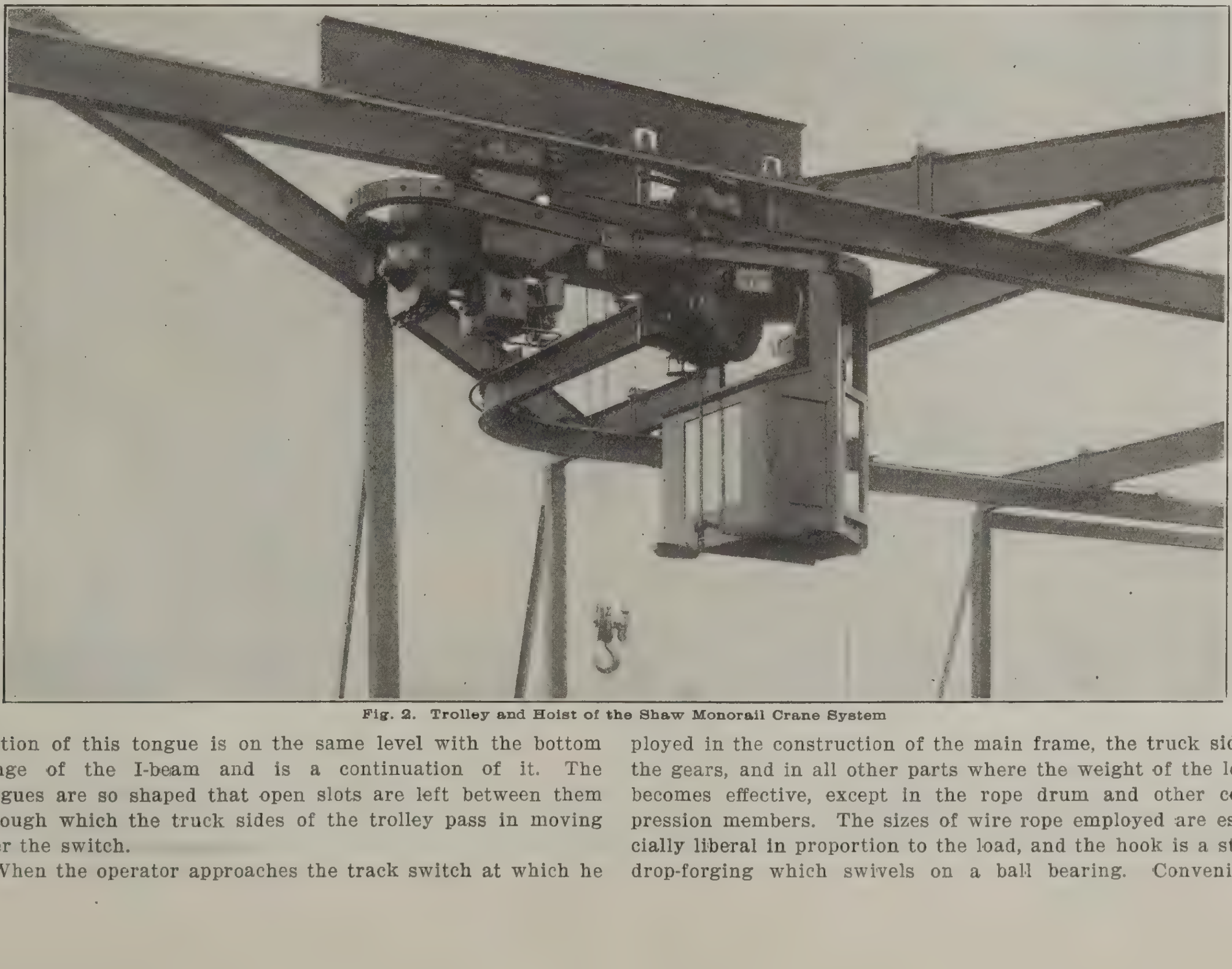


Fig. 2. Trolley and Hoist of the Shaw Monorail Crane System

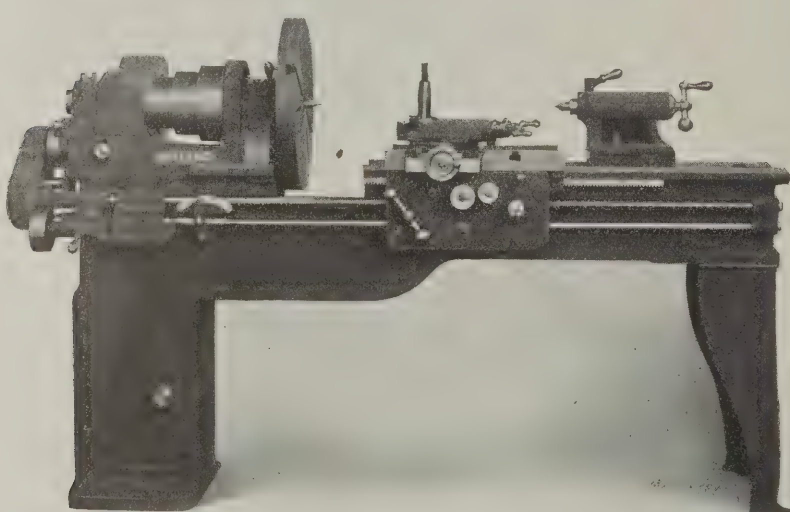
facilities have been provided for inspecting all internal parts without undue loss of time.

Curved buffers are provided at both ends of the trolley, forming a simple provision against collision with other trolleys, whether on curved or straight sections of the track. The hoist is equipped with motor and load brakes, the latter being of the multiple disk type and located in the hoist gear case. An automatic limit switch is also provided to prevent the lower block from being accidentally wound up into the trolley machinery. The motors have been designed especially for monorail work and embody the latest features applied for this class of service. The cage is arranged with a seat for the operator and all appliances necessary for giving him the requisite control over the crane.

WILLARD GAP-BED ENGINE LATHE

The gap-bed engine lathe illustrated herewith is built by the Willard Machine & Tool Co., Cincinnati, Ohio. This lathe is so designed as to make it suitable for both jobbing and manufacturing purposes. By removing the filling piece from the bed, the lathe may be made to handle work 21 inches in diameter up to 6½ inch face. When the filling piece is replaced, the lathe is transformed into a standard engine lathe which swings 13½ inches over the shears and is just as convenient to operate as any standard lathe of this type.

The headstock is of massive construction having a bearing of 21½ inches on the bed. The spindle is made of 60-point



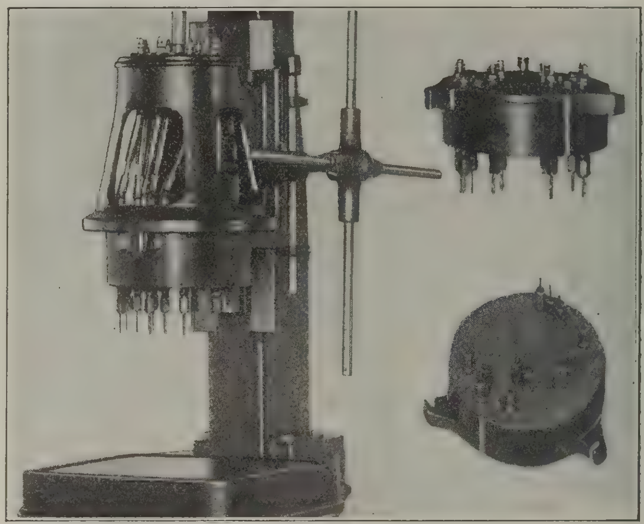
Willard Gap-bed Engine Lathe

carbon crucible steel; the front journal is 2⅝ inches in diameter by 4 inches in length, and the rear journal is 1 13-16 inch diameter by 3 inches in length. The bearings are of phosphor-bronze, carefully scraped to fit the spindle. The hole through the spindle is 1 5-16 inch in diameter, and is bored to fit a bushing for a No. 3 Morse taper. The tailstock spindle is 1¾ inch in diameter, the tailstock having a travel of 5¼ inches.

The carriage has a bearing 18 inches long on the V's. The bridge is 7¼ inches wide, and is equipped with a dial for use in screw cutting. The compound-rest is of new design, being unusually large and of particularly rigid construction. The crank handle for moving the carriage is at the left-hand side of the apron, which is an unusual arrangement for a gap-bed lathe. This handle is usually located at the right-hand side of the apron, where it is inconvenient for the operator to use it. A gib is attached to the carriage at the right-hand side of the apron for the purpose of stiffening it when it overhangs the gap. This lathe is furnished with 6, 7, 8, and 10-foot beds. It has a cabinet leg under the headstock end, an extra large faceplate, and the filling piece previously referred to, as part of its regular equipment. A cabinet leg for the tailstock end can be furnished as an extra.

CLUSTER BOXES FOR "NATCO" MULTIPLE-SPINDLE DRILLERS

The illustration presented herewith shows the head of a No. 9 multiple-spindle drilling machine, made by the National Automatic Tool Co., Richmond, Ind., equipped with a cluster box. Two other forms of cluster boxes are shown at the right-hand side of the illustration. These cluster boxes, or



"Natco" Drilling Machine equipped with a Cluster Box or Multiple Drilling Head

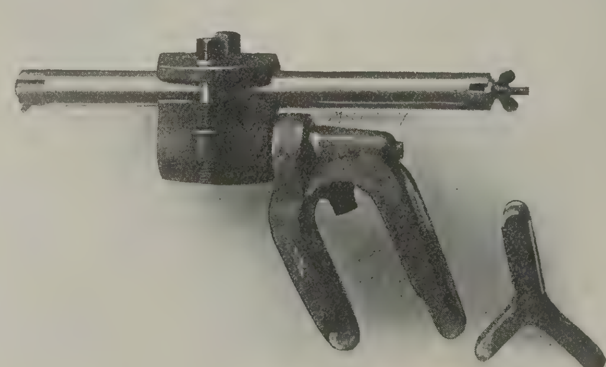
drilling heads, are used for special jobs of multiple drilling; they are made interchangeable, different cluster boxes being used for each class of work.

The boxes are driven by universal-joint spindles or a center-shaft drive. The universal-joint spindles can be detached quickly and are recommended in preference to the center-shaft drive. One reason for this is that it often makes it possible for simpler boxes or heads to be used. The universal-joint spindles also enable the adjustable rails to be used on the same machine.

With the cluster box equipment, a larger number of holes can be drilled than is possible when the machine is equipped with adjustable rails. The head has a circular range of 8⅜ inches, and the use of special cluster boxes enables this range to be increased. The machine is equipped with adjustable stops so that holes of predetermined depth can be drilled. The machine on which these drilling heads are used is the same as that illustrated in the New Machinery and Tools section for November, except that the one previously described was equipped with eight adjustable steel rails for carrying the drill spindles.

KRIEGER TOOL-HOLDER

The Krieger Tool & Mfg. Co., Grand Rapids, Wis., has recently placed upon the market the tool-holder shown below. The design has been developed to eliminate the spring which occurs with many other types of holders when taking



Tool-holder adapted to the Requirements of Heavy Work

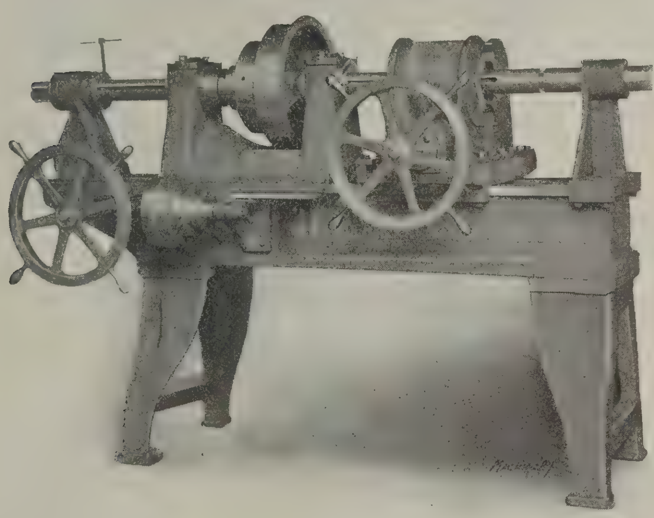
heavy cuts. It will be seen from the illustration that this holder has two shanks, only one of which need be used on light work. For heavy work, the ring is taken off the toolpost. One shank of the holder is then placed on each side of the tool-

post and the Y-shaped clamp goes through the slot in the tool-post. The three ends of this clamp engage with the shanks of the tool-holder, which is held securely in place when the set-screw is brought down upon the Y-clamp.

This tool-holder can be adjusted one inch below or one inch above the center of the lathe, and has been found particularly suitable for boring operations on stuffing-boxes and other classes of work where holes of different diameters are required.

UNDERWOOD ARMATURE AND AXLE BEARING BORING MACHINE

The machine illustrated herewith is a recent product of H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., and is designed for boring the babbitted bearings of axle and armature shafts of the Westinghouse and General Electric motors used in electric car service. In addition to this work, the machine can be used for boring a variety of work such as large pulleys, etc. The design of this machine enables it to be operated by unskilled labor.



Underwood Armature and Axle Bearing Boring Machine

The handwheel toward the right operates a powerful self-centering chuck which holds and centers split or round bearings in correct alignment with the boring-bar, no particular skill being required to do this work both accurately and rapidly. The jaws of the chuck will take bearings ranging from 4 to 12 inches outside diameter, and special oil grooves can be cut in a bearing after the box is bored. The cutting tool is held directly in the bar, the latter being of ample strength to bore with a single-ended cutter. In order that extremely accurate boring may be done on bearings of harder material than babbitt, an outboard support and extension bar are provided.

The bearings in the headstock are made to compensate for wear without changing the alignment of the spindle, and wide-faced pulleys make it possible to bore large sizes of work without the use of gearing. The feed is automatic, with three changes, and there is a hand control with provision for a quick return of the spindle. It has been possible to shorten the bed of the machine through the provision of means for telescoping the feed mechanism under the headstock, the headstock forming a cover for the slide. During a recent test, a split babbitt-lined bearing of 5 inches bore and 11 inches length was bored out in less than one minute.

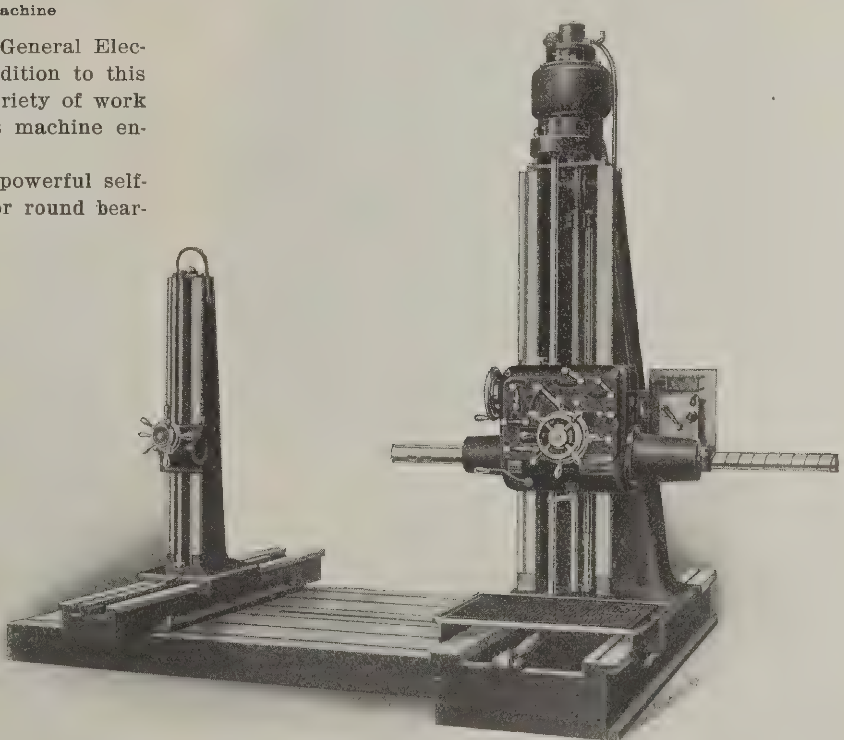
ROCHESTER BORING, MILLING, DRILLING AND TAPPING MACHINE

The Rochester Boring Machine Co., Rochester, N. Y., has brought out a new design of boring, milling, drilling and tapping machine. The operating levers and handwheels are located on the saddle within easy reach of the operator, so that the machine is convenient to work, and all changes of feed, speed and traverse in all directions, are obtained from a convenient position. The machine can be quickly started, stopped or reversed, independently of the motor or main drive. The saddle is of box construction, and is so designed that the entire operating mechanism is readily accessible.

The machine is regularly equipped with electric motor drive. The constant-speed motor is mounted on top of the column where it is out of the way of chips and dirt, and drives the vertical shaft, which transmits power to the driving mechanism enclosed in the saddle, through rawhide gearing. This arrangement simplifies the drive and gives a high power transmission efficiency. When belt drive is preferred, the machine is driven by a single pulley at the rear of the bed, the pulley being mounted on a splined shaft, which operates the vertical driving shaft in the column through bevel gears. The driving pulley is equipped with a clutch for starting, stopping and reversing.

The spindle is made of hammered, high-carbon crucible steel, and it is journaled in long taper bearings of phosphor-bronze, which are adjustable from the side and located at each end of the saddle, so that they are far enough apart to give a rigid support to the spindle. The feed and drive are applied between the bearings, the spindle being driven by two large spline keys fitted into a steel sleeve on which the driving gear is mounted. This sleeve is journaled in independent bearings, and clearance is provided between the sleeve and spindle to eliminate any vibration from the driving gears.

The concentric screw feed allows full traverse to be obtained without resetting. The method of feeding is through a long bronze nut engaging a square thread on the spindle. The nut only comes into contact with the sides of this thread and engages with the thread for the full length of the nut, so that an ample bearing surface is secured. The end thrust in either direction is taken on ball bearings of large diameter. The nut rotates at the same speed as the spindle when the feed is disengaged, and when the feed is applied, it is rotated faster than the spindle, according to the change-gear that is engaged; if the feed is reversed, the nut rotates slower than the spindle. This differential speed between the nut and spindle gives feed in either direction. The bar is controlled through positive planetary gearing by means of a handwheel, whether running or at rest.



Rochester Combination Boring, Milling, Drilling and Tapping Machine

A wide range of feeds and speeds is provided to meet all

requirements. The vertical milling feeds are provided for the saddle, and horizontal milling feeds for the column, independent of the boring feeds. All feeds are reversible and any desired change can be instantly obtained. The range of speeds can be readily changed to meet special requirements, giving faster or slower speeds of the same relative ratio. The power rapid traverse for the saddle, column and spindle is independent of the feeds. The power rapid traverse and feeds cannot engage together, and automatic limit stops are provided for every traverse in every direction.

GARDNER DISK AND RING WHEEL GRINDER

Fig. 1 illustrates a special disk grinder which is interesting because it is said to be the first disk grinder built with two spindles set parallel with each other. The rear spindle is mounted in the solid base of the machine and driven by a pulley belted to the countershaft in the usual way; this spindle has no lateral movement. The front spindle is driven from a pulley on the outer end of the rear spindle, a weighted idler being provided to maintain the required tension on the short

Fig. 1. Disk Grinder for finishing Parallel Surfaces in Different Planes

connecting belt. The front spindle is mounted in a head provided with a lateral adjustment which can be accurately regulated by means of the graduated handwheel shown beneath the front disk wheel. The table for supporting the work can be swung across the face of the wheel, but it is generally kept fixed in the position shown in the illustration. The purpose of this machine is to provide a rigid and accurate method of finishing two surfaces which must be parallel with each other, but in different planes. The method of regulating the adjustment of the movable spindle is particularly useful when it is required to have these surfaces at an exact distance from each other.

The novel features of the machine shown in Fig. 2 are the water shields and the angle-plates for holding the work on the lever feed tables. The hoods are of simple construction; they can be readily removed when adjusting or changing the ring wheels, and give free access at both sides for setting the work on the holder. It has been found that the wheels can be flooded with water when running at high speed, the pump for this purpose being set at the rear of the machine. The operation of the hoods is so efficient that scarcely a drop of water is thrown outside of the guards. The special angle-plates on which the work is held are provided with raised edges at the back and sides; these edges catch all water falling on the plate and return it to the pump. It is said that this

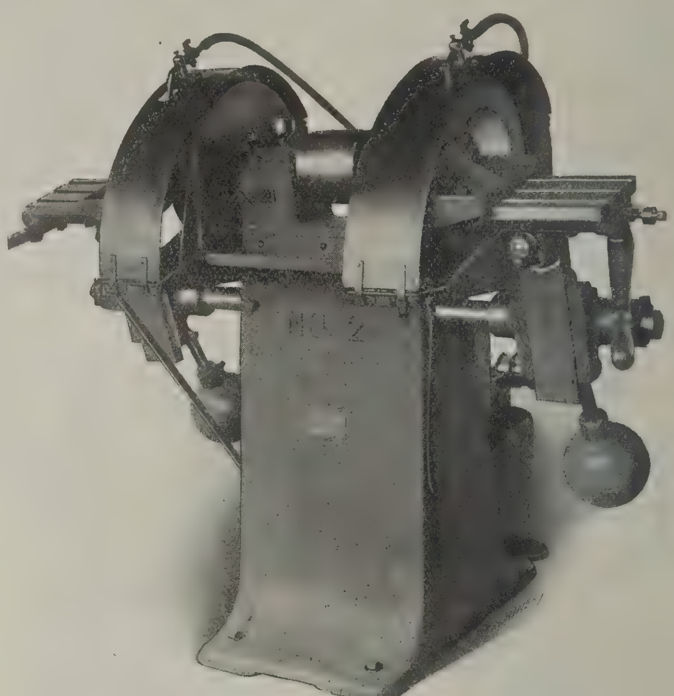


Fig. 2. Ring Wheel Grinder with Water Shields and Angle Plates for holding Work

equipment affords a particularly satisfactory method of applying water to grinding machines of this type. These machines are the product of the Gardner Machine Co., Beloit, Wis.

CALCULATING CHART

The accompanying illustration shows an interesting calculating chart that has been brought out by Mr. George M. Purver, 146 E. 8th St., Brooklyn, N. Y., for facilitating multiplications and divisions in cases where exact results are required. The slide-rule, as is well known, gives only exact

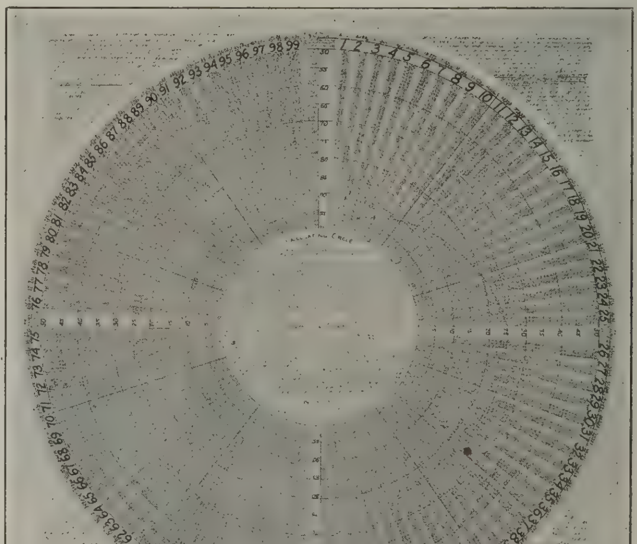


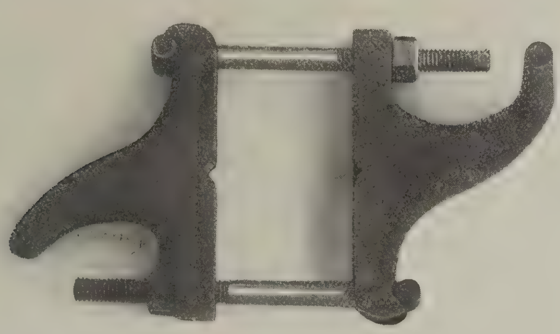
Chart for Rapid Multiplication and Division—Actual Diameter, about 15 inches

figures to very few places, and while it is satisfactory for most practical calculations where the assumed values themselves are approximate, there are conditions when the exact product is required. It is for cases of this kind that the calculating chart has been prepared. It gives instantly the product of all numbers of two figures only, and the product of a number of two figures with a number of four figures with

a slight calculation, which by training can easily be performed mentally. From a mathematical point of view the arrangement is rather unique, and there are several interesting points in the working out of the chart. Of course multiplications of numbers with any number of digets by other numbers of any number of digets can also be performed by writing down the results of the multiplication of any two figures by any other two figures, which shortens considerably the ordinary work of multiplication.

MICHAUD SAFETY LATHE DOG

The safety lathe dog illustrated herewith has recently been placed upon the market by Elmer J. Michaud, Willimantic, Conn. The clamping members of this dog are drop-forgings, held together by bolts in the manner shown. It will be seen

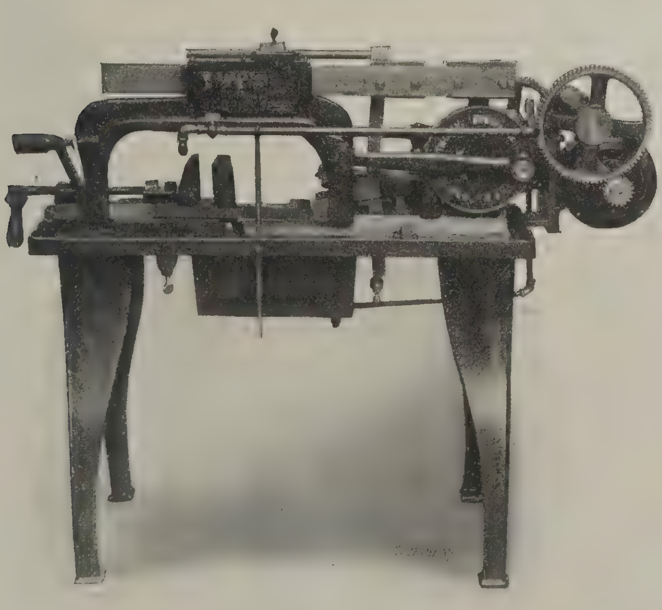


The Michaud Safety Lathe Dog

that the clamping members are provided with curved extensions which come out over the exposed ends of the bolts. The dog is mounted so that these extensions revolve ahead of the bolts, making it practically impossible for the operator's clothing to be caught or for him to be injured by the sharp edges on the bolt and nut.

ROBERTSON MOTOR-DRIVEN POWER SAW

The W. Robertson Machine & Foundry Co., Buffalo, N. Y., has recently equipped its No. 3 Economy power saw with a direct-connected motor drive. The method of attaching the motor to the saw frame is shown in the illustration, no drilling of extra holes being required for mounting it in place. The motor is back-geared and is a self-contained unit of standard



Robertson Economy Power Saw No. 3 equipped with Motor Drive

make; it is compound-wound and no starting box is required.

This machine cuts on the draw stroke and is equipped with this company's standard mechanical lift for the return stroke, which raises the blade from the work and greatly reduces the strain which it experiences in service. The maximum cutting capacity is 6 by 6 inches and the machine is so arranged that 10-, 12-, or 14-inch blades may be used. A friction band clutch in the driving gear provides for starting, and an automatic stop throws out the drive when the cut is completed. A rotary brass pump is used for pumping the lubricating fluid from the tank to the blade.

ROCKFORD HIGH-DUTY PRESS WITH AUTOMATIC BRAKE

The illustrations show a high-duty press manufactured by the Rockford Iron Works, Rockford, Ill., and also the patented automatic brake with which this machine is equipped.

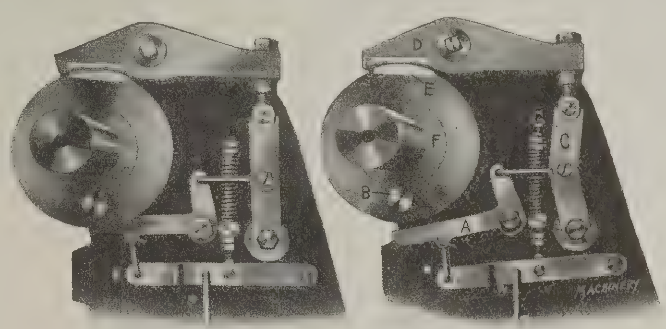


Fig. 1. Brake Mechanism of Rockford High-duty Press in the "Engaged" and "Released" Positions

The design of this brake has been developed with the view of saving a large percentage of the power which is consumed in operating some types of brake mechanism. The Rockford brake is automatic in its action and is applied only at the top of the stroke. The brake is not applied at any other point

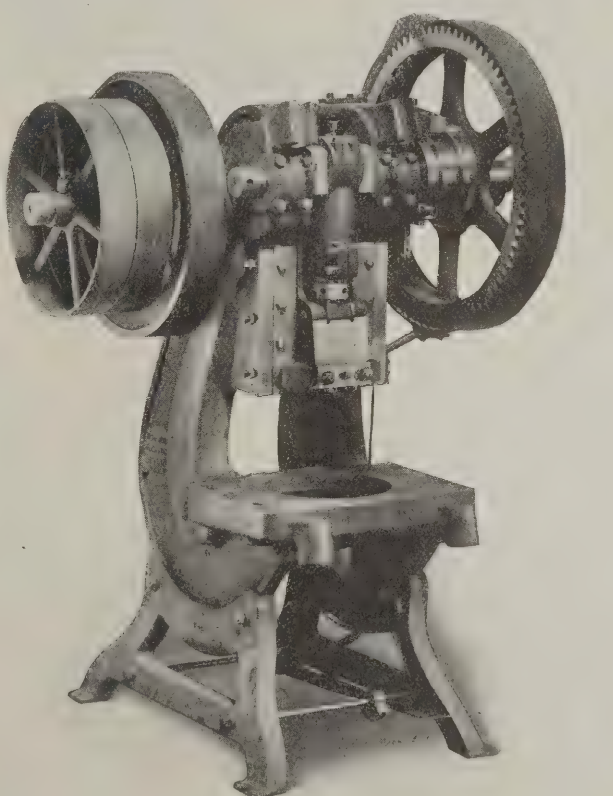


Fig. 2. Rockford High-duty Press equipped with Automatic Brake

during the shaft cycle so that friction losses are reduced to a minimum, only a sufficient amount of resistance being applied to stop the machine at the top of the stroke. The saving of power effected by this device in shops where a large number of presses are in operation will be appreciated.

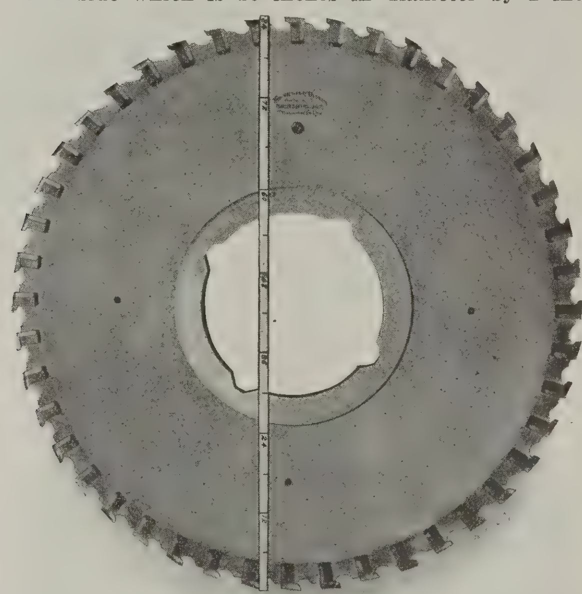
The action of the brake is automatically controlled by the treadle. When the treadle is depressed, the clutch release pawl *A* is drawn down, releasing the clutch pin *B* which is forced forward by a spring into one of the three hardened tool-steel contact points on the flywheel. Just before the clutch pin *B*

is released, and by means of the same pressure on the treadle, the toggle-joint C, which holds the brake D against a hardened tool-steel projection E on the driver F, is broken. This releases the brake D which is so held until the foot is removed from the treadle. The brake is placed on the right-hand side of the press so that all torsional strain on the shaft is eliminated, and this arrangement gives plenty of room on the left-hand side for the attachment of automatic feed equipment, oiling devices, etc.

HUNTER DUPLEX INSERTED-TOOTH SAW BLADES

The Hunter Saw & Machine Co., 57th and Butler Sts., Pittsburg, Pa., has recently manufactured two of the largest inserted-tooth, metal-cutting saw blades which have ever been placed upon the market. They have been given the trade name of "Hunter duplex," and are made from steel plates 1 inch in thickness and of special analysis to give the best results when subjected to the method of heat treatment used.

The finished saw is 84 inches in diameter, and has a collar on either side which is 26 inches in diameter by 1 inch in



Hunter Duplex Inserted-tooth Metal-cutting Saw Blade

thickness. These collars are riveted to the body of the saw and have four equally spaced keyways milled in them by which the saw blade is driven. Forty-four pockets are milled around the periphery of the saw and roughing and finishing teeth are inserted alternately in them. At the bottom of these pockets, the plate is drilled and tapped to admit a hexagon-headed brass screw which is used in setting the teeth to the proper height. These teeth are made of the best grade of high-speed steel, so that they have an ample cutting capacity, and each tooth is reinforced and rigidly held by a tool-steel wedge. An idea of the size of this saw may be gathered from the fact that the teeth weigh 1¾ pound each, the wedges ¾ pound each, and the saw blade 2000 pounds. These saws were designed for cutting 40-inch ingots, and an idea of their capacity may be gathered from the fact that they are capable of cutting 24-inch ingots in ten minutes. They are driven by a 75-H. P. motor.

NEW MACHINERY AND TOOLS NOTES

Bench Lathe: B. C. Ames Co., Waltham, Mass. A bench lathe equipped with a head that has an extra large spindle. The capacity of the machine is for work up to 2½ inches in diameter.

Pipe Wrench: Erie Stamping & Mfg. Co., Erie, Pa. A convenient form of pipe wrench made from a steel stamping and produced in such a way as to supply the demand for an adjustable pipe wrench at a moderate price.

Hollow Set-screw: Goodwin Hollow Set-Screw Co., Waterbury, Conn. A hollow set-screw designed to be driven in with a suitable wrench, but which has projections on its inner surface that make it possible to use a screw-driver in place of the regular wrench.

Motor-driven Buffing Lathe: Northampton Emery Wheel Co., Leeds, Mass. A motor-driven buffing and polishing lathe. The motor is completely enclosed and bolted to an adjustable bed, which has a vertical adjustment of 4 inches to provide for regulating the belt tension.

Automatic Wire Straightener and Cutter: F. B. Shuster Co., New Haven, Conn. An automatic wire straightener and cutter which has a capacity for lengths up to 67 feet and is said to be the largest machine of its type ever built. It is intended for cutting reinforcements for concrete flooring.

Metal Sawing Machine: Vulcan Engineering Sales Co., Chicago, Ill. A small metal sawing machine in which the saw blade is driven from the periphery by means of steel rolls journaled in removable steel bushings held in the double driving gear. The periphery drive makes a greater portion of the blade available for cutting.

Combination Saw and Rotary Planer: Vulcan Engineering Sales Co., Chicago, Ill. A combination saw and rotary planer mounted on a circular base. This machine is particularly suited to the requirements of structural steel shops. As it combines the functions of two machines in one, it should be a particularly useful equipment.

Horizontal Boring, Drilling and Milling Machine: Lucas Machine Tool Co., Cleveland, Ohio. A new size of precision horizontal boring, drilling and milling machine, known as model No. 31. This machine is similar in its essential details to preceding types built by this company. The new machine is the smallest one of the line.

Adjustable Boring Tool: Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. An adjustable boring tool in which the bar is made from high-carbon steel tubing. The cutter is held by a drop-forged eye-bolt which has a square yoke at one end to carry the cutter, and a threaded section at the other end for tightening the cutter in the bar.

Open Side Grinding Machine: Detrick & Harvey Machine Co., Baltimore, Md. An open side grinding machine similar in design to the open side type of planers. This machine is intended for grinding such pieces as railroad frogs, switches and crossings, safe and vault parts, and similar classes of work which cannot be handled with cutting tools.

Bench Filing Machine: B. C. Ames Co., Waltham, Mass. A new machine which is a modification of the preceding type manufactured by this company. In the new design, a bench countershaft has been added to the equipment to carry the belt out of the way of the operator, and there is a graduated swivel under the table for securing any desired angular setting.

Planing Machine with Reversing Motor: Woodward & Powell Planer Co., Worcester, Mass. A planing machine driven by a reversing motor which has the Triumph-Monitor system of control. The machine is without overhead gears, belts, belt-shifter or driving pulleys, the motor being coupled to the driving shaft. The controller is fastened to the planer housing.

New Cage-operated Traveling Wall Crane: Cleveland Crane & Engineering Co., Wickliffe, Ohio. A new type of cage-operated electric traveling wall crane which has a capacity of ten tons and consists of two main parts—the bridge proper and the trolley. An important feature of this crane is that the bridge is driven by two motors, which eliminates the use of a through lineshaft and simplifies the design of the machinery.

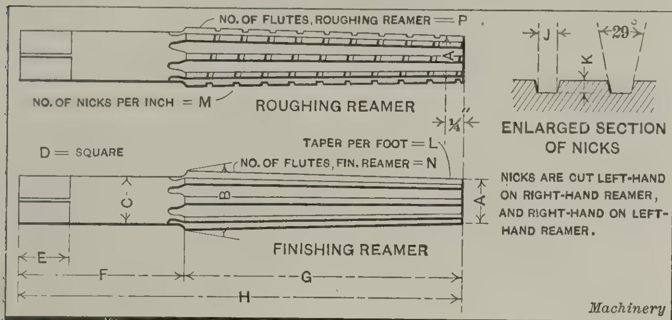
Broaching Machine with Motor Drive: J. N. Lapointe Co., New London, Conn. A motor-driven machine adapted for broaching various shaped holes of small sizes, which has the motor mounted on the same base with it. The switch is conveniently located on the front of the countershaft bracket and the machine has a large ball thrust bearing to receive the pressure from the screw; the countershaft is also equipped with ball bearings.

Geared Double Facing Head: Rochester Boring Machine Co., Rochester, N. Y. A geared double facing head for use on the Rochester horizontal boring machine. The faceplate on the head is geared to run slower than the bar and is made independent of it. The facing head on the outer support is also geared and runs slower than the boring-bar; this head is driven by the extension of the boring-bar through gears at the back of the column.

Automatic Screw Machine: Flanders Mfg. Co., Pontiac, Mich. An automatic screw machine which is the design of Mr. John J. Grant, and has a number of novel and interesting features. This machine has four spindles, all of which are at rest during the non-cutting movements of the machine. These spindles are fitted with the usual type of spring collet, but the stock is fed through without the intervention of feed sleeves or shells. Six changes of feed for the cutting movements are obtained by a simple gear-box, and the cams on the machine never require changing to suit different diameters and lengths of work. There is a constant rate of speed for the return movements, for feeding the stock and for the forward movements of the turret, regardless of the cutting speed. The same countershaft which drives the spindles provides for the constant speed drive, but in the case of the spindles, there are three rates of speed. This number may be doubled by transposing the pulleys on the countershaft and machine.

TAPER REAMERS FOR STANDARD TAPER SOCKETS

Several years ago, some tables were published in MACHINERY giving general dimensions of taper reamers for standard taper sockets, including Morse, Brown & Sharpe, and Jarno tapers. Complete data for the making of these tools have not, however, been published in any form, as far as the writer knows. The accompanying tables, therefore, have been prepared with an idea of placing on record all the information that might be required by the toolmaker in making these tools. Special attention is called to the information given for the making of the roughing reamers, which are made smaller in diameter at the small end than the finishing reamers, and which are provided with a groove cut like a thread on the cutting edges, as indicated. The purpose of this groove is to break up the chips. On ordinary right-hand reamers this groove is cut left-hand. The sides of the groove incline at an included angle of 29 degrees. The object of selecting this angle is to make it possible to use a tool having the same included angle as an Acme threading tool for grooving. A tool with inclined sides is preferable to a square tool on account of the greater ease with which the grooves or nicks can be cut. While the shape and exact dimensions for these grooves may seem to be rather unimportant details, yet in manufacturing it is important to so standardize all operations that standard tools can be used. The corners of the grooving tool are slightly rounded to prevent hardening cracks.



Notation used in Tables of Taper Reamers

In addition to the standard Morse, Brown & Sharpe, and Jarno taper reamers, dimensions of reamers for sockets for the so-called American taper are also included, so that the tables cover practically all reamers used for making taper sockets.

Tables of this kind are of value not only to the toolmaker who may be called upon to make a reamer for a standard taper socket, but also to the user of these tools, who often needs to find out certain dimensions on tools he is about to order, and to the machine designer, who has to keep in mind the tools used in the manufacturing processes. It also enables the designer to choose such tapers for taper locking bolts, etc., as can be reamed with standard taper reamers.

TABLE I. TAPER REAMERS FOR BROWN & SHARPE STANDARD TAPER SOCKETS

No. of Taper	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	0.200	0.250	0.312	0.350	0.450	0.500	0.600	0.750	0.900	1.045	1.250	1.500	1.750	2.000	2.250	2.500	2.750	3.000
B	0.252	0.318	0.416	0.444	0.564	0.667	0.803	0.958	1.119	1.346	1.573	1.838	2.114	2.385	2.656	2.927	3.198	3.469
C	7/32	9/32	3/8	13/32	1/2	19/32	23/32	27/32	1	1 7/32	1 7/16	1 11/16	1 15/16	2 1/8	2 3/8	2 5/8	2 7/8	3 1/8
D	5/32	7/32	9/32	5/16	3/8	7/16	17/32	5/8	3/4	29/32	1 1/16	1 1/4	1 7/16	1 19/32	1 25/32	1 31/32	2 5/32	2 11/32
E	1/4	5/16	3/8	7/16	1/2	5/8	3/4	13/16	7/8	1	1 1/16	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8
F	1	1 3/8	1 3/4	1 1/2	2	2 1/2	3 1/8	3 1/4	3 3/8	3 1/2	3 3/4	3 7/8	4	4 1/8	4 1/4	4 1/4	4 1/2	4 1/2
G	1 1/4	1 5/8	2 1/2	2 1/4	2 3/4	4	4 7/8	5	5 1/4	7 1/4	7 3/4	8 1/8	8 3/4	9 1/4	9 3/4	10 1/4	10 3/4	11 1/4
H	2 1/4	3	4 1/4	3 3/4	4 3/4	6 1/2	8	8 1/4	8 5/8	10 3/4	11 1/2	12	12 3/4	13 3/8	14	14 1/2	15 1/4	15 3/4
J	1/32	1/32	1/32	1/32	3/64	3/64	1/16	5/64	5/64	3/32	3/32	7/64	7/64	1/8	1/8	9/64	9/64	9/64
K	0.025	0.025	0.025	0.025	0.025	0.025	1/32	1/32	1/32	3/64	3/64	3/64	3/64	1/16	1/16	1/16	1/16	1/16
L	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	0.5161	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
M	3 1/2	3 1/2	3 1/2	3 1/2	3	3	3	3	3	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
N	6	6	6	6	6	6	8	8	8	8	8	10	10	10	14	14	14	14
P	4	4	4	4	4	4	5	5	5	6	6	6	6	6	8	8	8	8

Machinery

TABLE II. TAPER REAMERS FOR JARNO STANDARD TAPER SOCKETS

No. of Taper	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.100	1.200	1.300	1.400	1.500	1.600	1.700	1.800	1.900	2.000
B	0.144	0.269	0.400	0.531	0.659	0.787	0.916	1.044	1.169	1.297	1.422	1.550	1.675	1.800	1.928	2.053	2.181	2.306	2.431	2.556
C	1/8	15/64	3/8	15/32	19/32	11/16	13/16	15/16	1 1/16	1 1/8	1 3/16	1 5/16	1 7/16	1 1/2	1 5/8	1 3/4	1 13/16	1 7/8	1 15/16	2
D	3/32	11/64	9/32	23/64	29/64	33/64	39/64	45/64	51/64	27/32	57/64	63/64	1 5/64	1 1/8	1 7/32	1 5/16	1 23/64	1 13/32	1 29/64	1 1/2
E	3/16	9/32	3/8	1/2	5/8	5/8	3/4	7/8	7/8	1	1	1 1/16	1 1/16	1 1/8	1 1/8	1 1/8	1 1/4	1 1/4	1 1/4	1 3/8
F	5/8	1 1/4	1 1/2	1 3/4	1 15/16	2 1/8	2 5/16	2 1/2	2 3/4	2 15/16	3 1/16	3 1/8	3 1/4	3 3/8	3 7/16	3 9/16	3 3/4	3 7/8	4	4 1/8
G	7/8	1 3/8	2	2 5/8	3 3/16	3 3/4	4 5/16	4 7/8	5 3/8	5 15/16	6 7/16	7	7 1/2	8	8 9/16	9 1/16	9 5/8	10 1/8	10 5/8	11 1/8
H	1 3/4	2 5/8	3 1/2	4 3/8	5 1/8	5 7/8	6 5/8	7 3/8	8 1/8	8 7/8	9 1/2	10 1/8	10 3/4	11 3/8	12	12 5/8	13 3/8	14	14 5/8	15 1/4
J	1/32	1/32	1/32	3/64	3/64	1/16	1/16	5/64	5/64	3/32	3/32	3/32	7/64	7/64	7/64	7/64	7/64	1/8	1/8	1/8
K	0.025	0.025	0.025	0.025	0.025	1/32	1/32	1/32	1/32	3/64	3/64	3/64	3/64	3/64	3/64	3/64	3/64	1/16	1/16	1/16
L	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
M	3 1/2	3 1/2	3 1/2	3 1/2	3	3	3	3	3	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
N	6	6	6	6	6	8	8	8	8	8	8	8	10	10	10	10	10	12	12	12
P	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6

Machinery

TABLE III. TAPER REAMERS FOR MORSE STANDARD TAPER SOCKETS

No. of Taper	0	1	2	3	4	5	6	7
A	0.252	0.369	0.572	0.778	1.020	1.475	2.116	2.750
B	0.369	0.510	0.741	0.979	1.280	1.790	2.559	3.375
C	11/32	15/32	21/32	7/8	1 1/8	1 1/2	2	2 5/8
D	1/4	23/64	1/2	21/32	27/32	1 1/8	1 1/2	1 31/32
E	5/16	1/2	5/8	13/16	1	1 1/8	1 5/16	1 1/2
F	1 1/2	1 7/8	2 1/4	2 5/8	3	3 3/8	3 3/4	4 1/8
G	2 1/4	2 13/16	3 3/8	4	5	6	8 1/2	12
H	3 3/4	4 11/16	5 5/8	6 5/8	8	9 3/8	12 1/4	16 1/8
J	1/32	3/64	1/16	5/64	3/32	7/64	1/8	9/64
K	0.025	0.025	1/32	1/32	3/64	3/64	1/16	1/16
L	0.625	0.600	0.602	0.602	0.623	0.630	0.626	0.625
M	3 1/2	3 1/2	3	3	2 1/2	2 1/2	2 1/2	2 1/2
N	6	6	8	8	8	10	14	14
P	4	4	5	5	6	6	8	8

Machinery

TABLE IV. TAPER REAMERS FOR THE AMERICAN TAPER SOCKETS

No. of Taper	1	2	3	4	5
A	0.300	0.416	0.586	0.758	1.033
B	0.435	0.574	0.750	0.943	1.286
C	3/8	1/2	11/16	7/8	1 3/16
D	9/32	3/8	1/2	21/32	7/8
E	3/8	1/2	5/8	3/4	1
F	2	2 7/16	2 5/8	3	3 3/8
G	2 3/4	3 1/16	3 5/8	3 3/4	4 7/8
H	4 3/4	5 1/2	6 1/4	6 3/4	8 1/4
J	1/32	3/64	1/16	5/64	3/32
K	0.025	0.025	1/32	1/32	3/64
L	0.591	0.621	0.543	0.592	0.623
M	3 1/2	3 1/2	3	3	2 1/2
N	6	6	8	8	8
P	4	4	5	5	6

Machinery

STRING DROP-FORGING

BY J. W. JOHNSON*

String-forging is the most economical way of drop-forging small pieces like those shown in Fig. 4. By string-forging is meant the forming of small pieces in a string, without cutting off each piece separately after forging. A section of untrimmed work made by string-forging is shown in Fig. 1. The advantages of handling work by this method are first that it is an extremely rapid operation, in that more forgings can be made per day, and, moreover, there is less liability of the

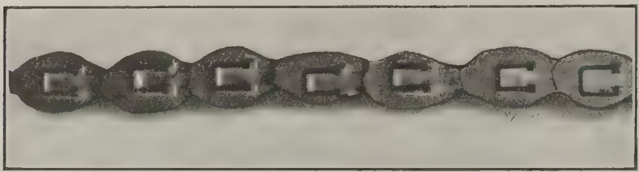


Fig. 1. Section of a String of Sixteen Forgings made in One Heat

drop-forger spoiling work by misplacing it in the dies than when transferring from the breakdown to the face impressions when drop-forging in the ordinary way. Likewise in trimming, the work may be handled more rapidly than is the case when each separate piece must be picked up and laid in the dies separately. While relatively few forgings can be string-forged, still many of the smaller forgings, say under three inches square in size, can be handled successfully in this way. No breakdown can be employed when string-forging is resorted to, for it would be obvious that the time gained by the string-forging method would be lost if it were necessary to shift the string to the breakdown for every forging. From the above it will be gathered that any forging which may be forged without a breakdown, if it does not exceed the approximate limits of three inches square, may be advantageously made by string-forging.

The small yoke for which the dies shown in Fig. 2 were constructed is made of steel. It is approximately ¾ inch wide and 1 inch long, the bosses on the ends being 5/16 inch in diameter. The dies used for this job had faces five by seven inches and the thickness of the blocks was seven inches each. Care should be taken in selecting blocks for string-forging dies for, even though the forgings be very small, the faces must not be too small or the amount of "beating surface" will be insufficient, and thus shorten the life of the dies. As will be seen, the dies are fitted with finishing impressions, and there is also a cut-off at the corner to sever the strings of completed forgings.

For making these forgings, 7/16 inch round steel bars were used. The advisability of using round stock might be questioned, but owing to the large variety of rectangular sizes that would accumulate if other than round stock were employed, it is better to use round stock, even though in some instances an extra blow is required. The bars, of lengths convenient

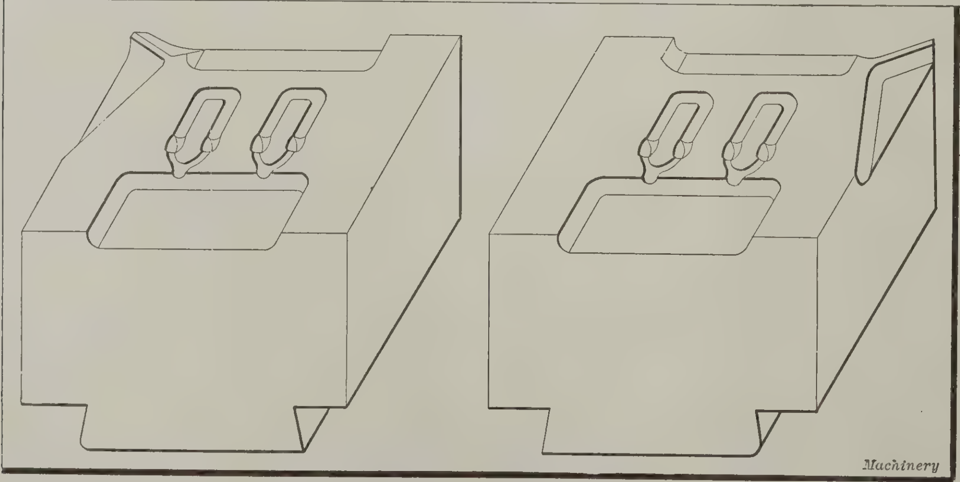


Fig. 2. The Drop-forging Dies

for handling, are heated and the forgings made by striking in the finishing impressions. From two to three blows complete each forging, after which the string is advanced to bring the completed work to the clearance cut at the rear side of the dies, thus permitting another piece to be forged. As many forgings as possible are made in one heat, leaving them all on the string. At the end of the heat the completed string of forgings is cut from the bar and the remainder of the bar is reheated to form another string.

For this work a 500-pound board drop was employed, striking from 30 to 40 blows per minute, and at this rate of speed from 4000 to 4500 completed forgings per day is the output. Work like this is best handled on a board hammer in preference to a steam hammer, and in fact, in the writer's opinion, steam hammers are inferior to board hammers except in the case of very large presses. The constant breakage of parts on a steam hammer is a great source of trouble.

For trimming these forgings from the string, the die shown in Fig. 3 is employed. This trimming die does not differ from the ordinary trimming die except that it is cut away on both ends in order to permit the rest of the string to clear. The tongue which trims the center of the yoke is dovetailed into the die as a separate piece, and in case of breakage, it is only necessary to fit a new center piece. In trimming, the first forging in the string is fitted over the die opening and the

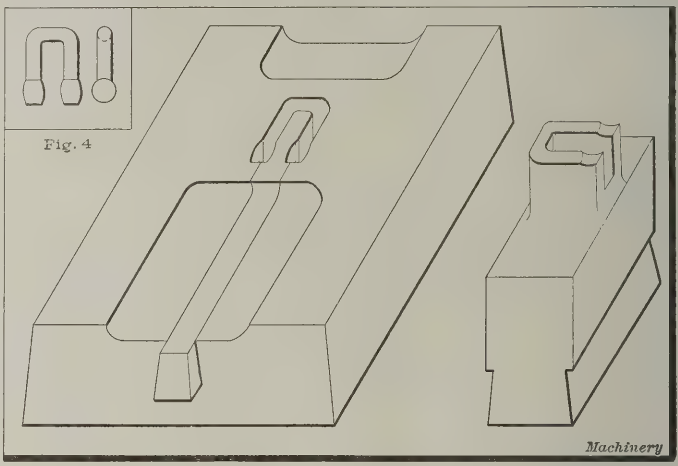


Fig. 3. The Trimming Die Fig. 4. Details of Forging

press tripped, after which the string is advanced until the second forging is in line and so on until all of the forgings are trimmed from the strip.

Another method of string-forging that is often employed when the work is very small is to provide the forging dies with three impressions in a row, so that three forgings are completed at a time. In trimming such work, however, the pieces are treated separately.

* * *

The Cleveland Planer Works uses chrome-nickel steel having a tensile strength of about 140,000 pounds per square inch of section, for the tool-holding studs in clapper-boxes. The ultimate breaking strength and tensile strength of this chrome-nickel steel is about the same, which is a peculiar advantage for tool-holding studs because of the abuse to which they are often subjected. Often a tool will be clamped close to the studs on one side and the nuts on the near studs will be screwed down first. Then when the nuts on the outer side are screwed down, a heavy stress is thrown on the first studs tightened, sufficient oftentimes to stretch or break them. If made of low carbon steel they will be stretched out of lead, thus causing great trouble, but if made of steel having equal elastic and tensile strengths the studs break before stretching much out of lead.

* * *

A man doesn't get behind the times because of age as often as because he just quits trying to keep up.

* Address: 19 Harrington St., Revere, Mass.

EFFICIENT PRODUCTION OF CYLINDRICAL WORK*†

SHOWING HOW TOTAL EFFICIENCY CAN BE INCREASED BY ROUGH LATHE TURNING PREPARATORY TO CYLINDRICAL GRINDING

Turning is one of the oldest of the mechanic arts, and the lathe is one of the oldest metal working machines; but the lathe has been a very inefficient tool until the present time. We now have lathes so designed that they can be made efficient. As a rule, however, we are not using the modern high power lathes as we should, and are losing what they were designed to save, *viz., time;* while we use them as roughing machines, we also use them as finishing machines.

Most cylindrical work must finally be brought to a size within small limits, and be truly cylindrical within still smaller limits; this led mechanics to study the art of refined turning. When this art had reached a high degree of refinement, men discovered that it did not satisfy them, and cylindrical grinding was introduced to give greater refinement than could be obtained with the lathe. At that time, it was the somewhat natural conclusion that the grinding machine should take up the work after the limit of refinement had been reached with the lathe, and the early grinding machines were designed with this object in view. Later, however, it was shown that ground cylindrical work could be produced at a cost no greater than the turning alone, by simply using the lathe to remove the larger portion of the metal and not at all as a means of refinement. The entire responsibility for refinement of the work was then transferred to the grinding machine.

While some understand this method and are using it to produce cylindrical work efficiently, the great majority are still under the spell of tradition, and are turning what they call "good work"—work that shows care and skill on the part of the operator and accuracy in the lathe. Such care in producing turned work is even more senseless today than the old-time practice of shaping acorns on screw heads, and putting cast-iron eagles on the tops of machine tools. In the former case, the grinding machine removes all trace of the lathe's accuracy and the operator's skill in a moment of time, while the latter remained for years to gratify the taste of those who had an eye for such artistic embellishment. The developments of the last few years have brought us face to face with the fact that, except in rare cases, efficiency in the production of cylindrical work means the use of the lathe as a roughing tool only, and the adoption of the modern grinding machine for refinement.

Most lathe operators and foremen seem to understand roughing to be simply turning work a few thousandths over the finish size. In reality, this is not roughing at all, but simply turning to a certain degree of refinement. It is difficult to secure roughed work from lathe operators, *i. e.*, work that is not in any sense refined. Tradition causes most operators to consume much more time than would be necessary if the work were merely roughed; sometimes they understand roughing, but confuse it with a certain degree of refinement. Roughing is not refinement of any degree, and refinement does not necessarily mean perfection. There are many degrees of refinement, but never degrees of accuracy or perfection. Accuracy and perfection are final and fixed; they have no limits.

Those who would produce cylindrical work efficiently must recognize the fact that different cases require different degrees of refinement; but whether the work requires a very low degree of refinement or a degree closely approaching accuracy, the lathe work to be efficient, should be the same, *viz.* as *rough* and as *cheap* as it is possible to make it. The lathe of today should only be a roughing tool, and the grinding machine a refining tool only—not a perfecting tool. Some grinding machines may produce greater refinement than others, but none can produce exact and perfect cylinders. While it is true that many mechanics look upon a high degree of refinement as accuracy, and speak of it as such, it is evident that this is not the case. When these facts are generally recognized, there will be greater efficiency in the production of cylindrical work. Because these facts about roughing and refining are not well understood, and because men do not combine the lathe and grinding machine in a well defined and efficient manner, the machine industry and railroads are losing large sums of money every year.

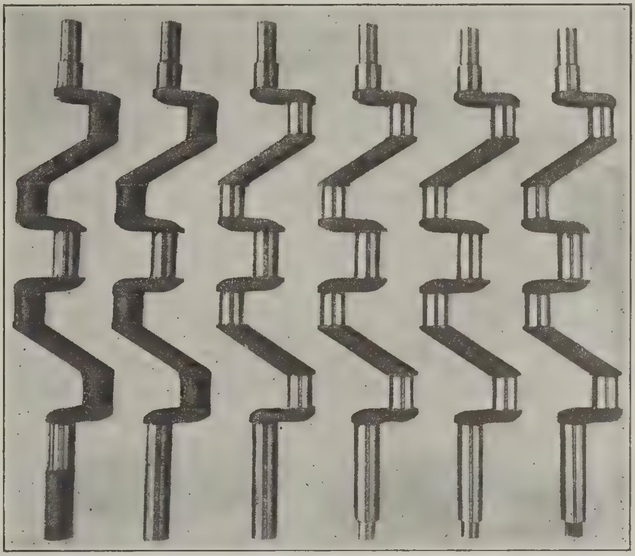


Fig. 2. Crankshaft requiring practically No Lathe Work in finishing

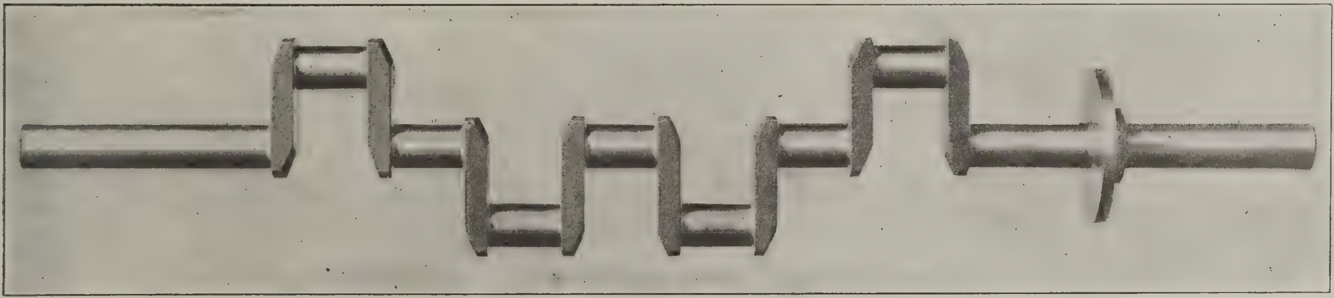


Fig. 1. A Crankshaft that is almost entirely finished in the Lathe

This loss is due to the fact that we turn closer than about 1/32 inch above the finished size. The word *about* is used because we lose by turning carefully. To require lathe work to be turned to thousandths today is like burning money for the fun of it. We are losing by allowing workmen to use any but the coarsest feeds that it is possible to use in each case. In some cases, it is even advisable to use the screw cutting gears. Feeds as coarse as four to the inch should be used in some cases, and feeds of six, eight and ten to the inch should be quite common. When the work is too frail to allow such coarse feeds to be taken with one cut, a second, or even three cuts should be made at a faster cutting speed; for, while it is true that very coarse and imperfect turning will require longer to grind than close, careful turning, the combination of coarse, cheap turning with grinding will produce cylindrical work

*Abstract of paper by Mr. C. H. Norton, of the Norton Grinder Co., Worcester, Mass., to be presented before the American Society of Mechanical Engineers, December, 1912.

†For additional information on grinding, see "Commercial Grinding," by F. B. Jacobs, in the October issue of MACHINERY, and other articles there referred to.

more efficiently. The modern grinding machine will remove metal most efficiently when that metal is in the form of coarse screw threads. High ridges do not increase the cost of production, and we lose money when workmen are allowed to caliper cylindrical work on the tops of the ridges, as nearly all of them do. This accounts for the misunderstanding about coarse turning and the allowance for grinding. Calipering on the tops of the ridges makes it necessary to turn with a relatively fine feed to enable clean grinding to be done. To avoid this, some workmen use a broad nose tool with the coarse feed, which necessitates the use of a slower cutting speed, because more metal is removed than with a pointed or grooved cutting tool. Ridges left by a more pointed tool do not increase the cost of producing that work, but decrease it.

We lose money by allowing workmen to measure roughed work elsewhere than at the end. Hours are wasted in calipering at several points and then resetting, and again turning the portions that have been put out by spring or tool wear, to secure straight work. It is very simple to feed a slight distance at the end of the work by hand, where the calipering can be done correctly, however coarse the power feed may be later on, or however high the ridges. The fact is overlooked that the modern grinding machine was designed to do all of the straightening and all of the sizing, regardless of what the errors of roughing may be. It is also forgotten, or has never been known, that the art of producing cylindrical work has progressed beyond that stage where it was necessary for the lathe to do its best before the grinding machine assumed the work of refinement.

The modern grinding machine is actually a correcting machine. The roughing can be rough, and roughness does not mean an approximate refinement. It is easy to figure the saving in time of turning a piece of work 6 inches in diameter by 6 feet long, when the last cut before grinding is made with a feed of six per inch, instead of thirty-two per inch, which is common. When it is considered that the grinding machine will grind this six per inch work to the finish size, in less time than is required to file thirty-two per inch work, we see the great possibilities for reducing the cost of producing work with the lathe, if combined with a modern grinding machine. In some cases money is lost by roughing at all in the lathe. Efficient production of cylindrical work is usually accomplished by first roughing in the lathe, but there are cases when the difference in favor of grinding without any roughing in the lathe is very great. The most important study for those who would secure efficient production of cylindrical work is the roughing of that work. It is here that we find the greatest possibilities for saving. If all would make a careful study of the roughing preparatory to grinding, instead of trying to improve upon the methods of grinding advocated by grinding machine makers, the result would be a more efficient production of cylindrical work and a clearer view of the real reasons why the grinding machine maker advocates certain methods. The reason why the modern heavy grinding machine was introduced would also be better understood.

At a works where large numbers of cylindrical pieces 1⅛ inch in diameter and about 10 to 11 inches long are manufactured, five minutes was required to turn about 1/16 inch from the diameter of each piece with a high-speed steel tool, the work being revolved as rapidly as the tool would stand. The plan was to turn close to the finish diameter, and care was taken to secure work that was smooth, straight, and round, so that time might be saved when grinding. They considered the grinding expensive and thought that this expense must necessarily be added to the cost of turning. The grinding in this case took one minute. The total time for producing these pieces was six minutes. A change was made in the shape of the tool point, and the size limit for turning, increased. The traverse feed was also increased, the cutting speed remaining unchanged. Each piece of work was now turned in one minute, while the grinding time was doubled so that it took two minutes. The saving of time resulting from the change was three minutes, or one-half of the original time.

Some idea of the time lost by allowing lathe work to be turned straight, smooth, and close to size, before grinding, may be obtained from the following illustration of actual work on some forgings about 4 feet 6 inches long. The turned portion had to be brought to a finish of 2 inches plus or minus 0.0005 inch in diameter, and 3 feet long. The lathe operator turned these pieces in the same manner that the majority of operators are now turning such work, *viz.*, as such work was turned before grinding machines were introduced, except that 0.010 inch was left on the diameter for grinding. The turning required two cuts, as there was more than ⅛ inch to remove and the work was somewhat frail, as well as irregular. The first cut was considered a very coarse heavy cut by the workman. The second was like the last cut in the majority of shops, *viz.*, it gave what the lathe men and most foremen call "a good job." When ready for grinding, the time consumed by turning was 25½ minutes. This appears to be too slow, but the forging was so slim that it would allow little, if any, increase in each roughing cut, and the lathe was an old-time low-power, frail machine. The grinding time on this job was three minutes, making a total of 28½ minutes.

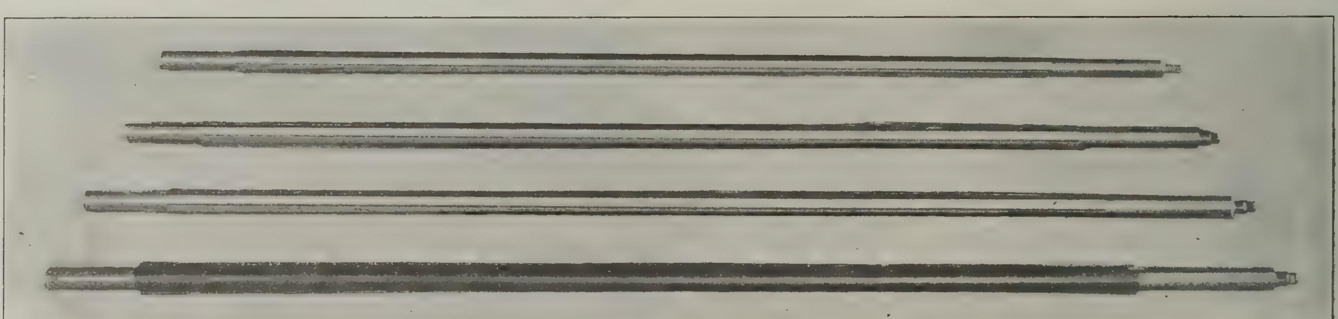


Fig. 8. Work Too Thin to be turned efficiently—finished entirely by grinding

Now note what was accomplished with the same low-power lathe and the same work, when tradition was ignored and the work made ready for grinding in the proper way. Two roughing cuts were taken, because the lathe was not powerful and the work was frail. The feed was ten per inch, cutting deep grooves; the time complete ready for grinding was nine minutes. The work was not straight, and was what many lathe men would style "a very poor job." The grinding time occupied to bring the work to exact limits was nine minutes, or three times longer than with the more careful turning, and the total time eighteen minutes, a saving of 10½ minutes on each forging. An attempt to rough this work with one cut instead of two resulted in a loss of two minutes. A modern, high-power lathe would have carried the same feed and depth of cut at a higher cutting speed, with a still further reduction of time. This shows us what may be accomplished with our weak low-power lathes. To install high-power lathes and continue to turn just as smoothly and accurately as of old, simply allowing a few thousandths for grinding, would seem the height of wastefulness. Whether high-power lathes, or old low-power lathes are used, mechanical industries are losing an enormous sum each year because of the lack of understanding of the efficient production of cylindrical work —the proper combination, in each individual case, of rough turning and grinding.

Some idea of what we are losing by not wearing our "thinking cap" is shown by the following: Some plain shafts, 1 5/16 inch in diameter and 62 inches long, were to be made

to ordinary limits of size and finish. Tests were made to determine whether it was better to turn these first, or to grind direct from the rough bars. The turning required six minutes ready for finish grinding, while to grind off the same amount as was turned required nine minutes. A number of mechanics, without thinking, pronounced it cheaper to turn these shafts first. But in this case, after turning in six minutes, each shaft required straightening before grinding; this consumed ten minutes on each shaft, totaling sixteen minutes. When the roughing was done by grinding instead of turning, no straightening was necessary, and the roughing cut was taken in nine minutes. In this case, therefore, the turning was actually lost. There may be similar cases where the shafts will require some little straightening, even if roughed by grinding, so that each case should be investigated, instead of making a rule that all must or must not be turned first. Usually, however, no straightening is necessary when roughing is done by grinding.

Money is being lost because the majority of designers have not kept pace with the development along these lines. A

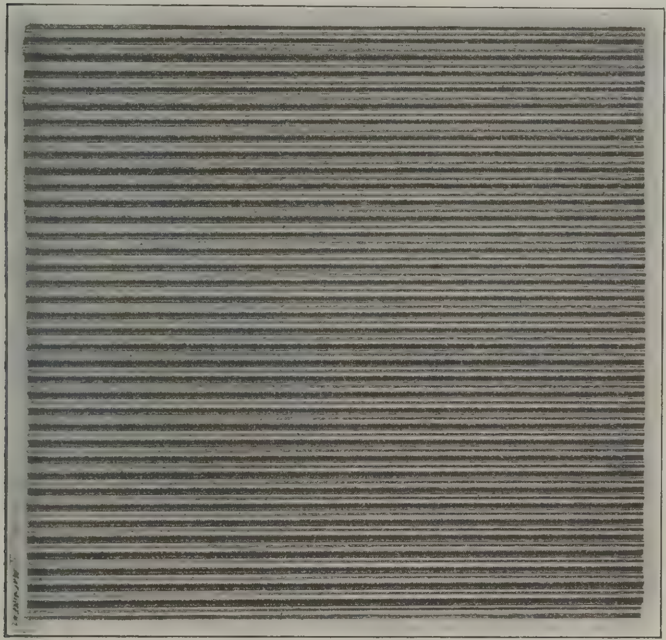


Fig. 4. Thirty-seven Slim Shafts ground direct from Rough

well-known runabout motor car has a crankshaft, which, if made about one inch longer over-all, could have been produced for 50 cents less on each crank. When it is considered that about 30,000 of these cranks have been made, representing a possible saving of $15,000, we see the importance of the combination of lathe and grinding work.

Fig. 1 shows a design of crankshaft that is expensive to machine, as it requires careful finished lathe work. It will be seen that this shaft has a flange that must be finished complete by the lathe. Aside from the flange, the design necessitates lathe finishing of the majority of the work. Grinding is a small part of the whole.

Fig. 2 shows a design that requires no lathe work whatever, there being clearance for the sides of the grinding wheel at all points. The illustration shows the six operations to complete the shaft after cutting off the ends and centering. These shafts are finished to the usual limits, direct from the drop-forging, by grinding. The net labor cost for cutting off ends, centering, machining complete with one keyway, and cutting the thread, so that the shaft is ready for the automobile, is 55 cents. The cost for grinding wheel is 2½ cents for each shaft, and the cost for the diamond to true and shape the wheel is 2 cents.

Another feature affecting the cost of production is the matter of shoulders. This is overlooked by many designers, and practically all draftsmen, who show sharp corners at the junction with the cylindrical portion. It is so easy to draw two sharp lines that cross each other and form a sharp corner. The fact that it costs less to provide room for the shoulder fillet on the other member than to make a sharp corner in the cylindrical member is lost sight of. This, no doubt, is the result of the experience of the past, when there were no powerful grinding machines to locate and form such shoulders cheaper than the lathe could. Shoulders made with the grinding wheel require a slight fillet.

When numbers of duplicate pieces are to be produced and a small fillet is allowed, not only can the cylindrical portion be roughed with the lathe and not at all refined, but the shoulders can also be roughed, because the grinding machine, when required, is provided with a locating bar. By the use of this bar, the exact location of all shoulders can be secured by grinding, without necessitating any measuring. At the same time, the cylindrical portion can be ground with the same grinding wheel. The roughing in the lathe can be done with the same tool that roughs the cylindrical portion because the lathe, in this case, is not required to give the shoulder any particular shape. When it is found best to locate and finish shoulders with the lathe, because there is no locating bar for the grinding machine, it should not be necessary to neck in at the shoulders for grinding. This is an old and out-of-date notion, for, with a shoulder cut sharp by the lathe tool, the grinding does not materially change the corner. A more efficient method, when no locating bar is at hand, is to rough the work in the lathe, leaving the shoulders about 1/32 inch long and of whatever angle the rough-turning tool may form. Next grind the cylindrical portion and, at the same time, cut out the angle at the shoulder with the grinding wheel. The work should then go to a lathe where a more skillful operator can locate the shoulders accurately; if a sharp corner is really necessary, it can then be made.

Fig. 3 shows work that is so slim that turning the main portion is out of the question, if it is to be produced efficiently. The main or center portion should be ground direct without turning. Fig. 4 shows thirty-seven slim shafts ground direct from the black stock. To turn them first would be a waste of time. They were 30 inches long by 11/16 inch in diameter in the rough. They were ground to 0.625 inch plus or minus 0.0005 inch; the work was handled twice and ground complete in seventeen minutes for each piece. The stock was tool steel. A lot of sixty countershafts of 35-point carbon steel, finish size 2 3/16 inches plus or minus 0.0005 inch by 66 inches long, were turned eight pitch, leaving about 1/32 inch for grinding. They were ground complete in thirty-five minutes each. The number of cubic inches of steel ground off was 278; 20.7 cubic inches of steel being removed for every cubic inch of wheel wear. The total wheel cost for sixty shafts was 38 cents, and the total cost for power, 35 cents. The type of wheel used was 24-combination grade L, alundum. The radial depth of cut when roughing was 0.001 inch and when finishing 0.0005 inch. The surface speed of work when roughing was 42 feet per minute, and finishing 35 feet per minute. The table traverse for roughing was 11¼ feet per minute and for finishing 10 feet per minute.

To produce cylindrical work efficiently we must make a study of everything that affects the problem in each individual case, instead of following tradition, which is costing us thousands of dollars every year. Lathe builders are offering some very efficient roughing lathes, but are we roughing with them? In most cases, we are not. The real roughing lathe needs a good system of multiple steadyrests to enable it to take rapid and deep coarse cuts. Will someone come forward with such a system of steadyrests? Instead of our lathe departments and grinding departments being separate, there should be one department for cylindrical work under one foreman. This would check the tendency of the lathe department to treat their work as a finished product, and the tendency of the grinding department to insist upon close careful turning in order to make a better showing on the grinding time, regardless of the real cost of production. There is much yet to be learned about the preparation of cylindrical work for grinding, as no two pieces of work require the same lathe treatment. There is also a great need for thinking men as foremen and operators. Such men can effect great savings by working out the best combination of turning and grinding for each class of cylindrical work.

NEW SHOP OF THE CINCINNATI GEAR CO.

The Cincinnati Gear Co. is now located in its new shop at 1825–1833 Reading Road, Cincinnati, Ohio. A good idea of the modern construction and equipment of this shop may be obtained from reference to Figs. 1, 2, and 3. The building has been provided with an exceptional window area which affords an ample amount of daylight, so that all machines may be operated without artificial illumination.

This company started in business in a small way, two years ago, and has grown rapidly. A specialty is made of rawhide and bevel gears, and an idea of the quantity of work turned out may be gathered from the fact that fifteen bevel gear machines are kept in operation all the time. All kinds of bevel gears—including those of fractional pitch—are cut without the use of form cutters or templets, planer generators being used exclusively.

Fig. 1. New Shop of the Cincinnati Gear Co., Cincinnati, O.

* * *

MACHINE TOOL EXHIBIT AT NATIONAL AUTOMOBILE SHOW

A new feature of much interest to the machine tool building industry will be added to the thirteenth National Automobile Show, to be held in Madison Square Garden and Grand Central Palace, New York, January 11 to 25. A machine tool exhibit is planned for the Part II period, or second week, beginning January 20, which is devoted exclusively to commercial vehicles. The proposed exhibit has received the approval of President E. P. Bullard, Jr., of the National Machine Tool Builders' Association and of its executive committee.

Fig. 2. Corner of the Lathe Shop showing Liberal Window Space

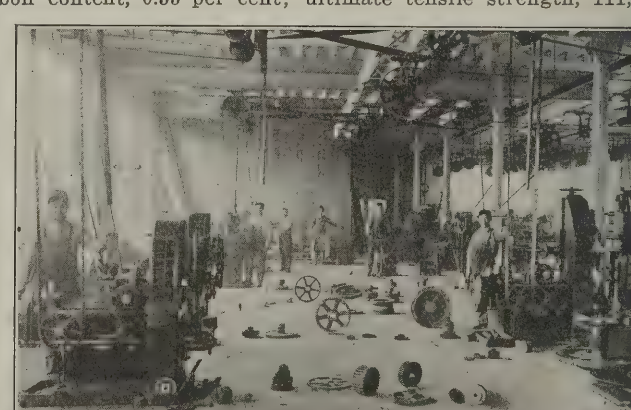


Fig. 3. The Spur Gear Shop and Some Samples of Work

The members of the Society of Automobile Engineers, many of whom will attend the show for the entire two weeks, have expressed themselves as being in favor of a display of machine tools and accessories used largely in the manufacture of motor cars. The time is ideal for the machine tool builders supplying the automobile trade to meet the men personally who are vitally interested in their product. Automobile factories throughout the country are constantly increasing their machine tool equipment, and their engineers will welcome the opportunity to see the latest developments.

The exhibit of cars in the second week of the show has not attracted the general public in large crowds, but chiefly business men, manufacturers and mechanical engineers concerned with the problems of transportation and in the development of motor trucks and delivery cars. The educational value of the proposed exhibit of machine tools to these classes is of no little importance. The intention of the management is to make the display of machine tools an annual feature of future shows.

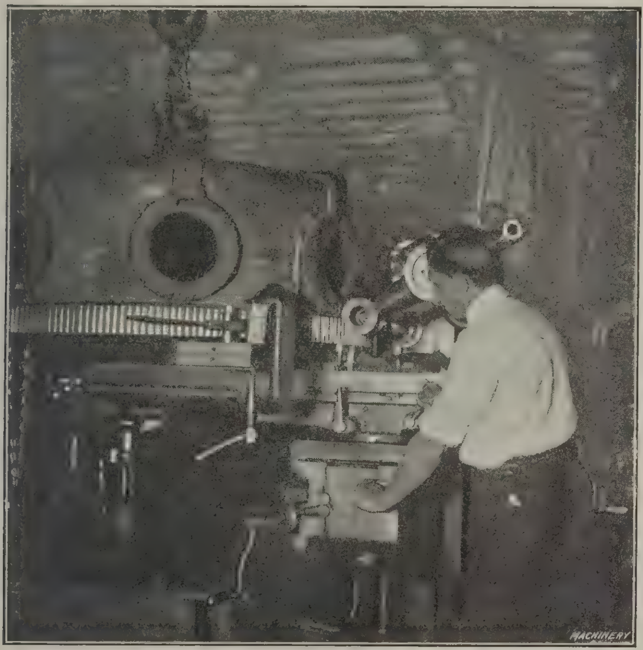
* * *

Tests made at Watertown Arsenal some time ago, which strikingly demonstrated the truth of Wöhler's law that the endurance of steel decreases rapidly with increases of stress above a certain percentage of the elastic limit, were cited in an article "The Factor of Safety" appearing in the first number of *The Travelers Standard*. Wöhler, a German railway engineer who was the first to scientifically investigate factors of safety, had observed that car axles often break after having run a certain number of miles although when new their strength was several times that required to carry the load, and from this fact was led to investigate the phenomena of fatigue of metals. The Watertown tests were made on steel specimens having the following characteristics: Carbon content, 0.55 per cent; ultimate tensile strength, 111,200 pounds per square inch; elongation, 12 per cent; reduction of area, 33 per cent; elastic limit 59,000 pounds per square inch. Under repeated alternate extension and compression stresses a specimen under maximum stress of 30,000 pounds per square inch withstood 76,326,240 repetitions without breaking; under 35,000 pounds a specimen broke at 900,720 repetitions; under 40,000 pounds, at 455,000; under 45,000 pounds, at 166,240; under 50,000 pounds, at 93,160; and under 60,000 pounds, at 12,400.

AN UNUSUAL GEAR CUTTING JOB

An unusual job of gear cutting was recently performed in the shop of William Ruwell, 719-21 Noble St., Philadelphia, Pa., and is believed to be one of the largest pieces of gear cutting which has ever been done on a No. 4 milling machine. The work consisted of an iron casting 56 inches in diameter which had a four pitch gear cut on its outside circumference. The gear face was 3 inches in width, the total width of the casting 24 inches, and its weight about 2680 pounds.

This gear was cut on a No. 4 Cincinnati universal high-power milling machine. The casting was supported by a ball bearing placed in the center at the top and a triple rope and block tackle was used to raise it into position. The weight of the casting was counterbalanced, the counterweight being located at a point where it could not interfere with the work. This arrangement worked so well that it was estimated that the casting was raised by a pull not exceeding ten pounds.



An Unusual Job for a No. 4 Milling Machine

The regular universal dividing head was moved to the extreme left end of the milling machine table; the spindle of the head was then placed in a vertical position and an arbor made to fit the hole in the casting. The other end of the arbor was located in the dividing head. The casting was now lowered onto this arbor and a stocking cut taken all the way around. The casting was then examined to see that this stocking cut gave accurate results, after which the worm-wheel of the dividing head was thrown out, and with the casting still mounted on the dividing head, a pawl was attached to the table of the milling machine. This pawl was now used for indexing the work, the C-clamp shown in the illustration being used to hold the casting securely in position. Although this work is considerably beyond the range usually covered by a No. 4 milling machine, the job was turned out with satisfactory results.

* * *

IMPORTANT PATENT DECISION AFFECTING TRUST AGREEMENTS

The United States Supreme Court, on November 18, affirmed the opinion of the Federal District Court of Maryland that the Standard Sanitary Mfg. Co., and forty-nine other defendants, constituting the so-called "bath-tub trust" are not, under the patent laws, warranted in making the license agreement under which they have been doing business. Under this license agreement, the various manufacturers of bath-tubs were allowed to use a patented device in their manufacturing processes, but only on condition that they abided by an attached price list, would not sell to jobbers who bought from independents, would not sell in a certain territory, and would not sell "seconds." The court held that it is illegal for the manufacturer of a patented article to fix the price at which articles manufactured by it must be sold at retail, and thus laid down the broad principle that there can be no monopoly in the unpatented product of a patented machine without the violation of the anti-trust law. Justice McKenna delivered this as the unanimous opinion of the court.

The Supreme Court in this decision refuses to extend the doctrine of the Dick mimeograph case to the unpatented product of a patented machine. The defendants in the bath-tub case owning patents on machines used in the manufacture of enameled ware attempted to fix prices and destroy competition in an unpatented product, but their conduct was held to be illegal. This decision, together with that of the Dick mimeograph case, in which it was held that the purchaser of a patented device could be compelled to buy from the patentee all the supplies used on that particular machine, are probably the two most important decisions in patent cases in a number of years.

* * *

HEAVY THIRTY-SIX-INCH LATHE JOB IN A PITTSBURG STEEL PLANT

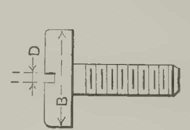
An exceptional lathe operation which was recently performed in one of the large steel plants in the Pittsburg district is illustrated herewith. The work is a 3½ per cent nickel steel shaft, which was turned from a forging 25 feet 5 inches in length by 22 inches in diameter, which weighed 33,000 pounds. When finished, the maximum diameter was 20 inches and the weight 28,000 pounds. The engine lathe used for this purpose is of the regular 36-inch triple-geared type manufactured by the Boye & Emmes Machine Tool Co., successors to Schumacher & Boye, Cincinnati, Ohio. The ability to deal with such a job, which is necessarily a most severe test, certainly speaks well for the capacity of the lathe on which the work was performed.

Turning an exceptionally Large Nickel Steel Shaft on a 36-inch Boye & Emmes Triple-geared Engine Lathe

SLOTS IN SCREW HEADS—WIDTH OF FLAT ON SHANKS OF TOOLS

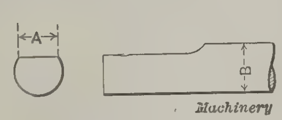
For ordinary fillister-head screws, where the diameter of the head is made in proportion to the diameter of the body of the screw, the width of the screw slot ought to be made according to the standard approved by the American Society of Mechanical Engineers in May, 1907. According to this standard, the width of the slot is figured from the formula $D = 0.173A + 0.015$ inch, in which D equals the width of the slot for the screw-driver and A equals the diameter of the body of the screw itself. When the screw heads are made especially large in proportion to the body of the screw, however, as shown in the illustration at the top of the accompanying table, this formula is not adaptable, as the screw slots would be entirely too narrow for the size of the head, and, in that case, it is better to base the width of the slot for the screw-driver on the diameter of the head rather than on the body diameter of the screw. In this case the width of the screw-driver slot is calculated from the formula $D = B \times 0.090$, in which D equals the width of the screw-driver slot and B the diameter of the head of the screw. This formula gives good proportions for average conditions, although, of course, judgment must be used in drawing the line between the conditions when the regular A. S. M. E. formula ought to be used and when the head is large enough to call for the use of the present formula. A table is given in which the width of the screw-driver slot is calculated for different diameters of head according to this formula.

TABLE OF SCREW-DRIVER SLOTS



B	D
3/16	0.017
7/32	0.019
1/4	0.022
9/32	0.025
5/16	0.028
11/32	0.031
3/8	0.034
7/16	0.039
1/2	0.045
9/16	0.050
5/8	0.056
11/16	0.062
3/4	0.067
13/16	0.073
7/8	0.079
15/16	0.084
1	0.090
1 1/16	0.095
1 1/8	0.101
1 3/16	0.107
1 1/4	0.112
1 5/16	0.118
1 3/8	0.124
1 7/16	0.129
1 1/2	0.135

TABLE OF FLATS FOR SET-SCREW ON SHANKS OF TOOLS



B	A	B	A
1/8	0.047	1 5/16	0.492
5/32	0.058	1 3/8	0.515
3/16	0.070	1 7/16	0.539
7/32	0.082	1 1/2	0.562
1/4	0.094	1 9/16	0.586
9/32	0.105	1 5/8	0.609
5/16	0.117	1 11/16	0.633
11/32	0.129	1 3/4	0.656
3/8	0.140	1 13/16	0.679
13/32	0.152	1 7/8	0.703
7/16	0.164	1 15/16	0.726
15/32	0.176	2	0.750
1/2	0.187	2 1/16	0.773
9/16	0.211	2 1/8	0.797
5/8	0.234	2 3/16	0.820
11/16	0.258	2 1/4	0.844
3/4	0.281	2 5/16	0.867
13/16	0.304	2 3/8	0.890
7/8	0.328	2 7/16	0.914
15/16	0.351	2 1/2	0.937
1	0.375	2 5/8	0.984
1 1/16	0.398	2 3/4	1.031
1 1/8	0.422	2 7/8	1.078
1 3/16	0.445	3	1.125
1 1/4	0.469	...	.....

The width of the flat for set-screws on round shanks of tools may not seem to be of great importance, but, nevertheless, it is advisable to have a standard for this. The accompanying table gives, therefore, the width of the flat A for a number of different diameters B figured from the formula $A = \frac{3}{8} B$. If the flat is milled to this width, the appearance of the tool shanks will be satisfactory, and by using a standard, uniformity is assured.

Tools with a square milled on the shanks often present a bad looking appearance by having sharp corners. This often produces burrs on the square itself, which prevent the tools from entering the socket or wrench in conjunction witn which they are used, and—what is still worse—is often the cause of bruised and cut hands. A well-proportioned square having a good round corner is obtained if the width across the flats is made ¾ times the diameter of the shank. A.

LAUNCHING OF THE NEW YORK

The ninth U. S. dreadnaught *New York* was launched at the Brooklyn Navy Yard October 30. This battleship is a sister ship to the *Texas*, building at Newport News by the Newport News Shipbuilding & Drydock Co., and is the largest yet launched. Her keel was laid in September, 1911, and when launched the construction was about sixty per cent completed; the hull at launching weighed over 9000 tons. About 25,000 pounds of special grease was used to lubricate the launching ways. These ways consist of two wooden tracks, each about four feet wide and thirty feet apart upon which the vessel rests at launching, being supported in a cradle or sliding ways built to conform to the hull. The spectacular "sawing off" of the sliding ways to release the vessel was made obsolete by a double trigger device, located in the launching ways amidship, and operated by two hydraulic plungers. The vessel had been wedged up onto the launching ways and was held only by the triggers when the signal was given. The turn of a valve released the liquid in the cylinders, and the weight of the vessel pressed the triggers down out of the way, thus freeing her to slide into the water. The mechanism worked perfectly and will be used hereafter; it insures the safety of the men, and enables the time of release to be fixed to the fraction of a minute.

The *New York* is the largest and most formidable battleship in the world, the mean displacement being 27,000 tons; the length on water line, 565 feet; breadth at water line, 95 feet; mean drafts, 28 feet 6 inches. The propelling machinery is triple expansion reciprocating engines of 28,100 H. P. driving two propellers. The main battery comprises ten fourteen-inch rifles and four submerged twenty-one-inch torpedo tubes; and the secondary battery, twenty-one five-inch rapid fire guns, and smaller pieces. The cost of the fourteen-inch gun and mount is $62,000 for the gun and $50,000 for the mount. The life of a gun before relining is necessary is 225 rounds. The range at fifteen degrees elevation is over twelve miles, and the penetration of face-hardened armor at six miles is sixteen inches. The cost of a round of ammunition is $600. The total cost of the vessel, hull and machinery exclusive of armor and guns is about $6,000,000.

* * *

PERSONALS

Robert Cary has resigned his connection with the Gisholt Machine Co., Warren, Pa., and taken a position as superintendent of the J. N. Lapointe Co., New London, Conn.

H. S. Kartscher has left the designing department of the Pratt & Whitney Co., Hartford, Conn., to take the position of chief draftsman of the Rivett Lathe & Grinder Co., Brighton, Boston, Mass.

M. O. Frenier, mechanical engineer, formerly with the engineering department of the Knox Automobile Co. of Springfield, Mass., has opened an engineering office at 168 Bridge St., Springfield, Mass.

J. E. Brennan, who for several years held the position of assistant superintendent of the Remington Arms–Union Metallic Cartridge Co., at the works in Ilion, N. Y., has been appointed superintendent of the works.

A. J. Jones, formerly with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, has been made secretary and manager of the Acme Machine Tool Co., of Cincinnati, manufacturer of turret lathes and screw machines.

Walter G. Lamont, late with Elliott & Fisher Co., Harrisburg, Pa., manufacturer of billing machines, has taken the position of mechanical engineer with the Simplex Non-Refillable Seal & Stopper Co., at Baltimore, Md.

Henry K. Swinscoe has resigned the position of assistant superintendent of the South Works of the American Steel & Wire Co., Worcester, Mass., to enter the employ of the Morgan Spring Co., of Worcester, as superintendent.

Clifford F. Kern, formerly president of the Kern Machine Tool Co., Hamilton, Ohio, has disposed of his interest in that company and purchased the Von Wyck Machine Tool Co. of Cincinnati, manufacturer of 15-inch engine lathes.

Fred R. Jochmus, who for several years has been assistant foreman in the machine shop department of the Remington Arms–Union Metallic Cartridge Co., at Ilion, N. Y., has been appointed foreman of the machine shop department.

F. B. Jacobs, for several years in the employ of the Carborundum Co., Niagara Falls, N. Y., in various capacities, and

a frequent contributor to MACHINERY, has resigned from his position as salesman in the company's Philadelphia office.

Edward K. Hammond of Chicago, a frequent contributor to the technical press, has joined the editorial staff of MACHINERY. Mr. Hammond is a graduate of Armour Institute of Technology, and has had practical shop and editorial experience.

Corneil Ridderhof, formerly treasurer and manager of the Wilmarth & Morman Co., Grand Rapids, Mich., and an occasional contributor to MACHINERY, has taken a position as assistant manager of the Western Gas Engine Corporation, Los Angeles, Cal.

Charles A. Schaefer, formerly general foreman of Schumacher & Boye, and for fourteen years with that company, has taken a position as superintendent of the John B. Morris Machine Tool Co., Cincinnati, O., manufacturer of lathes and radial drills.

Frank J. Lapointe, secretary of the J. N. Lapointe Co., who has been acting as superintendent of the works, will now give his whole attention to the engineering department of said concern, as Mr. Robert Cary, formerly of the Gisholt Machine Co., Warren, Pa., is now the superintendent.

Walter B. Snow, publicity engineer, 170 Summer St., Boston, has recently increased his staff by the addition of Mr. Fred R. Lufkin, formerly of the instruction staff in electrical engineering of the Massachusetts Institute of Technology, and late assistant superintendent of lighting and wires of Brookline, Mass.

Joseph Wolf, formerly of the Hisey-Wolf Machine Co., Cincinnati, Ohio, has become interested in the Cincinnati Electrical Tool Co., and has been made vice-president and general manager. The company makes portable electric drills and grinders and Mr. Wolf will take entire charge of the management of the business.

E. P. Bullard, Jr., president of the Bullard Machine Tool Co., delivered an address Tuesday evening, November 26, before the Cleveland Engineering Society in Cleveland, Ohio, on the subject, "A New Era in Machine Design," in which the basic principles of the design and construction of machines which will fully meet the new requirements of the present-day manufacturer, were discussed.

E. J. Kearney, president of the Kearney & Trecker Co., Milwaukee, Wis., who was very ill with pneumonia in Boston, at the time of the recent National Machine Tool Builders' Association's annual convention in New York, has recovered, after having been confined to the hospital for five weeks. Mr. Kearney is gradually regaining his strength, and recently passed through New York on his way home with Mrs. Kearney, traveling by easy stages.

Henry Hess has resigned as president of the Hess-Bright Mfg. Co. and has sold all of his holdings in that company. It is understood that no change in the policies of the company is contemplated. Mr. Hess became interested in ball bearings while general director of the German Niles Tool Works. The Deutsche Waffen-und Munitions Fabriken ball bearings had just become famous through their use in the German Mercedes automobile in the winter of 1901. Up to this time all the early types of ball bearings had been failures as applied to automobiles. Owing to its novel mechanical features and high efficiency, the German Mercedes car made a great sensation, and the general adoption of ball bearings in automobiles soon followed. Armed with the American rights of the DWF ball bearings, Mr. Hess came to this country and in 1904 formed the Hess-Bright Mfg. Co. The company started with a small one-room office, and grew until today it owns a new factory and thirteen acres of land at Front St. and Erie Ave., Philadelphia. The history of the company is, in part, Mr. Hess's history. At first the bearings were used only in automobiles. Since then, however, the field has broadened, and Mr. Hess has made applications of the bearings in many other types of machines in the industrial world, especially adapting them for use at points where plain bearings would not stand up, as where high speed is necessary. Mr. Hess has contributed largely to the technical literature of ball bearings and is looked upon as one of the foremost authorities in America on the subject. He was judge of the mechanical exhibit at the St. Louis Exposition; he is a member of the council of the American Society of Mechanical Engineers, a former president of the Society of Automobile Engineers, and chairman of the Philadelphia Branch, president of the Engineers Club of Philadelphia and a member of the fair practice committee of the Motor and Accessories Manufacturers Association.

COMING EVENTS

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

December 5-7.—Sixth annual convention of the National Society for the Promotion of Industrial Education in Philadelphia, Pa. Headquarters, Hotel Walton. C. A. Prosser, secretary, 105 East 22d St., New York.

January 11-18.—National Association of Automobile Manufacturers show of pleasure vehicles at Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 20-25.—National Association of Automobile Manufacturers show of auto-truck and delivery cars at Grand Central Palace, New York. M. L. Downs, secretary, 7 East 42d St., New York.

NEW BOOKS AND PAMPHLETS

ROAD LEGISLATION AND ADMINISTRATION IN IOWA. By John E. Brindley. 112 pages, 8¾ by 5¾ inches. Three tables of information on road legislation and administration. Published by the Engineering Experiment Station, Iowa State College of Agriculture and Mechanical Arts, Ames, Iowa, as Bulletin No. 28.

TABLE OF ANGLES OBTAINABLE ON THE DIVIDING HEAD. Prepared and published by C. W. Ripsch and P. W. Hirsch, 113 Hawthorn St., Dayton, O. Price 25 cents.

These tables were prepared to meet the needs of machinists and toolmakers who are required to find angles on the dividing head of the milling machine quickly. The tables cover all the angles obtainable by simple indexing, using the plates furnished with the machine and an additional plate containing ninety holes, and are calculated to the nearest second.

THE A B C OF THE DIFFERENTIAL CALCULUS. By William Dyson Wansbrough. 148 pages, 7⅜ by 5⅛ inches. 30 illustrations. Published by D. Van Nostrand Co., New York. Price $1.50.

The object of this little book, which is clearly expressed by the title, is to present the essential details of the differential calculus in as concise and readily understandable a manner as possible. The present is the third edition, and is practically unchanged. The book can be recommended to those who wish to study the calculus at home. The subject is presented simply and progressively; the language often is unmathematical and the examples are drawn from everyday practice.

EMERY AND THE EMERY INDUSTRY. By A. Haenig. 103 pages, 7½ by 5 inches. 45 illustrations. Published by D. Van Nostrand Co., New York. Price $2.50.

The development of competition in the machinery industry has fully justified the expression that "time is money." This condition has led to the development of many forms of machinery that not only assist the workman in carrying out certain operations, but in many cases, actually do away with a large amount of hand work. Among such improvements, the substitution of emery wheels for the old type of grindstone, or for the file, has found wide application. In the present text, the author presents to both the engineer and layman, a general discussion of the subject of emery and the emery industries, treating of the raw materials, the finished wheels, and machines used to drive them, in the classes of work where they find application.

THE MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1913. 330 pages, 6¼ by 4¼ inches. 71 illustrations. Published by Emmott & Co., Ltd., 65 King St., Manchester, England.

The latest edition of this annual contains a variety of useful information on mechanical engineering which is presented in convenient form for reference. The opening chapters deal with subjects pertaining to power installations and cover steam, gas and oil units. Following this section comes information on power transmission with useful tables on the standard dimensions of equipment used for this purpose. A considerable amount of useful information on machine shop practice is also presented chiefly in tabular form. In addition, the book contains a number of tables on the characteristics of engineering materials and also tables of mathematical constants. Considering the low publisher's price—six pence— this book is a remarkably cheap and valuable handbook.

FORGING, STAMPING AND GENERAL SMITHING. By Benjamin Saunders. 428 pages, 8¾ by 5¾ inches. 728 illustrations. Published by Spon & Chamberlain, 123 Liberty St., New York. Price $7.50, net.

The information presented in this book will be found of value to foreman-blacksmiths, engineers and managers, and others concerned with the operation of blacksmith shops. The text includes matter on forging, stamping and general smithing, the methods in each case being freely illustrated and described in a concise and readily understood manner. The author is, himself, a practical foreman-blacksmith and has drawn his information from a wide experience with the subject upon which he writes. One of the points of particular value is that the time required to complete given operations is indicated in connection with the description of the method to be followed. The time and other data presented have been carefully verified by the writer; the work, therefore, may be taken as a guide by those who are looking into the efficiency of blacksmith shop operation.

GASOLINE ENGINES; THEIR OPERATION, USE AND CARE. By A. Hyatt Verrill. 275 pages, 7½ by 5¼ inches. 152 illustrations. Published by Norman W. Henley & Son, New York. Price $1.50.

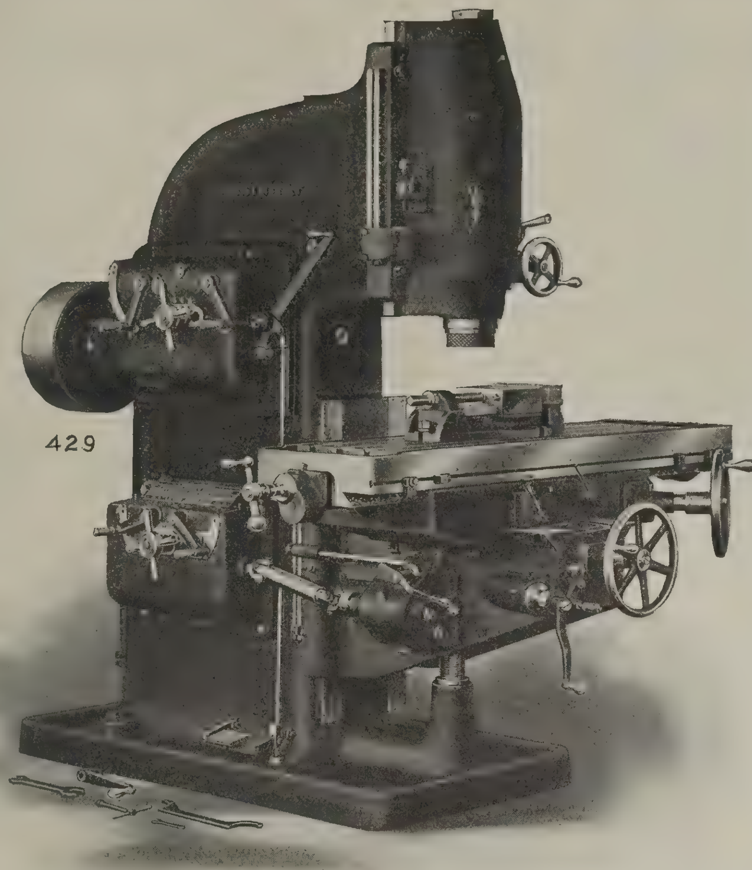
The wide application of gasoline engines to motor-driven vehicles and to a variety of classes of stationary service, has created a need for a book dealing with the methods of operating and caring for this type of equipment. The subject is one which affords an opportunity for highly technical treatment, but such a text would be of little value to the many users of gasoline engines who are non-technical men. It is for the use of such readers that the present volume has been written. The text gives all necessary information concerning the operation and care of gasoline engines in simple language, and the use of technical terms has been avoided as far as possible. There are certain cases, however, where technical terms have to be used, as for instance, in ordering new parts, but to make these clear, a glossary has been included which gives the meaning of all the technical terms used.

SOFT SOLDERING, HARD SOLDERING AND BRAZING. By James F. Hobart. 190 pages, 7 by 4¾ inches. 62 illustrations. Published by D. Van Nostrand Co., New York. Price $1, net.

Some mechanics believe that the operations of soldering and brazing are comparatively simple, requiring no special degree of skill or experience on the part of the workman. As a matter of fact they involve a wide range of manipulations, and frequently demand experienced workmanship of a high order. At the same time, so many mechanics are accustomed to performing soldering operations with tools and appliances which might be greatly improved upon, that the author has been led to offer this book in the hope that it will serve as a practical aid to an improvement of methods. If such a purpose can be accomplished, the interests of both mechanics who seek advancement and employers who are awake to the importance of efficiency and economy, will be advanced by a careful study of this volume. The different phases of soldering and brazing are dealt with, the subject matter being based upon the author's experience in this work.

TOOTHED GEARING. By George T. White. 217 pages, 7⅜ by 4¾ inches. 136 illustrations. Published by D. Van Nostrand Co., New York. Price $1.25.

This book is presented by the author with the view of explaining simply the action of the principal forms of gear teeth. The two forms of tooth profile in most common use—the cycloidal and the involute—have been considered in detail, neither being strongly advocated in preference to the other. On cut gears, the involute curve is preferred to the cycloidal, and has almost entirely displaced it on such wheels. This change has gone so far that the involute form may very shortly become the generally accepted standard the world over for machine-cut teeth. The contents by chapter heads are: Kinematics; The Spur Wheel—Cycloidal Teeth; Annular Wheels—Cycloidal Teeth—; The Spur Wheel—Involute Teeth; Obliquity of Action, etc.; Pin Gearing; Non-Circular Wheels; Lobed Wheels; Helical Wheels; Bevel Wheels; Skew Bevel Wheels; Worm-Gearing; Oblique Worm and Wheel; Screw Wheels or Spiral Wheels; Strength of Teeth; Durability; Trains of Wheels; The Odontograph.



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How to Read a Drawing. By Vincent C. Getty. 64 pages, 9¾ by 6¾ inches. 61 illustrations. Published by J. B. Lippincott Co., Philadelphia and London. Price $1, net.

There is probably no study of more general use to the practical mechanic than the reading of drawings. No matter what class of work he is engaged upon there will be constant occasion for him to use drawings in carrying on his work. This knowledge can be readily acquired by the young mechanic without being well informed on engineering or other technical matters, as it is only necessary for him to be able to read English to enable him to acquire a working knowledge of mechanical drawings. In presenting this book, the author has endeavored to explain the methods of reading a drawing without the use of technical terms, but where it has been absolutely necessary to include such terms an explanation of them has been given. The main principles of drawing are thoroughly explained and sufficient examples are given to enable anyone to clearly understand a drawing which may be placed before him. This is a book which is particularly adapted to home study and should enable any mechanic to acquire knowledge upon a subject that will be of particular value to him.

Practical Mathematics. By Claude Irwin Palmer. Part I. Arithmetic With Applications; 139 pages, 7⅛ by 4¾ inches. 20 illustrations. Part II, Geometry with Applications; 149 pages, 7⅛ by 4¾ inches. 130 illustrations. Published by McGraw-Hill Book Co., 239 West 39th St., New York. Price 75 cents, net, per volume.

The subject of mathematics is one with which many mechanics are insufficiently acquainted, and the realization of this fact causes many to attempt to remedy the deficiency by attending evening classes. During the past eight years Mr. Palmer has taught evening classes in mathematics comprising a total of over 500 men, and has prepared the text to meet the requirements of such students. In all cases, the subject matter has been made as practical as possible in order that its application to actual problems which the students will subsequently encounter in the shop, may be made as easy as possible. The series will be completed by two other volumes covering the subjects of algebra and trigonometry, and it appears that the complete text should meet a need in presenting mathematical subjects in evening classes, continuation schools, etc., which are primarily intended for the education of practical men of somewhat advanced years.

The Theory of Engineering Drawing. By Alphonse A. Adler. 312 pages, 9 by 6⅛ inches. 273 illustrations. Published by D. Van Nostrand Co., New York. Price $2.

The subject matter of this volume is largely the same as that of many other treatises on descriptive geometry but the author has given it the title "Theory of Engineering Drawing," believing that this indicates the ultimate purpose of the book in a better way. The text was written with the purpose of correcting certain weaknesses in the presentation of the subject of descriptive geometry, and emphasizes the fact that the student is concerned with the representation on a plane of objects in space or three dimensions. Although analysis is important as affecting primary purposes, the development of methods for representation and interpretation of the resulting drawings cannot be regarded as an end in itself. The number of fundamental principles treated in the text has been reduced to a minimum; indeed it will be found that the entire text is based on the problem of finding the piercing point of a given line on a given surface, together with a few additional problems. The author believes that this method of treatment has simplified the presentation of a somewhat abstract subject, so that it may be more readily grasped by the average student.

Petrol Engine Construction and Drawing. By W. E. Dommett. 55 pages, 11 by 8½ inches. 26 illustrations. Published by Longmans, Green & Co., Fourth Ave. and 30th St., New York. Price 75 cents, net.

Existing books on machine design have failed to present information to meet the requirements of draftsmen engaged in work dealing with petrol engines and to meet this requirement, a series of drawings was prepared for use at Guildford and Kingston-on-Thames Technical Institutes. These drawings have been embodied in the present book with the view of compiling a text to meet the requirements of technical students, engineers, apprentices and junior draftsmen, who are either engaged on work in connection with petrol (gasoline) engines or are otherwise interested in the subject. Some of the dimensions in these drawings are given in millimeters on account of the extensive use of this system on the continent of Europe. For purposes of reference, a very brief description has been given of the four-cycle and two-cycle engines. The purpose of so doing has been to encourage the student-draftsman to enter into the mechanical principles underlying the operation of the parts which he is drawing in addition to simply producing a view of them for the use of the engineering department. In view of the wide application of petrol engines on motor cars, marine vessels, aeroplanes and stationary engines, it is believed that this work should be one of considerable value.

The Modern Gasoline Automobile. By Victor W. Page. 693 pages, 8⅝ by 6 inches. 380 illustrations. Published by Norman W. Henley & Son, New York. Price $2.50.

In preparing this book, the author's object has been to develop a text on the modern gasoline automobile which will be readily understood by non-technical readers. The usefulness of such a book will be readily appreciated when it is remembered that a large number of the owners of automobiles are business and professional men who have very little mechanical knowledge. The present book has been written primarily for the benefit of such readers and with this purpose in view, technical terms have been eliminated from the text as far as possible. At the same time, the author has appreciated the necessity of entering into a considerable amount of detail in order to present the subject in an adequate manner. This is probably one of the most striking differences between this book and preceding books which have been written by other authors with the view of covering the same subject. It is an established fact among automobile builders and sales agencies that many persons are deterred from purchasing an automobile, not on account of lack of means for the initial investment or provision for maintenance, but owing to the somewhat general belief that the upkeep of a car requires considerable mechanical ability. While this is undeniably true, any business man should be able to acquire much of the necessary knowledge concerning the operation and maintenance of a car from Mr. Page's book.

Hygiene for the Worker. By Dr. William H. Tolman. 231 pages, 7⅜ by 5¼ inches. Profusely illustrated. Published by the American Book Co., New York. Price 59 cents, postpaid.

It has been truly said that good health is the first requisite of success in any business undertaking. This is particularly true in the case of industrial workers who are more or less dependent upon physical strength in earning their livelihood. Dr. Tolman has had unusual opportunities for studying the conditions governing the health and general welfare of industrial workers and has developed his text with the particular object of making it acceptable reading for workers who are just starting upon their business career. The fault of many books intended to teach methods of hygiene is that they have been made more or less dependent upon a knowledge of anatomy. In the present book, such scientific terms have been entirely eliminated and a simple description is given of the necessary steps for the young worker to take in order to preserve his health and vitality in the best possible working condition. The book is freely illustrated with drawings especially prepared for the purpose and should be of particular interest and value to the class of readers for which it is intended. The chapter titles are as follows: Applying for a Position; Preparing for the Day's Work; Good Habits for the Workmen; Suitable Clothing; Food and Drink; Alcohol and Tobacco; The Noon Hour; Hygiene of the Workroom; Fatigue; After Hours; Holidays and Outings; Choice of Occupation; Occupational Dangers—Accidents; Occupational Dangers—Poisons and Fumes; Fire; First Aid to the Injured; Tuberculosis, etc.

Commercial Engineering. By "A General Manager" (Alfred B. Liversedge). 369 pages, 8¾ by 6⅛ inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price $1.80.

The text presented in this book reproduces a series of articles which recently appeared in the *Mechanical World*. The primary aim of the text was to fill in the gap which exists between the information acquired from any form of technical or business education and the actual application of the knowledge so acquired in commercial or engineering fields of endeavor. Business aptitude or the ability to handle engineering work to advantage can only be acquired through years of actual experience, and such experience necessarily entails making a start in positions of minor importance. One of the objects of the matter presented in this text is to afford a means for employes holding positions of minor importance to get in touch with the work carried on by the directing officials of large corporations. It is believed that a study of such methods will prove of particular value, as a knowledge of the workings of the organization of large corporations will place the employe in a position to undertake readily the duties of a more important position, when the opportunity of so doing presents itself. In addition, this book presents information which should be of value to the man higher up in pointing out the possibilities of markets which exist for engineering products, and the best methods of conserving these markets for his company. One of the valuable features of the method of presentation of this text is that it will appeal to a wide circle of technical readers occupying positions of varying importance.

NEW CATALOGUES AND CIRCULARS

Edwin Burhorn Co., 71 Wall St., New York. Catalogue of Burhorn and "Acme" cooling towers.

American Engineering Co., Philadelphia, Pa. Report of tests made on Taylor gravity underfeed stokers.

New Jersey Foundry & Machine Co., 90 West St., New York. Circular of cranes, tracks, trolleys and hoists.

Green Fuel Economizer Co., Matteawan, N. Y. Booklet entitled "Best Proportions of Boiler and Economizer Surface."

George Nash Co., 217 Pearl St., New York. Card illustrating "Perfection" spring winder for winding springs by hand or in the lathe.

Otto Gas Engine Works, 33d and Walnut Sts., Philadelphia, Pa. Special number of the *Otto Cycle* describing the Otto horizontal crude oil engine operating on the Diesel principle.

W. S. Rockwell Co., 50 Church St., New York. Catalogue 16 on semi-automatic furnaces for annealing, hardening, tempering, and heat treating, aluminum, brass, copper, german silver, sterling silver, steel, etc.

Kern Machine Tool Co., Hamilton, Ohio. Circular of sixteen-inch ball bearing, sensitive type, drilling machines furnished in 1-, 2-, 3- and 4-spindle combinations, with and without table elevating screw.

Emmert Mfg. Co., Waynesboro, Pa. Catalogue No. 12 of Emmert vises, comprising patternmakers' and woodworkers' universal vises, toolmakers' and machinists' universal vises, machinists' plain vises and combination pipe vises.

De Laval Steam Turbine Co., Trenton, N. J. Booklet on the new De Laval steam turbines with velocity stages, built in sizes up to 600 H. P., and suitable for direct connection to centrifugal pumps, blowers, small generators, etc.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 88 on hydraulic leather belt presses, listing six distinct types of leather presses; also hydraulic pumps, accumulators, fittings, etc., generally required with hydraulic presses.

Otis Elevator Co., 11th Ave. and 26th St., New York. Catalogue of inclined elevators for quick handling of freight and merchandise, truck elevators, overhead carriers, dock elevators, ramp elevators, dumbwaiters, horizontal conveyors, etc.

George W. Richardson, 4212-16 24th Place, Chicago, Ill. Circular of the Richardson direct-reading metal slide-rule, having distinctive features; also Johnson's combination pocket rule made of german silver, forming a hook-rule, caliper-gage, protractor, triangle, or try-square.

Green Fuel Economizer Co., Matteawan, N. Y. Catalogue of standard and special fuel economizers; mechanical draft outfits; heating, ventilating and drying outfits; hot blast heaters; steel plate fans; motor- and engine-driven fans, cast-iron volume blowers, exhausters, etc.

Cincinnati Precision Lathe Co., Cincinnati, O. Catalogue of Cincinnati precision lathes which have the following features: no cone pulleys, continuous spindle bearings, absence of belt pull on spindle, variable speed and reverse without shifting of belts, permanency of alignment, etc.

Cochrane-Bly Co., Rochester, N. Y. Circular on the Cochrane-Bly universal shaper which was illustrated and described in the October number. The shaper is designed especially to meet the needs of tool- and die-makers, being adapted to produce accurate work on dies, special tools, jigs, etc.

Celfor Tool Co., Buchanan, Mich. Table of feeds and speeds for Celfor drills working in cast iron, medium and hard or very tough steel, ranging from ¼ inch to 3 inches diameter. The tables are printed on "Crystaloid," in convenient shape for hanging up in the shop for ready reference.

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Data sheets on ball bearings comprising propeller shaft ball bearings, mounting for double exhaust fan, two direction thrust bearings, special bearings for automobile steering pivots, vertical shaft bearings, and classified index to titles of ball bearing data sheets.

Crocker-Wheeler Co., Ampere, N. J. Bulletins Nos. 150 and 158, superseding Bulletins Nos. 114, 133 and 123, on coupled and belt type alternating-current motors two- and three-phase 50 KVA and up; and adjustable speed motors 1/3 to 32 H. P., speed ranges 2 to 1, 2.5 to 1 and 3 to 1, made in eleven frame sizes.

Manning, Maxwell & Moore, 85-89 Liberty St., New York. Twelve page bulletin descriptive of Shaw electric monorail system with fixed tongue switch which effects an advance and improvement in monorail construction, eliminating the danger of accidents and delays incident to the use of the moving-tongue type.

Foster Machine Co., Elkart, Ind. Circular of plain head and geared head turret lathes, plain head and geared friction head screw machines, universal or set-over turret lathes, special friction head

CONTENTS FOR DECEMBER

The first column of page numbers applies to the Engineering and Railway Editions: the second to the Shop Edition.

screw machines, cock grinder for grinding water and gas cocks up to two inches diameter, tap holders, box tools and other accessories.

Vulcan Engineering Sales Co., Fisher Bldg., Chicago, Ill. Catalogue of punches, shears, rolls, bulldozers, etc., made by the Rock River Machine Co., comprising the "Badger" single end punch and shear, "Badger" single end punch, "Badger" coping punch, "Badger" power plate bending roll and air compressors for general purposes.

Platt Iron Works Co., Dayton, Ohio. Catalogue of Platt horizontal and vertical centrifugal pumps, illustrating different forms of centrifugal pumps adapted to many kinds of service. Users of this apparatus will find interesting and valuable data on the general subject of centrifugal pumps and the conditions necessary for their economical use.

De Laval Steam Turbine Co., Trenton, N. J. Catalogue and treatise on the De Laval steam turbines, containing 120 pages, 6 by 9 inches. The relative advantages of the several fundamental types of turbines are discussed and much space is devoted to a discussion of the "speed-compromise" problem. The publication is an interesting and valuable contribution to trade literature.

Foote Bros. Gear & Machine Co., 210-220 North Carpenter St., Chicago, Ill. Price list of standard gears, comprising spur, bevel, worm gears, raw hide pinions and reducing gears. The catalogue contains 240 pages and comprises considerable data on gear elements that are required in the design and cutting of gearing; also weight tables, gages, drill sizes, thread shapes, power of belting, capacity of cisterns and tanks, etc.

Niagara Machine & Tool Works, Buffalo, N. Y. Catalogue No. 50 of tools and machines for working sheet metals, tinsmiths' and roofers' tools, etc., comprising folders, brakes, bench machines, beaders, flangers, groovers, double seamers, forming rolls, tube formers, stakes, snips, roofing tools, gutter beaders, notchers, rotary shears, foot squaring shears, lever punches and shears, power squaring shears, power rotary shears, etc.

William Cramp & Sons Ship & Engine Bldg. Co., Philadelphia, Pa. Pamphlet on gear bronzes describing six kinds, including Parsons' manganese bronze. The characteristics of each kind are given with illustrations showing application in use. The bronzes named range from the type suitable for light loads and high speeds to Parsons' manganese bronze adapted for heavy loads and slow speeds, under excessive strain and shock.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin No. 11 on "National" pipe, and defining "spellerizing" which is a method of treating metal. The heated bloom is worked by rolls having regularly shaped projections, and then by smooth face rolls, the result being a uniform dense texture of the steel which is better adapted to resist pitting and corrosion than is the structure of common steel. A list of bulletins published by the company is also included.

National-Acme Mfg. Co., Cleveland, Ohio. Calendar for 1912-13, made in the form of a wall pocket, having two openings through which the calendar for the month and advertisements of the National-Acme automatic screw machine appear. The leaves can be removed and transposed to the back, keeping the entire calendar for the year intact, if desired. The illustrations and print appear in white on a black background, creating a very pleasing effect. A limited supply is available for distribution.

General Electric Co., Schenectady, N. Y. Bulletin A 4037 on isolated and small plant switchboards; A 4036 (superseding bulletin 4917) on direct-current exciter panels; 4974 on current limiting reactances; 4993 (superseding bulletin 4858) on type RI single-phase motors; A 4004 (superseding bulletin 4836) on the G-E steam flow meter; A 4034 on type W long-life flame arc lamps; and A 4039 on direct-current motor-starting and speed-regulating rheostats and panels, superseding bulletins 4600, 4599, 4532 on the same subject.

Pennsylvania R. R. Co., Philadelphia, Pa. Booklet on the American Land & Irrigation Exposition held in New York City November 15 to December 2 at the 71st Regiment Armory. The P. R. R. Co. in common with other progressive railroads, is educating farmers to produce more and better crops. Larger crops mean more freight and merchandise to be transported, more passengers and better dividends. The booklet is illustrated with examples of farm products and is one of a series of interesting and valuable farm publications issued by the company.

Earle Gear & Machine Co., Wyoming and Stenton Aves., Philadelphia, Pa. Pamphlet on herringbone gears describing their characteristics and superiority to spur gearing where smooth, uniform transmission is required. Examples of herringbone gears made by the company are illustrated, ranging up to 365 H. P. capacity, in which example the pitch diameters of the gearing and pinion are 76 and 11 inches, respectively, and the face width 21 inches. The pamphlet also illustrates examples of miter and bevel gears, wormwheel balanced gears, etc.

Deane Steam Pump Co., 115 Broadway, N. Y. Catalogue D 167 on sand riddlers; D 169, on hydraulic air-charging device; D 171, on horizontal duplex piston pumps operated by direct-connected gasoline engines; D 202, on duplex steam pumps piston pattern; D 217, on duplex horizontal double-acting power pumps; D 220, on portable mine pumps, outside packed plunger pattern; D 219, on modern water works for town and city supply; supplement B to D 200, on deep well pumping machinery; D 222, on automatic pumps and receivers; D 224, on horizontal double-acting single-cylinder power pumps.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of "Universal" conductor pipe and eave-trough machinery, paint rolls, drop presses, melting outfits and dies for ceilings, sidings, cornices, etc. Circular of "Universal" garage equipment comprising turntables, jacks and floor cranes. Circular of "Canton" alligator shears made in five sizes ranging in capacity from 1½ inch square round or equivalent cross-section, soft steel or iron, to 3 inches square or equivalent section. Circular of portable floor crane and hoists for use in machine shops, factories, garages, etc. Circular of turntables for shop and factory railways.

Dodge Mfg. Co., Mishawaka, Ind. Abridged catalogue 106-A-12 on power transmission machinery, comprising price lists of steel shafting; keyseating and shouldering shafting; keyseating iron and iron center wood rim pulleys, rope sheaves, etc.; safety collars; flange couplings; compression couplings; universal joint couplings; shaft hangers and adjustable pillow blocks; adjustable ball-and-socket drop and post hangers; countershafts; step bearings; bearing metals; belt tighteners, friction clutches; cut-off couplings; adjustable mule stands; wood split pulleys; iron center wood rim pulleys; machine molded solid iron pulleys, standard iron split pulleys, etc.

Vulcan Engineering Sales Co., Fisher Bldg., Chicago, Ill. Catalogue No. 3 of Hanna pneumatic standard riveters, screen shakers, revolving dumping riddles, oscillators, mold dryers, etc. The principle of the interesting toggle mechanism of the riveter is clearly shown in outline illustrations and by a view of a model furnished to salesmen. Among the advantages claimed are one blow to a rivet, saving of time and air, heavy predetermined compression, reduced wear and tear, etc. The "anatomy" of the Pedrick and Ayer hydro-pneumatic riveter, also controlled by the company, is shown with list of parts. A list of users of Hanna riveters, 1912, and testimonials from users are issued in separate pamphlets.

New Departure Mfg. Co., Bristol, Conn., manufacturer of "New Departure" ball bearings, has issued a series of data sheets devoted exclusively to the adaptability of these bearings to machine tools and shaft hangers. The data sheets cover the three types of ball bearings of "New Departure" manufacture, each of which has its peculiar qualifications. The sheets are 8½ by 11 inches, printed on one side, and have two holes punched in one edge for a loose-leaf binder. They show the design of specific mountings in a milling machine head, speed cones and driving pulley of a drilling machine, an air compressor base with layshaft and crankshaft, a high-speed grinding spindle and a grinding or polishing head. The construction of the "New Departure" shaft hanger is illustrated and described. This hanger is equipped with a ball bearing developed especially for the service. The sheets and loose-leaf binder will be sent free to any address on request, when written on the letter paper of manufacturing concerns.

TRADE NOTES

Reed Mfg. Co., Erie, Pa., manufacturer of vises, has erected a one-story brick addition 50 by 200 feet.

J. N. Lapointe Co., formerly of Marlboro, Mass., manufacturer of broaching machines and broaches, has moved to its new factory in New London, Conn.

Williams Tool Co., Erie, Pa., manufacturer of pipe tools and threading machines, has just erected a two-story brick addition for office purposes.

Oneida Steel Pulley Co., Oneida, N. Y., manufacturer of steel pulleys, has extended its plant by a one-story cement and steel addition 112 by 310 feet.

Wayo Mfg. Co., 642 Ellicott Square, Buffalo, N. Y., has placed on the market a brush-bar belt dressing, consisting, of a bar of dressing with a leather brush fixed in one end for cleaning the belt before applying the dressing.

Duff Mfg. Co., N. S. Pittsburg, Pa., manufacturer of jacks, has recently placed an order with Tate-Jones & Co. of Pittsburg for a

THE DISCRIMINATING PIANO MANUFACTURER

buys <u>the Felton & Guilleaume Imported Steel Music Wire</u> because he has learned that the wire plays the most important part in the tone of the instrument. He has tried out many wires and he knows the Genuine F & G, in either the Black, Red or Green Label grades, is to be depended upon <u>at all times</u> for uniformity of strength and quality.

F & G Wire is now used, also, by manufacturers of Calculating Machines, Typewriters, Automatic Machines, Carpet Sweepers, Toys, Electrical Work, etc., and by hundreds of other manufacturers who have tried out scores of other makes and found by severe comparative tests that the F & G stands in a class by itself for staunch reliability.

If you have trouble in procuring what you need in High Grade Steel Wire, tell us your requirements and let us submit samples, or

Ask for descriptive circular No. 3076.

HAMMACHER, SCHLEMMER & CO.

HARDWARE TOOLS AND SUPPLIES,

4th Avenue and 13th Street New York, Since 1848

large double chamber heat-treating furnace, similar to the furnace installed some time ago by this company for the White Co. in Cleveland Ohio.

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa., announces that the interests in the company owned by Mr. Henry Hess have been purchased by the German D. W. F. Co. (Deutsche Waffen-und Munitions Fabriken). The policy of the company will be directed by Mr. Bright, the new president. A. T. Bruezel is the secretary and C. L. McCalla, treasurer.

Edgemont Machine Co., Dayton, Ohio, manufacturer of friction clutch pulleys and power transmission machinery, is now located in its new factory on National Ave. and Niebert St., Dayton. The new plant is large and modern in every respect and considerable new equipment has been installed which has increased the manufacturing capacity about four times.

Skinner Chuck Co., New Britain, Conn., has purchased the planer chuck business of the Francis Reed Co., Worcester, Mass, and has moved the stock of finished chucks and patterns to the plant at New Britain. The Francis Reed Co. manufactures a line of improved drilling machinery and has manufactured the Jordan planer chucks for upwards of twenty years, but has decided to concentrate on the manufacture of its line of drilling machinery.

Union Mfg. Co., New Britain, Conn., has taken over the manufacture of the hand-operated punch, shear and rod-cutting machine formerly made by P. G. H. Bennett & Co., Boston, Mass. The machine will be made in three sizes, and is intended for general use in machine shops, blacksmith shops, garages, etc., for wire and rod cutting, shearing bars and plates, and punching holes. The company will require no new manufacturing equipment for the production of this machine.

Joseph Dixon Crucible Co., Jersey City, N. J. At the regular monthly meeting of its board of directors held October 21, the following changes were made in the officers and directors, on account of the death of the vice-president, William H. Corbin: George E. Long, former treasurer, was elected vice-president to succeed Mr. Corbin; J. H. Schermerhorn, former assistant secretary and assistant treasurer, was elected a director and treasurer; and Albert Norris was elected assistant secretary and assistant treasurer.

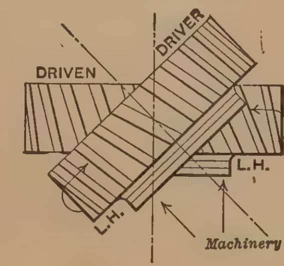
New Process Raw Hide Co., Syracuse, N. Y., has just erected additions which make its plant the largest in the world devoted exclusively to gear making and to gear cutting. The additions are a four-story-and-basement wing, 65 by 180 feet, extending at right angles to the old building, and a heating plant in the rear 50 by 60 feet, housing three 125 H. P. boilers. The new buildings are fire-proof throughout, having steel framework, reinforced concrete walls, brick curtain walls, and steel window sashes. New equipment costing $100,000 has been installed.

Standard Machinery Co., Providence, R. I., has bought six acres in Auburn, R. I., and has made plans for the erection of three buildings. The new location is about four miles from the present plant in Providence, and is on the Shore Line division of the N Y., N. H. & H. R.R. The main building will be 175 feet by 350 feet; and the second building, 100 feet square; and the third building, 60 feet square. The group of buildings will provide about three times the floor area of the old plant. The company expects to occupy the new plant some time next spring.

Palmer-Moore Co., Syracuse, N. Y., for the past two years builders of the Moore two-cycle automobile engine, has increased its capital to $200,000 fully paid in, and will at once begin the manufacture of motor trucks. T. G. Meachem is president of the corporation and T. W. Meachem, vice-president. Charles L. Palmer is secretary-treasurer. The large plant of the Syracuse Stove Works, including three and a half acres of land and 90,000 feet of floor space, has been purchased and will be equipped with new machinery with the view of turning out the first two hundred trucks within six months.

SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—I

Shafts at 45 Degrees Angle, Ratio Equal, Center Distance Approximate



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C_a = approximate center distance.
3. P_n = normal pitch (pitch of cutter).
4. α = angle of spiral of driving gear.
5. β = angle of spiral of driven gear.
6. N = number of teeth nearest $\dfrac{2\,C_a\,P_n \cos\alpha \cos\beta}{\cos\alpha + \cos\beta}$

To find:

a. When spiral angles are 22½ degrees.

1. D = pitch diameter $= \dfrac{N}{0.9239\,P_n}$ 2. O = outside diameter $= D + \dfrac{2}{P_n}$
3. T = number of teeth marked on cutter $= N \div 0.788$.
4. L = lead of spiral $= 7.584\,D$.
5. C = center distance $= D$.

b. When spiral angles are other than 22½ degrees.

1. D = pitch diameter of driver $= \dfrac{N}{P_n \cos\alpha}$ 2. d = pitch diameter of driven gear $= \dfrac{N}{P_n \cos\beta}$
3. O = outside diameter of driver $= D + \dfrac{2}{P_n}$.
4. o = outside diameter of driven gear $= d + \dfrac{2}{P_n}$.
5. T = number of teeth marked on cutter for driver $= N \div \cos^3\alpha$.
6. t = number of teeth marked on cutter for driven gear $= N \div \cos^3\beta$.
7. L = lead of spiral for driver $= \pi D \cot\alpha$.
8. l = lead of spiral for driven gear $= \pi d \cot\beta$.
9. C = actual center distance = sum of pitch radii.

Example

Given or assumed:

1. See illustration. 2. $C_a = 4$ inches. 3. $P_n = 10$.
4 and 5. $\alpha = \beta = 22½$ deg. 6. $N = 37$.

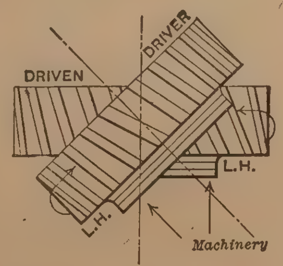
To find:

1. $D = \dfrac{N}{0.9239\,P_n} = \dfrac{37}{0.9239 \times 10} = 4.005$ inches.
2. $O = D + \dfrac{2}{P_n} = 4.005 + \dfrac{2}{10} = 4.205$ inches.
3. $T = N \div 0.788 = 37 \div 0.788 = 47$ teeth. (No. 3 cutter).
4. $L = 7.584\,D = 7.584 \times 4.005 = 30.374$ inches.

Contributed by James H. Carver

SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—II

Shafts at 45 Degrees Angle, Ratio Equal, Center Distance Exact



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. P_n = normal pitch (pitch of cutter).
3. C = center distance.
4. α_a = approximate spiral angle of one gear.
5. β_a = approximate spiral angle of the other gear.
6. N = number of teeth nearest $\dfrac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{\cos\alpha_a + \cos\beta_a}$

To find:

1. α and β = exact spiral angles found by trial from $\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{N}$.
2. D = pitch diameter of one gear $= \dfrac{N}{P_n \cos\alpha}$.
3. d = pitch diameter of the other gear $= \dfrac{N}{P_n \cos\beta}$.
4. O = outside diameter of one gear $= D + \dfrac{2}{P_n}$.
5. o = outside diameter of other gear $= d + \dfrac{2}{P_n}$.
6. T = number of teeth marked on cutter for one gear $= N \div \cos^3\alpha$.
7. t = number of teeth marked on cutter for other gear $= N \div \cos^3\beta$.
8. L = lead of spiral for one gear $= \pi D \cot\alpha$.
9. l = lead of spiral for other gear $= \pi d \cot\beta$.

Example

Given or assumed:

1. See illustration. 2. $P_n = 8$. 3. $C = 10$ inches. 4. $\alpha_a = 15°$. 5. $\beta_a = 30°$.
6. $N = \dfrac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{\cos\alpha_a + \cos\beta_a} = \dfrac{2 \times 10 \times 8 \times 0.96593 \times 0.86603}{0.96593 + 0.86603} = 73$ teeth.

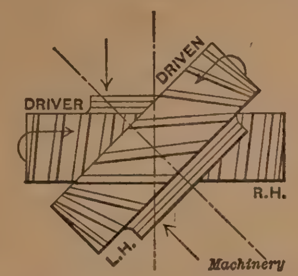
To find:

1. α and β from $\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{N} = \dfrac{2 \times 10 \times 8}{73} = 2.1918$; by trial α and β, respectively, $= 14° 44'$ and $30° 16'$.
2. $D = \dfrac{N}{P_n \cos\alpha} = \dfrac{73}{8 \times 0.96712} = 9.435$ inches. 3. $d = \dfrac{N}{P_n \cos\beta} = \dfrac{73}{8 \times 0.86369} = 10.565$ inches.
4. $O = D + \dfrac{2}{P_n} = 9.435 + \dfrac{2}{8} = 9.685$ inches. 5. $o = d + \dfrac{2}{P_n} = 10.565 + \dfrac{2}{8} = 10.815$ inches.
6. $T = N \div \cos^3\alpha = 73 \div 0.904 = 81$ teeth. 7. $t = N \div \cos^3\beta = 73 \div 0.645 = 113$ teeth.
8. $L = \pi D \cot\alpha = \pi \times 9.435 \times 3.803 = 112.72$ inches.
9. $l = \pi d \cot\beta = \pi \times 10.565 \times 1.714 = 56.889$ inches.

Contributed by James H. Carver

SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—IV

Shafts at 45 Degrees Angle, Ratio Unequal, Center Distance Exact



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. P_n = normal pitch (pitch of cutter).
3. R = ratio of large to small gear = $N \div n$.
4. α_a = approximate spiral angle of large gear.
5. β_a = approximate spiral angle of small gear.
6. C = center distance.
7. n = number of teeth in small gear nearest $\dfrac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{R\cos\beta_a + \cos\alpha_a}$.
8. N = number of teeth in large gear = $R\,n$.

To find:

1. α and β, exact spiral angles, by trial from $R\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{n}$.
2. D = pitch diameter of large gear = $\dfrac{N}{P_n\cos\alpha}$. 3. d = pitch diameter of small gear = $\dfrac{n}{P_n\cos\beta}$.
4. O = outside diameter of large gear = $D + \dfrac{2}{P_n}$.
5. o = outside diameter of small gear = $d + \dfrac{2}{P_n}$.
6. T = number of teeth marked on cutter for large gear = $N \div \cos^3\alpha$.
7. t = number of teeth marked on cutter for small gear = $n \div \cos^3\beta$.
8. L = lead of spiral for large gear = $\pi\,D\cot\alpha$.
9. l = lead of spiral for small gear = $\pi\,d\cot\beta$.

Example

Given or assumed:

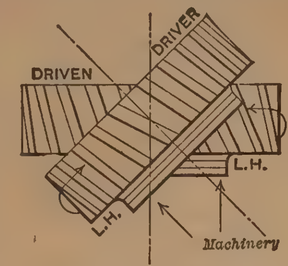
1. See illustration. 2. $P_n = 4$. 3. $R = 4$.
4. $\alpha_a = 50$ degrees. 5. $\beta_a = 5$ degrees. 6. $C = 30$ inches.
7. $n = \dfrac{2\,C\,P_n\cos\alpha_a\cos\beta_a}{R\cos\beta_a + \cos\alpha_a} = \dfrac{2 \times 30 \times 4 \times 0.643 \times 0.996}{(4 \times 0.996) + 0.643} = 33$ teeth.
8. $N = R\,n = 4 \times 33 = 132$ teeth.

To find:

1. α and β from $R\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{n} = \dfrac{2 \times 30 \times 4}{33} = 7.273$. By trial $\alpha = 50°\,21'$, and $\beta = 5°\,21'$.
2. $D = \dfrac{N}{P_n\cos\alpha} = \dfrac{132}{4 \times 0.63810} = 51.716$ inches. 3. $d = \dfrac{n}{P_n\cos\beta} = \dfrac{33}{4 \times 0.99564} = 8.286$ inches.
4. $O = D + \dfrac{2}{P_n} = 51.716 + \dfrac{2}{4} = 52.216$ inches. 5. $o = d + \dfrac{2}{P_n} = 8.286 + \dfrac{2}{4} = 8.786$ inches.
6. $T = N \div \cos^3\alpha = 132 \div 0.26 = 508$ teeth. 7. $t = n \div \cos^3\beta = 33 \div 0.987 = 33$ teeth.
8. $L = \pi\,D\cot\alpha = \pi \times 51.716 \times 0.82874 = 134.6$ inches.
9. $l = \pi\,d\cot\beta = \pi \times 8.286 \times 10.678 = 278$ inches.

SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—III

Shafts at 45 Degrees Angle, Ratio Unequal, C. D. Approximate



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C_a = center distance.
3. P_n = normal pitch (pitch of cutter).
4. R = ratio of gear to pinion, $N \div n$.
5. α = angle of spiral on gear.
6. β = angle of spiral on pinion.
7. n = number of teeth in pinion nearest $\dfrac{2\,C_a\,P_n\cos\alpha\cos\beta}{R\cos\beta + \cos\alpha}$
8. N = number of teeth in gear = $R\,n$.

To find:

a. When $\alpha = \beta = 22\tfrac{1}{2}$ degrees.

1. D = pitch diameter of gear = $\dfrac{N}{0.9239\,P_n}$. 2. d = pitch diameter of pinion = $\dfrac{n}{0.9239\,P_n}$.
3. O = outside diameter of gear = $D + \dfrac{2}{P_n}$. 4. o = outside diameter of pinion = $d + \dfrac{2}{P_n}$.
5. T = number of teeth marked on cutter for gear = $N \div 0.788$.
6. t = number of teeth marked on cutter for pinion = $n \div 0.788$.
7. L = lead of spiral on gear = $7.584\,D$. 8. l = lead of spiral on pinion = $7.584\,d$.
9. C = actual center distance = $\dfrac{D + d}{2}$.

b. When α and β are any angles.

1. D = pitch diameter of gear = $\dfrac{N}{P_n\cos\alpha}$. 2. d = pitch diameter of pinion = $\dfrac{n}{P_n\cos\beta}$.
3. O = outside diameter of gear = $D + \dfrac{2}{P_n}$. 4. o = outside diameter of pinion = $d + \dfrac{2}{P_n}$.
5. T = number of teeth marked on cutter for gear = $N \div \cos^3\alpha$.
6. t = number of teeth marked on cutter for pinion = $n \div \cos^3\beta$.
7. L = lead of spiral on gear = $\pi\,D\cot\alpha$. 8. l = lead of spiral on pinion = $\pi\,d\cot\beta$.
9. C = actual center distance = $\dfrac{D + d}{2}$.

Example

Given or assumed:

1. See illustration. 2. $C = 12$ inches. 3. $P_n = 6$. 4. $R = 3$. 5. $\alpha = 20$ deg. 6. $\beta = 25$ deg.
7. $n = \dfrac{2\,C\,P_n\cos\alpha\cos\beta}{R\cos\beta + \cos\alpha} = \dfrac{2 \times 12 \times 6 \times 0.93969 \times 0.90631}{(3 \times 0.90631) + 0.93969} = 34$ teeth approximately.
8. $N = Rn = 3 \times 34 = 102$ teeth.

To find:

1. $D = \dfrac{N}{P_n\cos\alpha} = \dfrac{102}{6 \times 0.93969} = 18.091$ inches. 2. $d = \dfrac{n}{P_n\cos\beta} = \dfrac{34}{6 \times 0.90631} = 6.252$ inches.
3. $O = D + \dfrac{2}{P_n} = 18.091 + \dfrac{2}{6} = 18.424$ inches. 4. $o = d + \dfrac{2}{P_n} = 6.252 + \dfrac{2}{6} = 6.585$ inches.
5. $T = N \div \cos^3\alpha = 102 \div 0.83 = 123$ teeth. 6. $t = n \div \cos^3\beta = 34 \div 0.744 = 46$ teeth.
7. $L = \pi\,D\cot\alpha = \pi \times 18.091 \times 2.747 = 156.12$ inches.
8. $l = \pi\,d\cot\beta = \pi \times 6.252 \times 2.145 = 42.13$ inches.
9. $C = \dfrac{D + d}{2} = \dfrac{18.091 + 6.252}{2} = 12.1715$ inches.

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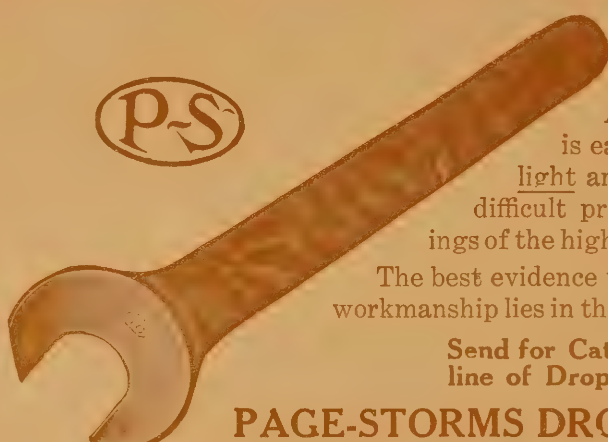

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All the Strength Without the Weight!

Any manufacturer can produce a light wrench. It is easy enough to cut away steel. But to make a wrench light and yet retain the strength of the discarded metal is a difficult proposition. Such wrench making demands drop forgings of the highest grade, plus long experience and specialized methods.

The best evidence that Page-Storms Wrenches embody such material and workmanship lies in the fact, that only from gross misuse are they ever broken.

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VANADIUM

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A 45 in. Vanadium steel blooming mill pinion, in the LaBelle Iron Works, Steubenville, O., rolled 265,230 tons before replacement. The highest previous record of any 3½% nickel steel pinions in the same mill was 149,035 tons.

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These results are shown by the steel company's records.

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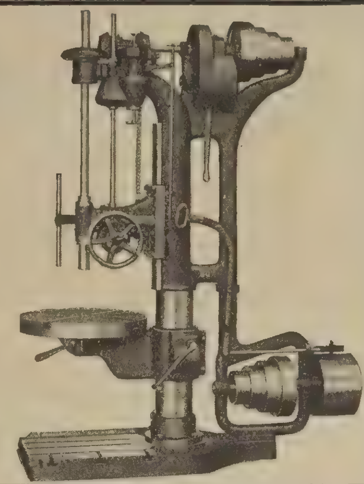

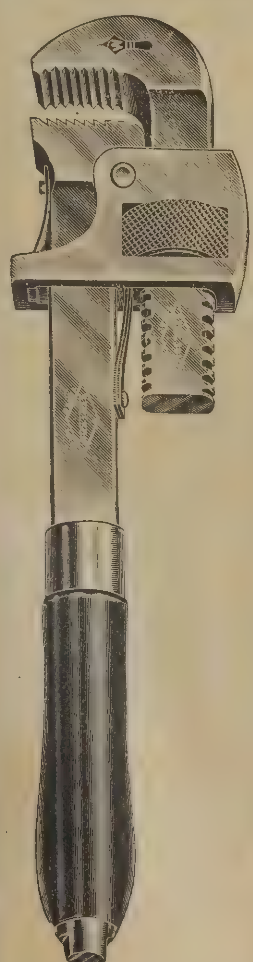

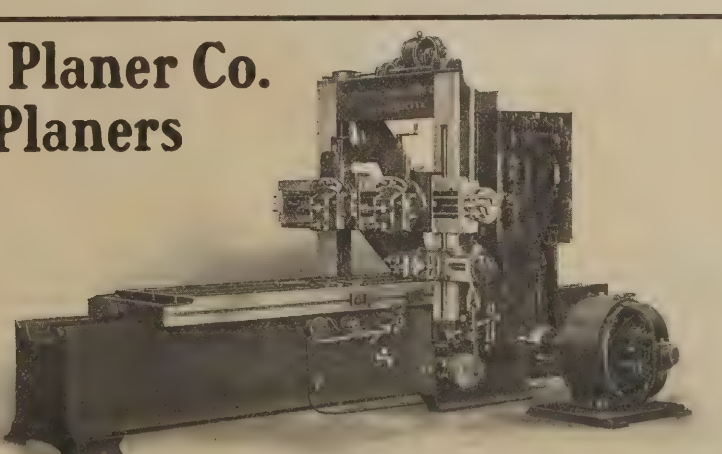

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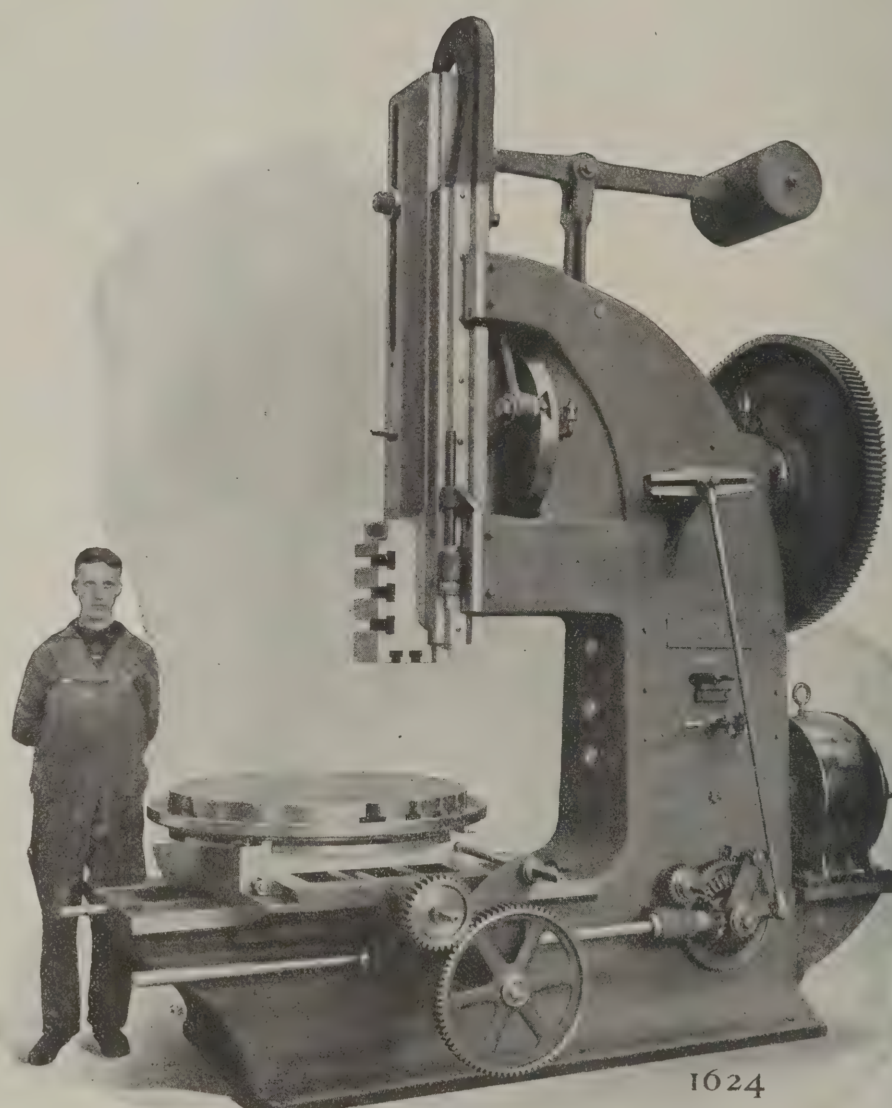
The Bement Crank Slotter



Will stand up under the heaviest cuts on the toughest metal.

The frame is extremely rigid. It is a continuous box section casting.

The cutter bar is supported close to the work by a rigid knee. The guides are adjustable so that they support the cutter bar to a point immediately above the work being machined.

Table has variable power feeds in all directions.

It also has hand adjustment by convenient means.

All surfaces are scraped to a close bearing.

Powerful drive is provided, either through wide belt and cone of large diameter or by means of direct connected motor.

Sizes—6 to 36 inches.

Write for illustrated circulars and any information desired.

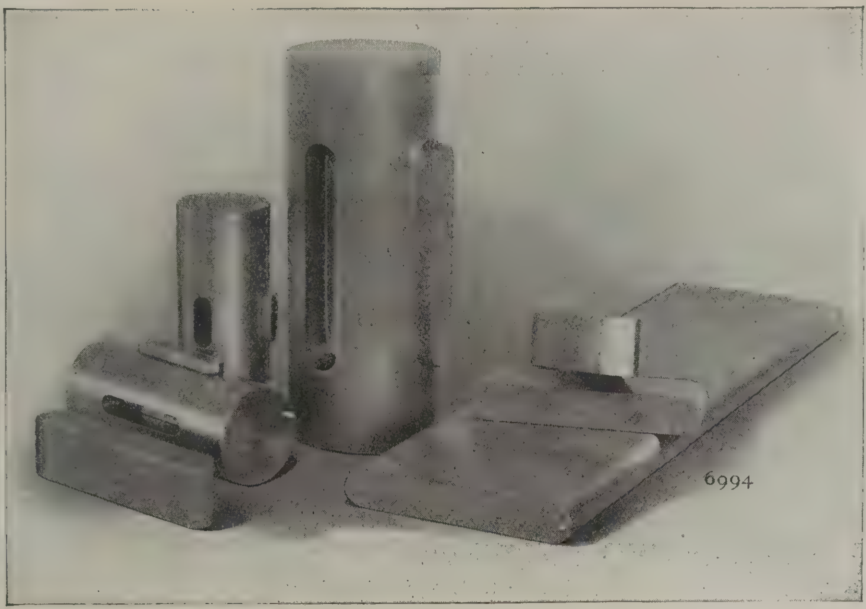
NILES-BEMENT-POND CO.

111 Broadway, New York, U. S. A.
23-25 Victoria Street, London, S. W.

Sales Offices and Agencies—Boston, 93-95 Oliver St. **Philadelphia,** 21st and Callowhill Sts. **Pittsburgh,** Frick Bldg. **Cleveland,** The Niles Tool Works Co., Rockefeller Bldg. **Hamilton, O.,** The Niles Tool Works Co. **Detroit,** Majestic Bldg. **Chicago,** McCormick Bldg. **St. Louis,** 516 No. Third St. **Agent for Gulf States,** N. C. Walpole, Brown-Marx Bldg., Birmingham, Ala. **Agents for Colorado,** Hendrie & Bolthoff Mfg. and Supply Co., Denver. **California, Nevada and Arizona,** Harron, Rickard & McCone, San Francisco and Los Angeles. **Washington and Idaho,** Hallidie Machinery Co., Seattle and Spokane. **For Oregon,** Portland Machinery Co., Portland.

Agents for Canada, The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto and Vancouver. **Italy,** Ing. Ercole Vaghi, Milan. **Germany,** F. G. Kretschmer & Co., Frankfurt a.M. **Japan,** F. W. Horne, 6 Takiyama-cho Kyobashiku, Tokyo. **Austria-Hungary,** E. Krause & Co., Vienna, Prag and Budapest. **R.** S. Stokvis & Zonen, Ltd., Rotterdam. **Mexico,** Smith & Wiggin, Cinco de Mayo, 6, Mexico City.

RECTANGULAR KEYS ARE NOW A COMMERCIAL SUCCESS



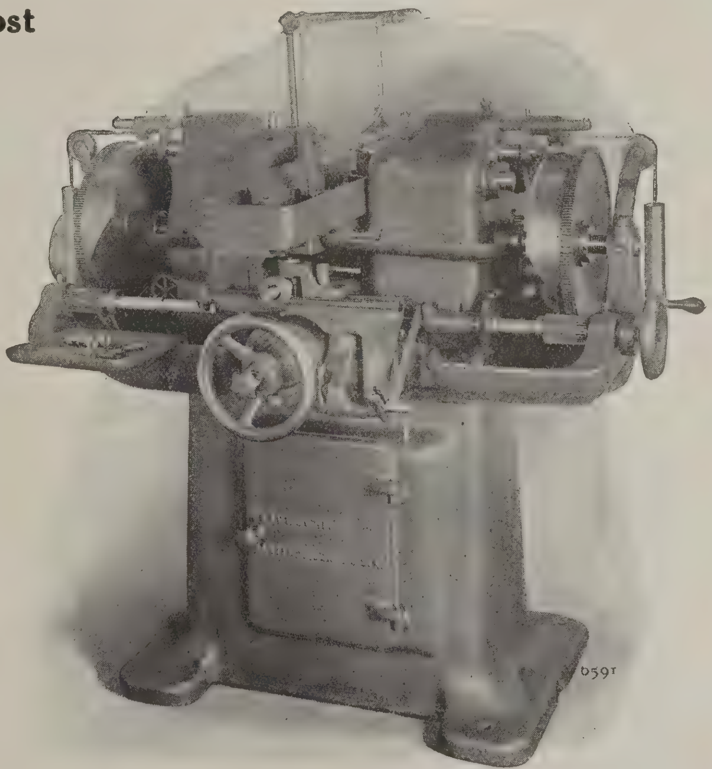
The heretofore excessive cost of milling the keyways has been eliminated by the development of the

P. & W. Spline Milling Machine

which rapidly mills the keyways in one simple operation, with the result that this system of keying is as cheap as any other.

Rectangular Keys by far the most Efficient and Economical

1. They do not materially weaken the shaft. **2.** They will not work loose. **3.** Their shearing strength is practically equal to a solid member. **4.** Two keys may be placed opposite each other on the shaft.



Cost of Cutting Keyways Greatly Reduced

For keyways and slots the Spline Milling Machine has proven the greatest labor-saving machine that has ever been produced. The metal is removed very rapidly and an accurate keyway or slot is cut in a remarkably short time. Automatic features enable one operator to take care of from six to eight machines in some instances.

Accurate Machine Keys Ready to Drive In

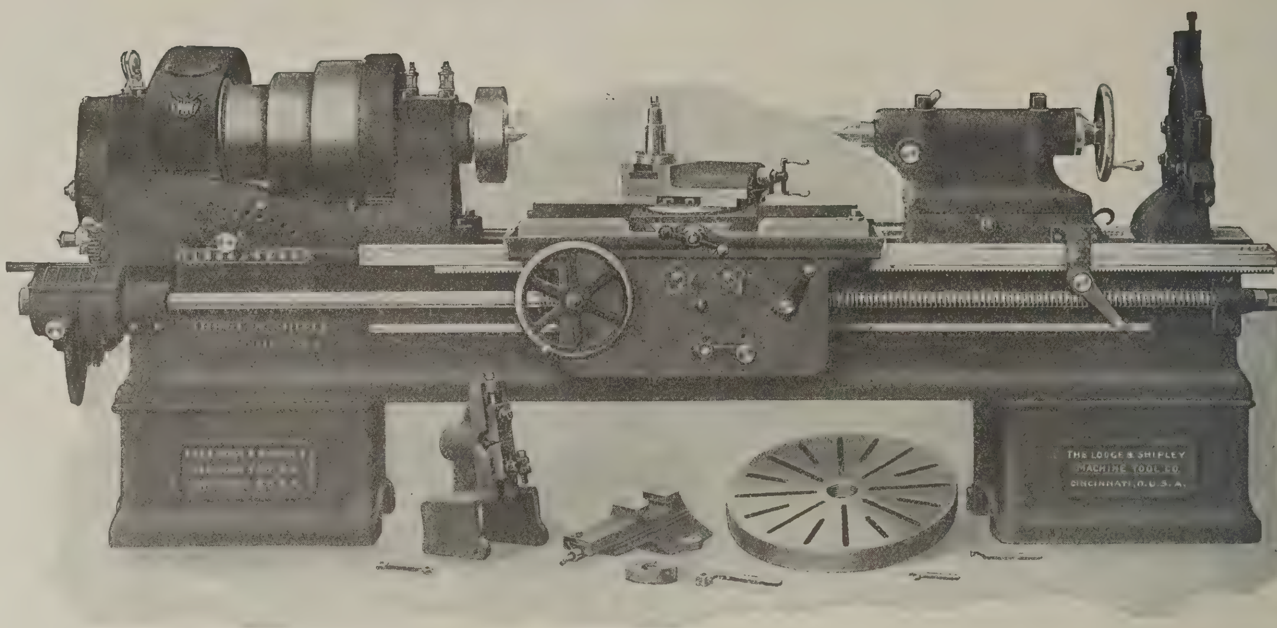
without fitting, any width, depth, or taper; finished and guaranteed to micrometer measurements, can be obtained from the **Standard Gauge Steel Company, Beaver Falls, Pa.**

Write for descriptive circular "Spline Milling Machine."

PRATT & WHITNEY COMPANY, Hartford, Connecticut

Sales Offices and Agencies—New York, 111 Broadway. **Boston**, 93-95 Oliver St. **Philadelphia**, 405 No. 21st St. **Pittsburgh**, Frick Bldg. **Cleveland**, The Niles Tool Works Co., Rockefeller Bldg. **Cincinnati**, 336 West 4th Ave. **Hamilton, O.**, The Niles Tool Works Co. **Detroit**, Majestic Bldg. **Chicago**, 12 No. Jefferson St. **St. Louis**, 516 No. Third St. **Agent for Gulf States**, N. C. Walpole, Brown-Marx Bldg., Birmingham, Ala. **For California, Nevada and Arizona**, Harron, Rickard & McCone, San Francisco and Los Angeles. **For Washington and Idaho**, Hallidie Machinery Co., Seattle and Spokane. **For Oregon**, Portland Machinery Co., Portland. **For Colorado**, Hendrie & Bolthoff Mfg. & Supply Co., Denver. **Agents for Canada**, The Canadian Fairbanks-Morse Co., Ltd., Montreal, St. John, Toronto, Winnipeg, Calgary and Vancouver. **London, E. C.**, Buck & Hickman, Ltd., 2 and 4 Whitechapel Road. **London, S. W.**, Niles-Bement-Pond Co., 23-25 Victoria St. **Birmingham**, Pratt & Whitney Co., Exchange Bldgs., New St. **Paris**, Fenwick Freres & Co., 8 Rue de Rocroy, Agents for France, Belgium and Switzerland. **Japan**, F. W. Horne, 6 Takiyama-cho Kyobashiku, Tokyo. **Italy**, Ing. Ercole Vaghi, Milan. **Germany**, F. G. Kretschmer & Co., Frankfurt a.M. **Austria-Hungary**, E. Krause & Co., Vienna, Prag and Budapest. **Holland**, R. S. Stokvis & Zonen, Ltd., Rotterdam. **Agents for Mexico**, Smith & Wiggin, Cinco de Mayo, 6, Mexico City.

Lodge & Shipley Engine Lathes are



24" Lodge & Shipley Three Step Cone Head Lathe

Drop forged steel quick change gears give 32 changes of feed and thread. Tailstock has tool steel spindle and plug clamp for locking same in absolute alignment. Double plate apron supports all studs front and back.

There continues to be a call for the five or four step cone head engine lathe with the single back gearing. This we can supply.

Many customers are demanding the three step double back geared head with its wider belt and two reductions by gearing—a much more powerful type of head, and generally better adapted to getting the good out of modern tool steels.

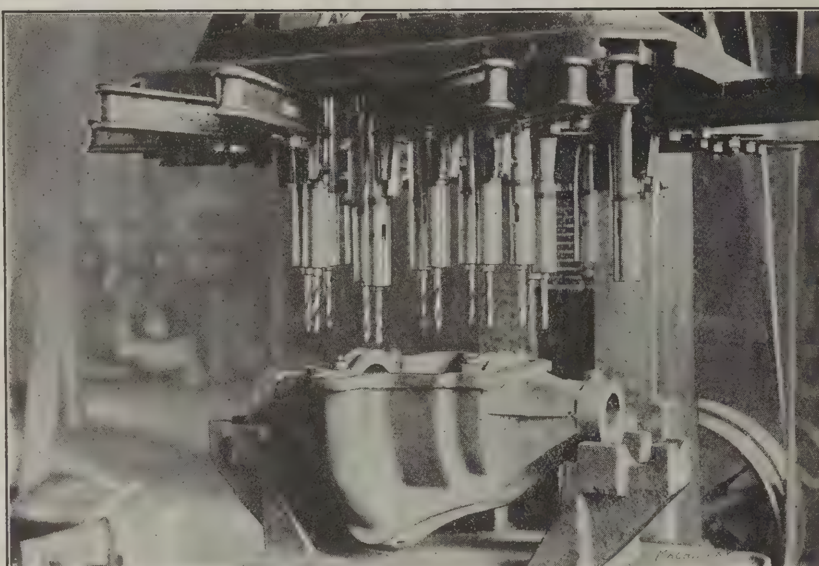
Our single pulley drive, with its greatly increased power not only on the two back geared ratios but as well on its open belt of great width, and running over a pulley of extra large diameter, is the type which gives the nearest to ideal conditions for strictly modern lathe work.

Submit your lathe problems to us, preferably with blue prints and full information, and we will give you expert advice gratis.

THE LODGE & SHIPLEY MACHINE

Domestic Agents—Brown & Zortman Machinery Co., Pittsburg; Charlotte Supply Co., Charlotte; W. R. Colcord Machinery Co., St. Louis; Dewstoe Machine Tool Co., Birmingham; Hallidie Machinery Co., Seattle; The Hallidie Co., Spokane; Harron, Rickard & McCone, San Francisco, Los Angeles; Hendrie & Bolthoff Mfg. & Supply Co., Denver; Kemp Machinery Co., Baltimore; Marshall & Huschart Machinery Co., Chicago and Indianapolis; Motch & Merryweather Machinery Co., Cleveland, Detroit; C. T. Patterson Co., Ltd., New Orleans; Prentiss Tool & Supply Co., New York, Boston, Buffalo, Syracuse, Rochester; Robinson, Cary & Sands Co., St. Paul, Duluth; W. E. Shipley Machinery Co., Philadelphia; Tennet Supply Co., Spartanburg, S. C.; Galligher Machinery Co., Salt Lake City, Utah; Zimmerman-Wells-Brown Co., Portland, Ore.

Twelve Holes at a Time

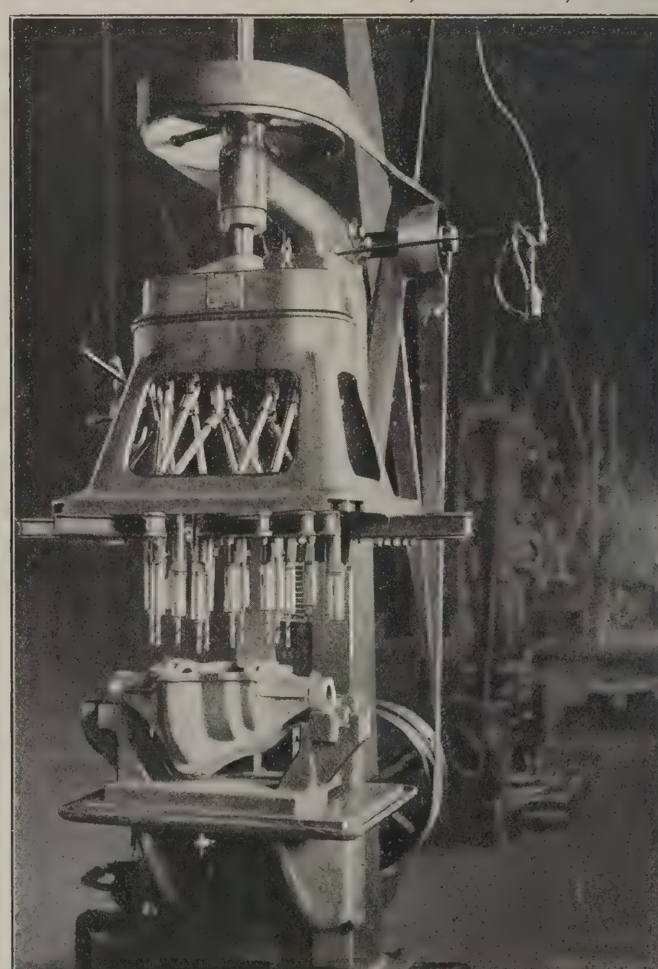


That's the "Baush" way—all drilled together and every hole the same. There's the biggest kind of advantage in this method for any multiple drilling, but in the automobile factory it is absolutely indispensable because there are so many jobs of multiple drilling—bolt holes in hubs, gear cases, rear axle differential housings and the many similar parts that go into an automobile—that one or more Baush Multiple Drilling Machines can be kept busy all the time. A typical example of good automobile practice is the drilling of rear axle differential housings, as shown, at the plant of the Columbia Motor Car Co., Hartford, Conn.

There are twelve $\frac{5}{16}''$ holes, $\frac{3}{4}''$ deep, the work being placed in a cradle, and a jig or template applied through which the drills operate. (To more clearly show the work this template was removed before photographing.) Ten pieces per hour is average production on this work, using a sixteen spindle machine, with four idle spindles, and for over a year and a half the machine has been in constant use on work of this class. A quantity producer, a cost reducer, and with the work once properly set up, accuracy guaranteed.

Are you doing work like this in the old fashioned way—one hole at a time? If so, the "Baush" can probably effect a large saving for you. There's no cost and but little effort required to make sure.

Write us, sending blue prints or sketches of some particular job, or jobs, you have in mind and we'll tell you just what the "Baush" can do on it.

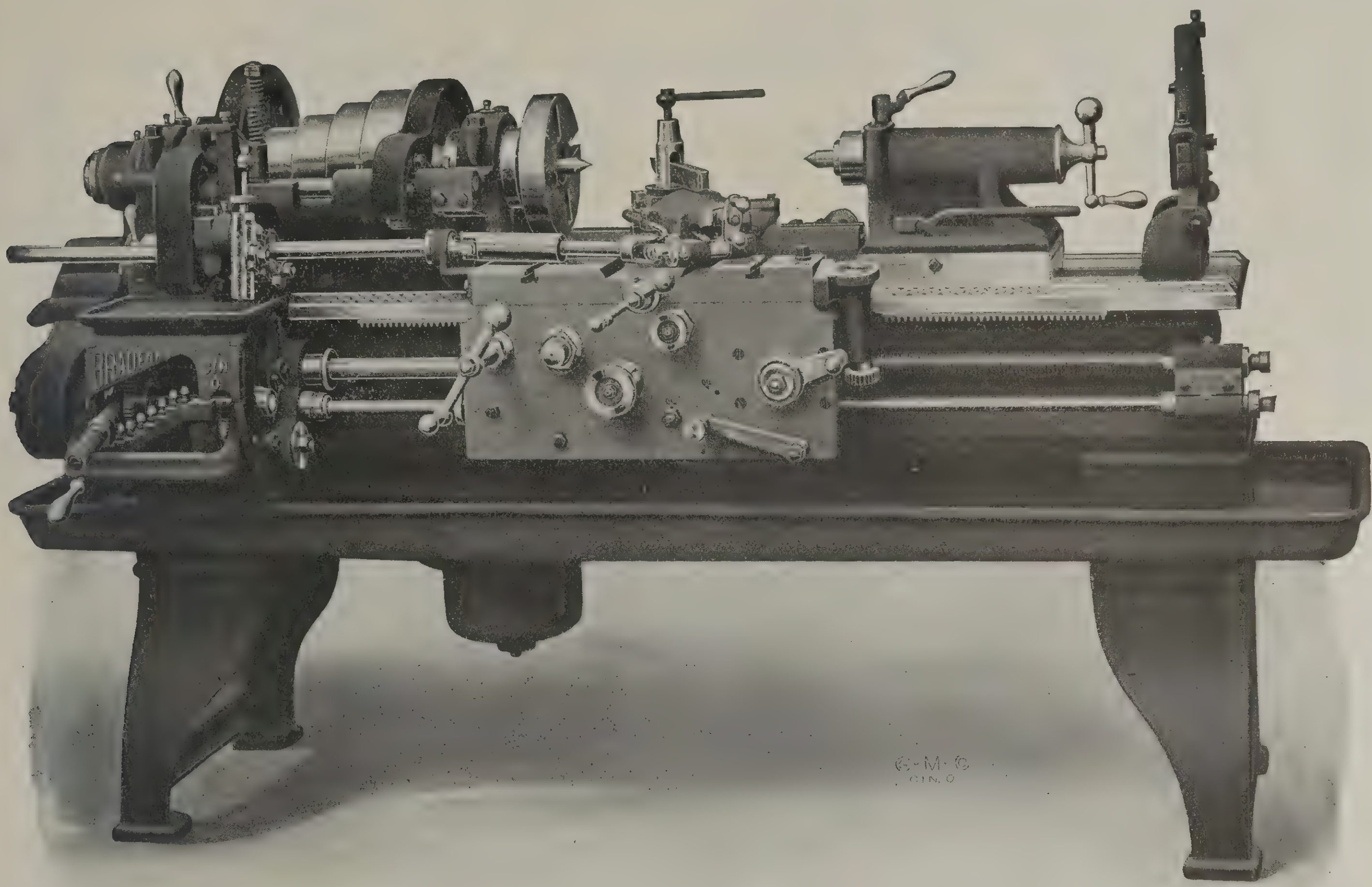


Standard No. 10A carried in stock

Baush Machine Tool Company

200 Wason Avenue SPRINGFIELD, MASS., U. S. A.

New York Office, 50 Church Street. Chicago Office, McCormick Building



IF YOU HAVE THE WORK— WE HAVE THE LATHE

No matter what your requirements in the lathe line, up to 42-inches swing, there's a **Bradford Lathe** which will fill the bill a little better than *any* other tool and a lot better than *most* of the machines marketed at the same prices. A strong claim; but the "Bradford" can prove it to any lathe buyer who will meet us half way—that is, with a mind open to conviction.

It is workmanship, as well as materials, that tells. In Bradford Lathes they are combined. For instance, small gears are cut from bar steel, and larger gears, where subject to unusual strains, are either steel or bronze; studs are tool steel, hardened and ground; spindles are of high carbon crucible steel, bored from the solid, roughed and finished on the lathe and then ground absolutely true and perfect; the feed rack is steel, made in one section up to 12 feet in length, and in every other detail throughout equally approved practice is followed and modern appliances are used to maintain the high Bradford standard.

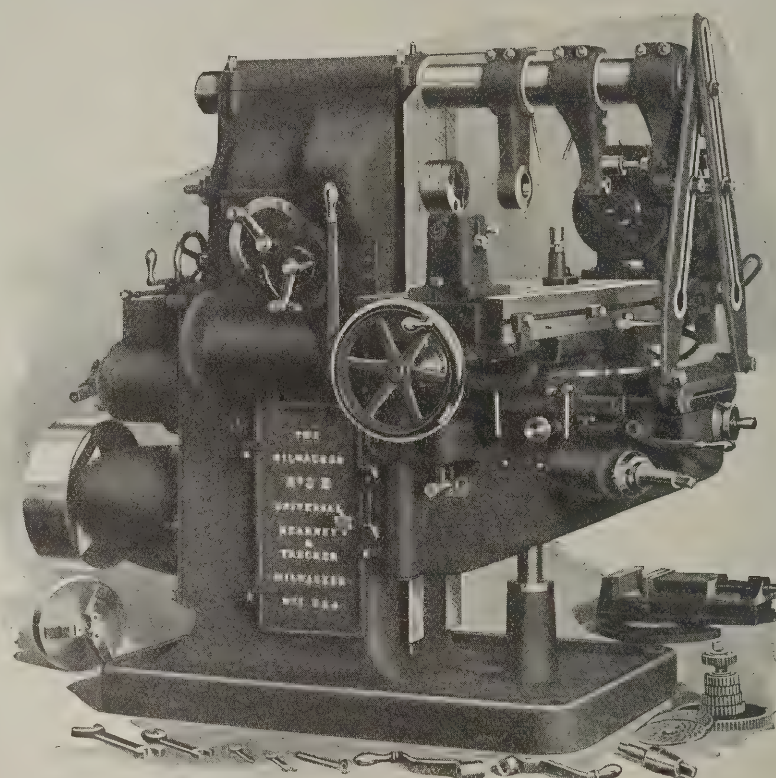
Let us send you details on the line—or any single machine— 14 to 42 inch swing.

THE BRADFORD MACHINE TOOL COMPANY

CINCINNATI, OHIO, U. S. A.

AGENTS—Swind Machinery Co., Philadelphia. Hill, Clarke & Co., New York. Taylor Machinery Co., Boston, Mass. The H. A. Stocker Machinery Co., Chicago, Ill. Marshall & Huschart Machinery Co., St. Louis, Mo. Somers, Fitler & Todd Co., Pittsburgh, Pa. E. A. Kinsey Co., Cincinnati, O. and Indianapolis, Ind. The Mine & Smelter Supply Co., Denver, Colorado. Pacific Tool & Supply Co., San Francisco, Cal. F. W. Horne, Yokohama, Agent for Japan, China and the Far East. Chas. Churchill & Co., Ltd., London, Birmingham, Glasgow, Newcastle-on-Tyne. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg, Denmark, Sweden and Norway.

Should the Toolroom Universal be Used For Heavy Manufacturing?

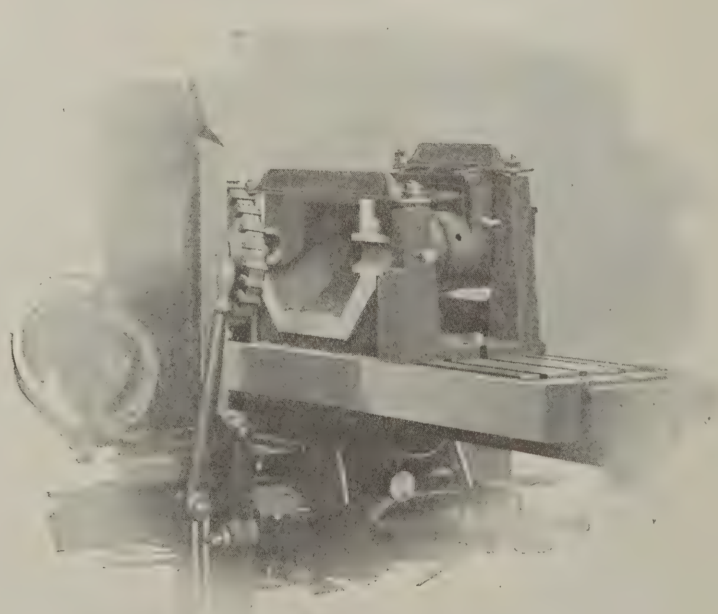


The idea has long prevailed among manufacturers as well as users of Universal Milling Machines that if they could show a high degree of accuracy under test, and be reasonably convenient, nothing more was desired.

Milwaukee Millers

were designed with the firm belief that accuracy was of little value unless there was sufficient stiffness and rigidity to withstand the strain of the heaviest cut and still maintain that accuracy, and that the time spent in perfecting alignment was lost if it disappeared the instant the cutter struck the work.

We can tell but little in this limited space as to how these beliefs are carried into practice, but please notice that the knee is a box section *in fact*, without the usual slotted top (no knee is a box section that has the slotted top) to close when the saddle clamps are set tight or the cut started.



FACE MILLING TRACTION ENGINE CYLINDER

The spindle is of special steel, running in the hardest bronze bearings and these bearings, as well as all gears and bearings of the drive and feed change mechanism, are flooded with streams of oil, insuring the maintenance of their original accuracy through years of service, be it heavy or light.

Should the toolroom Universal be used for heavy manufacturing?

Yes, if it is a MILWAUKEE and shop conditions make it expedient.

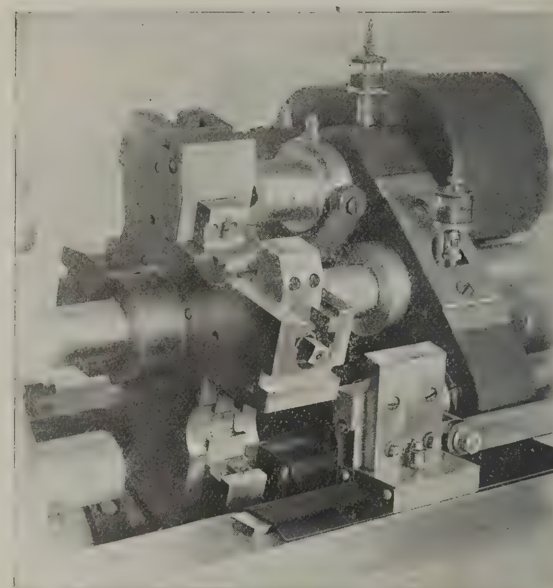
Every toolroom and shop foreman should have a copy of our 1912 catalog which shows clearly why the above statement is true.

KEARNEY & TRECKER CO., Milwaukee, Wis., U. S. A.

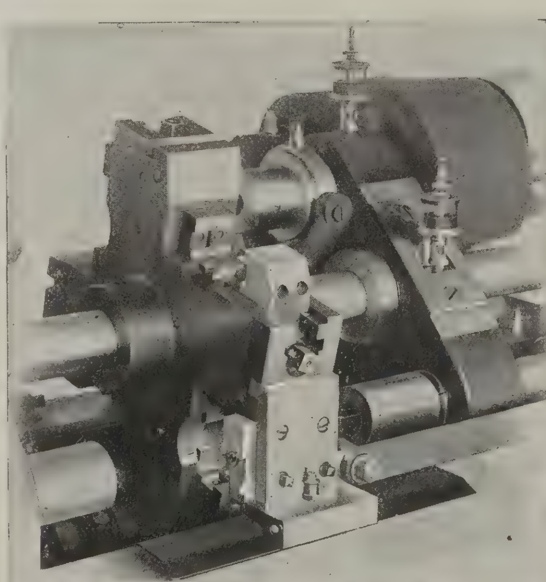
NEW BRITAIN AUTOMATICS

The Steady Rest

The Steady Rest adds greatly to the durability and positive accuracy of the "New Britain" Automatic. Operating upon the sliding key principle, each section of the chuck turret is provided with a slot to receive the tongue of the Steady Rest, which automatically slides into position after each indexing of the turret. This tongue is not the sole support however, the main support being located beneath the chuck turret section—a steel block which slides upon an incline so that adjustments for wear may be taken.



STEADY REST OUT OF POSITION

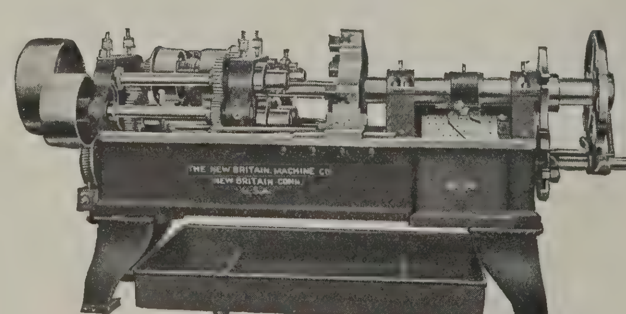


STEADY REST IN POSITION

Steady Rests are applied to both Single and Double Head machines. They support the turret right at the point where machining is taking place, and no torsional strains affect the accuracy of the machine, as would be the case were the turret supported from the end.

This and other features of these machines, also fine examples of the work they handle, fully described in the New Catalogue.

Ask us to mail a copy and then decide for yourself whether "New Britain" Automatics are applicable to some of your work. They are great labor savers—highly economical—and thoroughly practical on a wide range of product.



THE NEW BRITAIN MACHINE COMPANY

64 BIGELOW STREET, NEW BRITAIN, CONN.

AGENTS: Alfred H. Schutte, Paris, Cologne, Brussels, Milan, Bilbao and Berlin. Schuchardt & Schutte, London and St. Petersburg.

JUST OUT

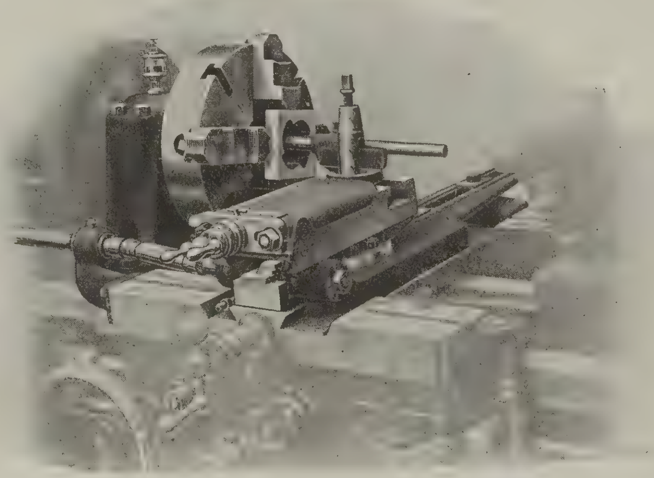


Illustration No. 3 Showing Internal Relief

This lathe has just been put on the market, consequently is the **very latest** in tool room lathes.

The new Relieving Attachment designed for application to this machine is the **only mechanism** of its kind that will perform **all classes** of relieving **without changes** in or **additions** to the regular equipment.

This attachment can be applied to any type of "American" High Duty Lathe, either belt or motor driven, regardless of style of head.

The construction of this mechanism is such as to permit the tool slide to operate at every 30 degrees, thus providing 12 operating positions within a circle.

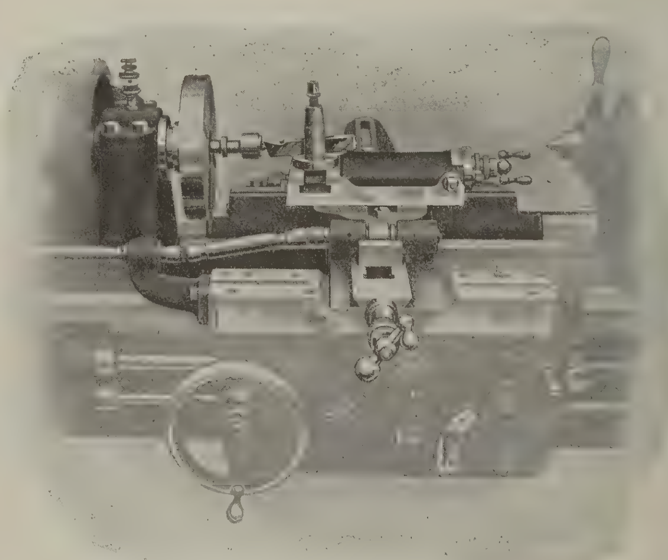
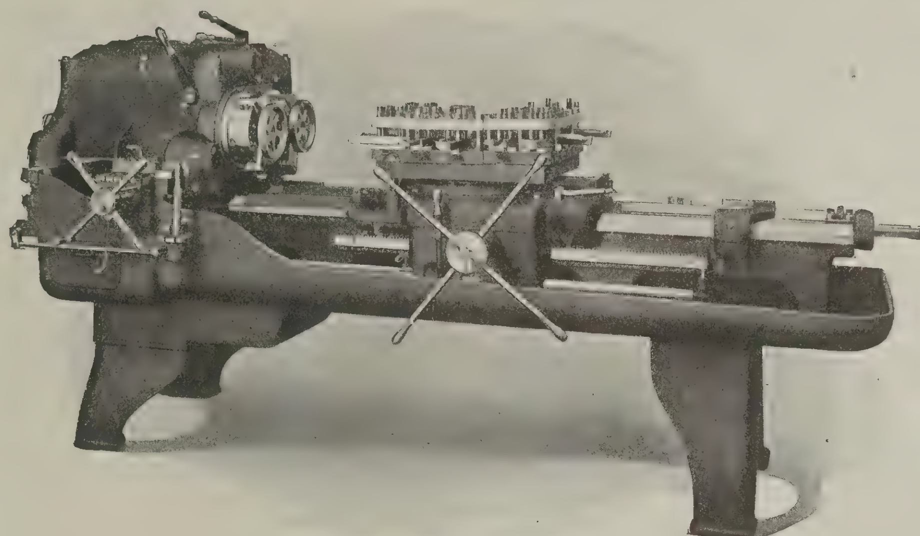


Illustration No. 4 Showing End Relief

LATHES
PLANERS

THE AMERICAN TOOL WORKS

The Double Spindle Flat Turret Lathe
The Machine for a Continuous Run



THE Double Spindle Flat Turret Lathe meets the demand for largest output. At the expense of a little delay in setting up for a new piece of work—a negligible delay on work which requires no changes in tooling for periods of several days—the Double Spindle will turn out the greatest number of absolutely duplicate pieces at the lowest cost per piece. It is a manufacturing lathe, designed principally to handle chucked work, swings 10 inches on each spindle, and may be used as a Single Spindle Machine if desired, in which case it can carry a chuck 17 inches in diameter.

The Double Spindle Machine gets its output by the use of two sets of tools, carrying on two similar cuts at the same time. Speeds and feeds are the most advantageous, long cuts on both pieces being taken at the same time, and the short cuts, also, taken simultaneously.

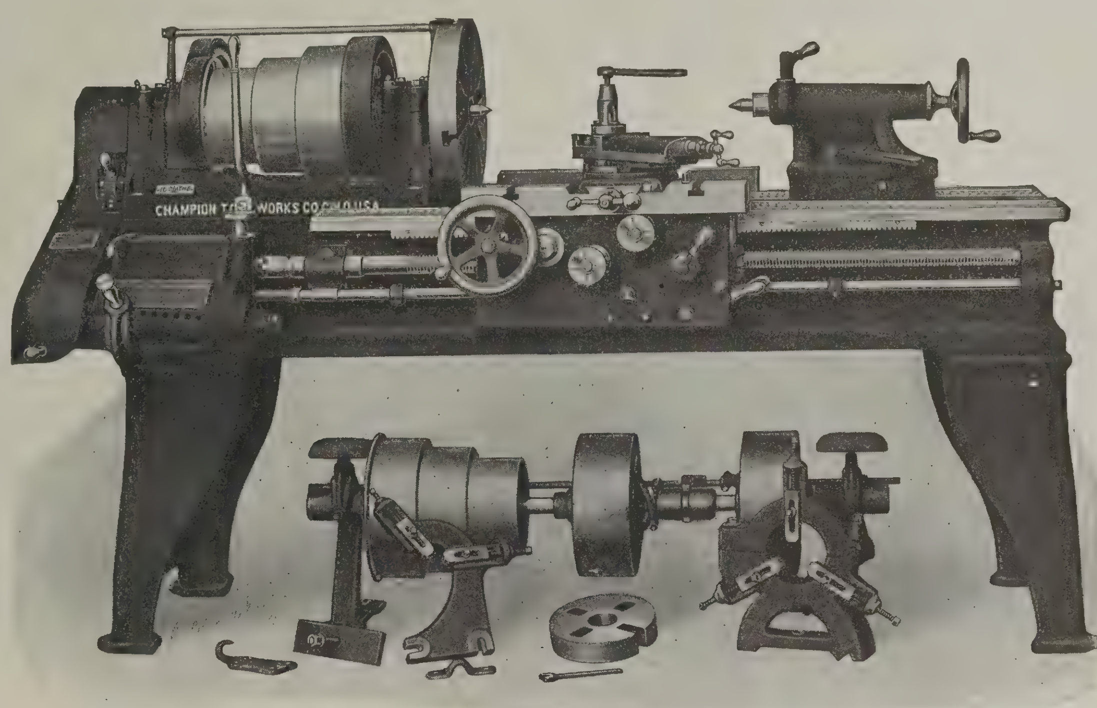
The Double Spindle requires a little more time in setting the second set of tools so that they may act in harmony with the first set, but even this is minimized by the auxiliary adjustments provided for many of the tool holders. With the doubling of the tooling there is naturally some restriction of the range of work, but it is nothing compared to the restrictions of other machines offered for manufacturing purposes.

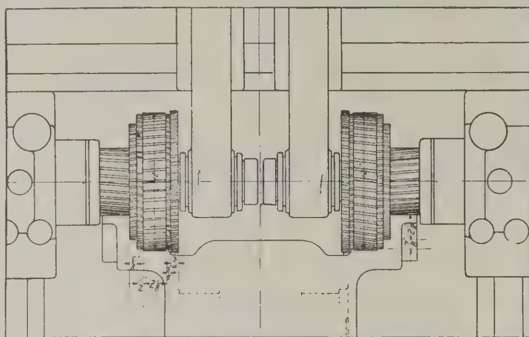
There is a new circular on this machine. Send for it.

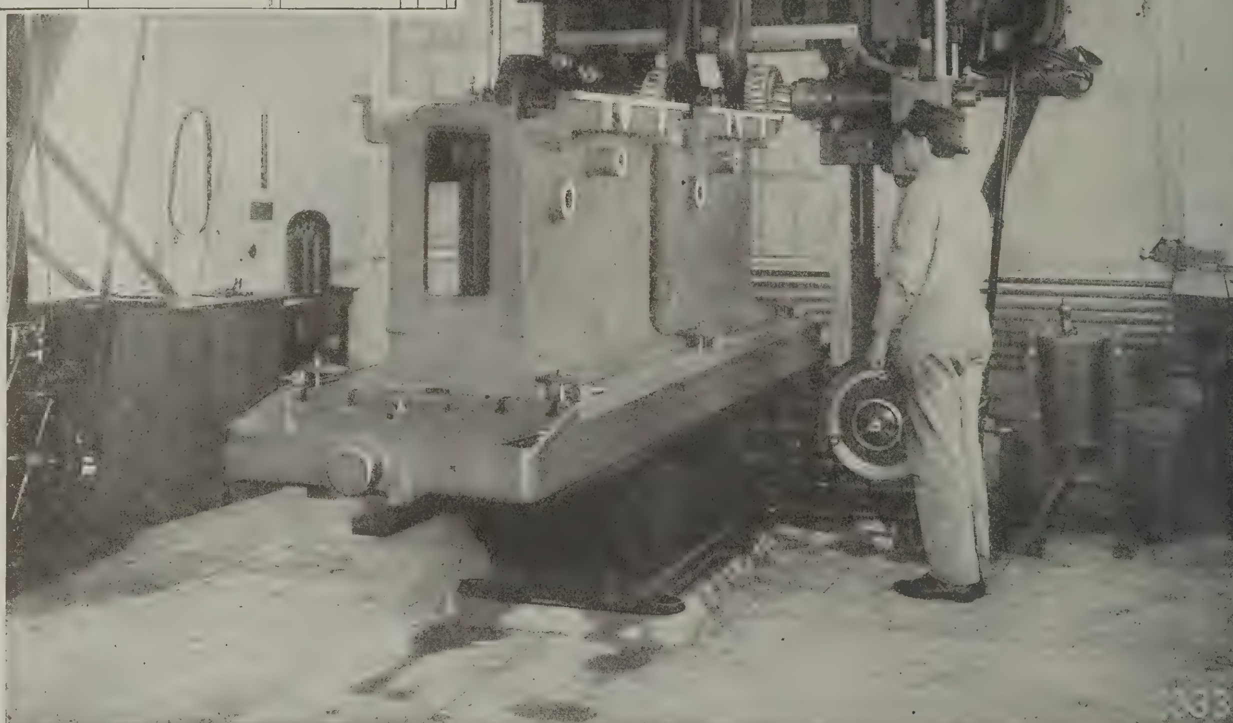
Jones & Lamson Machine Company

Springfield, Vermont, U. S. A. **Queen Victoria Street, London, Eng.**

Germany, Holland, Belgium, Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany. France and Spain, Ph. Bonvillain and E. Ronceray, 9 and 11 Rue des Envierges, Paris. Italy, W. Vogel, Milan.



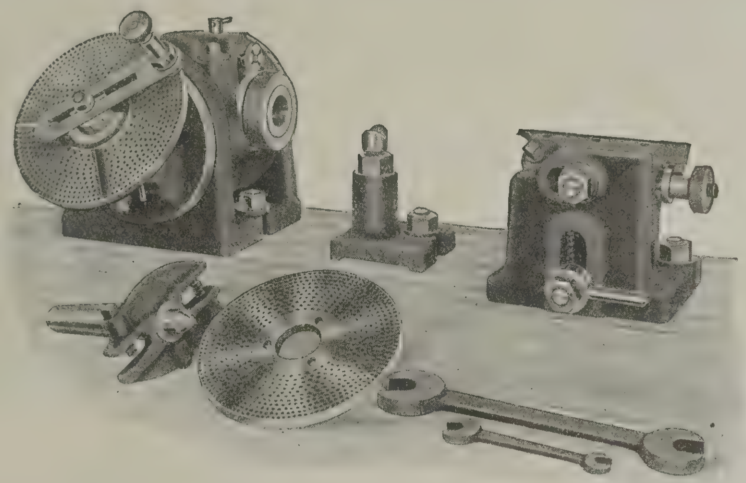




Courtesy of the Auto Press Company College Point, Long Island.

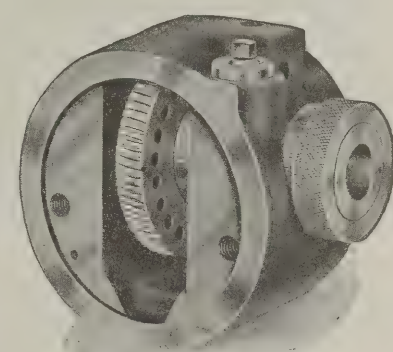
KEMPSMITH

UNIVERSAL DIVIDING HEAD



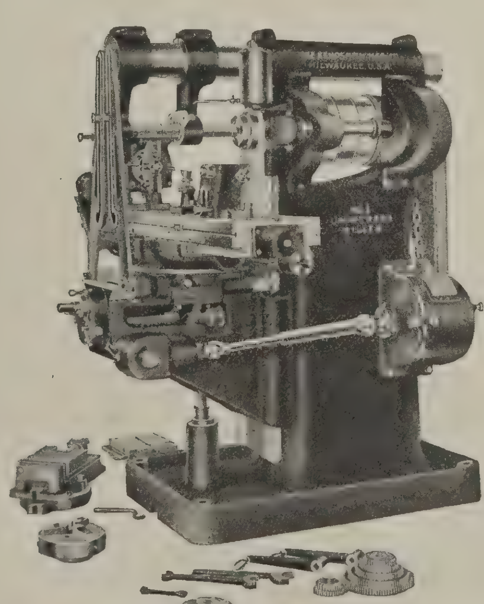
The Most Advanced of All Dividing Heads

Radically Different from any other



The worm-wheel is big ($5\frac{1}{4}''$ dia. on $10\frac{1}{2}''$ head, and $6\frac{1}{2}''$ dia. on $13\frac{1}{4}''$ head) and yet is located centrally within the head proper, between the front and rear spindle bearings.

We arrange the worm at a pronounced angle from the horizontal, and this brings the point of mesh around from under the worm-wheel and gives us practically the whole inside space of the head for the worm-wheel.



And another big advantage results from the same thing, for the index plate, being mounted direct on the worm-shaft, is brought up from the horizontal into a convenient and easily read position, directly in the operator's line of vision, and in much better light.

These are only two of its many good points. All are elaborately described in our Book on the Universal Dividing Head. Get it.

STRONG (see the absence of frail and delicate parts).
SIMPLE and CONVENIENT, nothing complicated.
ACCURATE (every tooth of worm-wheel tested. Average cumulative error .0005.)

The Kempsmith Manufacturing Co.

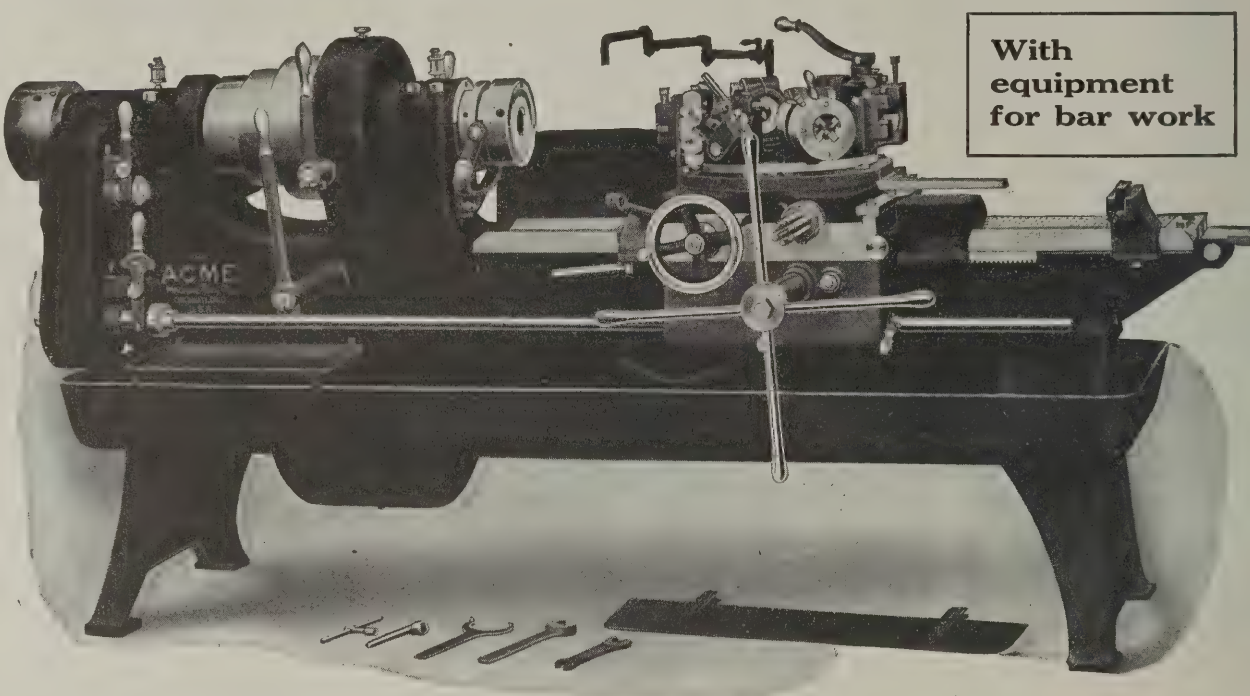
MILWAUKEE, WISCONSIN, U. S. A.

NEW YORK OFFICE—30 Church Street. FOREIGN AGENTS—Selson Engineering Co., London, England. Thielicke & Co., Berlin, Germany. Edgar Bloxham, Paris, France. O. R. San Galli, St. Petersburg, Russia. Hans Schulze, Vienna, Austria. A. Engelmann & Co., Liege, Belgium. Stussi & Zweifel, Milan, Italy. Schaufelberger & Co., Zurich, Switzerland. Post Van der Burg & Co., Rotterdam, Holland. Aktiebolaget Goteborgs Maskinaffar, Gothenburg, Sweden. Bevan & Edwards Pty., Ltd., Melbourne, Australia. Parke & Lacy Co., Ltd., Sydney, N. S. W., Australia. Leslie A. Walker, Wellington, N. Z.

How Would You Handle This Work?

Suppose you were turning a certain fixed quantity of 22 by 1½-inch shafts, with shoulders at both ends, one end threaded and the other drilled and tapped; not enough to keep a turret lathe busy, yet too much to handle profitably on an engine lathe. Suppose, also, you faced practically the same conditions on a quantity of chucked work, say pieces 12 inches in diameter, with three or four operations to complete. What would you do?

With equipment for bar work



The logical, practical, economical thing would be to install an **Acme Combination Flat Turret Lathe**—the machine which **handles both classes of work**, rapidly, accurately and economically with simple tool equipment; the machine with the **perfect** chuck, opened and closed while the machine is running; has no end motion, making it possible to do second operation work requiring **exact** shoulder lengths, and jaws which do **not** overhang, allowing short work to be gripped without tilting the jaws; the machine with the positive, automatic roller-feed which **takes any section of bar**, round, square or hex, **equally well.**

We'd like to send you the catalog showing the flat turret and its rigid tool supporting system, the adjustable stops for each tool and many other advantages in design, construction and operation.

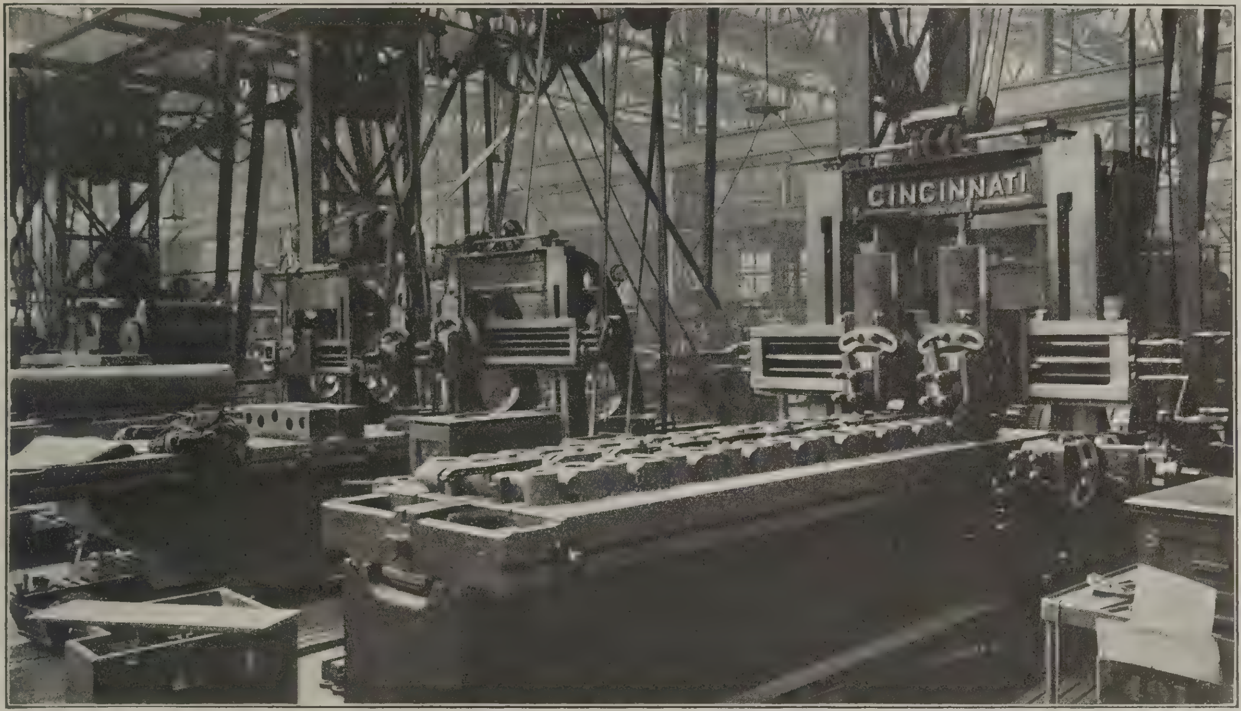
THE ACME MACHINE TOOL COMPANY

CINCINNATI, OHIO, U. S. A.

Manufacturers of Screw Machines and Turret Lathes

DOMESTIC AGENTS—The Prentiss Tool & Supply Co., New York, Boston, Syracuse and Scranton. Marshall & Huschart Machinery Co., Chicago, Milwaukee, Indianapolis and St. Louis. W. E. Shipley Machinery Co., Philadelphia. Motch & Merryweather Co., Cleveland, Cincinnati, Detroit, Pittsburgh and Columbus. Syracuse Supply Co., Buffalo and Rochester. Harron, Rickard & McCone, San Francisco and Los Angeles. Hallidie Machinery Co., Seattle and Spokane. Zimmermann-Wells-Brown, Portland, Ore. Galligher Machinery Co., Salt Lake City. Dewstoe Machine Tool Co., Birmingham and Atlanta. Kemp Machinery Co., Baltimore and Richmond, Va. Northern Machinery Co., Minneapolis. C. T. Patterson Co., Ltd., New Orleans. Mine & Smelter Supply Co., Denver.

FOREIGN AGENTS—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver. George H. Alexander, Birmingham, England. J. Lambercier & Co., Geneva, Switzerland. Thielicke & Co., Berlin, Germany. E. Isbecque & Ci, Antwerp, Belgium. Ing. A. Baldini, Pontedera, Italy. G. Hartman, Christiania, Norway. Andrews & George, Yokohama, Japan. Barquz DeAlmeida & Co., Brazil. Krajewski Pesant Co., Cuba.



Just Another Proof of "Cincinnati" Efficiency

A little job like machining twenty gas engine connecting rods at one time, only goes to prove that Cincinnati Planers increase production and give maximum planer efficiency. The accompanying illustration shows a 42-inch Two Head Cincinnati Planer of the widened type; the twenty connecting rods are clamped to the platen and the two heads are working on the bosses at either end of the rods. When the bosses are finished on one side they are reversed and finished on the other side. One of these bearings is 4″ and the other 5½″; the rods are steel castings, and the cutting tools are operated at a speed of forty feet per minute with a ⅛″ depth of cut and a transverse feed of 3-32″ per stroke.

Only a planer of the Cincinnati type can handle work in the quantities shown above—and maintain close accuracy in every piece. The quick reverse aluminum pulleys, extra capacity tables, variable speed drive, rigidly braced bed, wide V tracks and other features put Cincinnati Planers in a class by themselves. Send for catalog and details of

EFFICIENCY PLANERS — PLANER EFFICIENCY

CINCINNATI PLANER CO., Cincinnati, Ohio, U. S. A.

DOMESTIC AGENTS:—Prentiss Tool & Supply Co., New York, Syracuse, Buffalo, Rochester, Boston and Scranton, Pa. Marshall & Huschart Mchy. Co., Chicago, Milwaukee, St. Louis and Indianapolis. Motch & Merryweather Mchy. Co., Cleveland, Cincinnati and Detroit. W. E. Shipley Mchy. Co., Philadelphia, Pa. Baird Mchy. Co., Pittsburg, Pa. Harron, Rickard & McCone, San Francisco and Los Angeles, Cal. Eccles & Smith Co., San Francisco and Los Angeles, Cal., (Large Planers and Boring Mills). Hallidie Mchy. Co., Seattle and Spokane. Robinson, Cary & Sands Co., St. Paul and Duluth. Zimmerman-Wells-Brown Co., Portland, Oregon. Galligher Mchy. Co., Salt Lake City. Hendrie & Bolthoff Co., Denver, Colo. Dewstoe Machine Tool Co., Birmingham, Ala. Kemp Mchy. Co., Baltimore, Md.

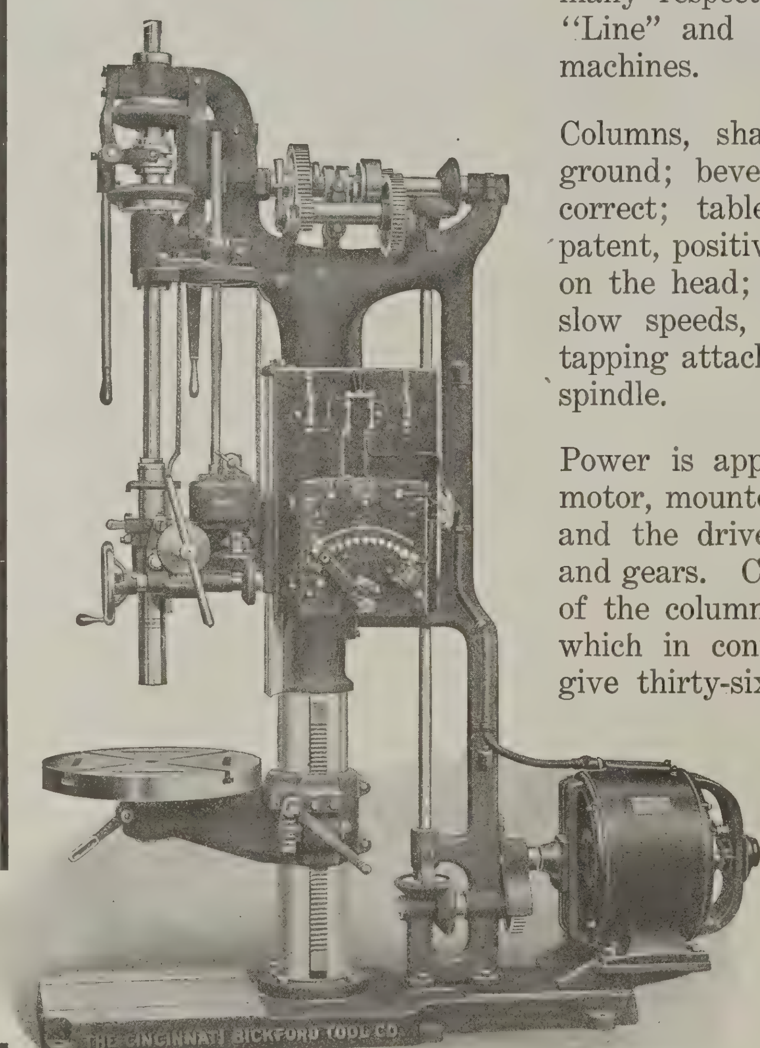
FOREIGN AGENTS:—Ludw. Loewe & Co., Berlin. R. S. Stokvis & Zonen, Rotterdam, Holland and Brussels, Belgium. Geo. W. Goodchild & Partner, London, E. C. J. Lambercier & Co., Geneva, Switzerland. Ing. Ercole Vaghi, Milan. Donauwerk Ernst Krause & Co., Vienna, Austria. Andrews & George, Yokohama, Japan. Thos. McPherson & Son, Melbourne, Australia. Krajewski-Pesant Co., Havana, Cuba. G. Hartman, Kristiania, Norway.

THE CINCINNATI

In This Upright Drilling Machine We Offer

A High Speed, High Power, Essentially Accurate Machine, in Sizes from 24-inch to 42-inch Swing

A machine that fills the demand for a High Speed Drill in which the demonstrated advantages of Cincinnati construction are incorporated, but differing in many respects from the regular Cincinnati "Line" and the entire field of competing machines.



Columns, shafts, sleeves and spindles are ground; bevel gears are planed theoretically correct; tables and arms are very heavy; patent, positive geared feed is located directly on the head; friction back gears give fast or slow speeds, instantly; and patent geared tapping attachment is located directly on the spindle.

Power is applied through a variable speed motor, mounted on the base of the machine, and the drive is by means of vertical shaft and gears. Controller is mounted on the side of the column and provides eighteen speeds, which in connection with the back gears, give thirty-six spindle speeds, all obtainable from the working position. This arrangement gives correct spindle speeds for 70 feet cutting speed on all sizes—and slower speeds are available by the use of friction back gears.

New Catalogue shows full line—
Yours for the asking.

THE CINCINNATI BICKFORD TOOL

DRILLING MACHINERY FOR BOTH HIGH

Domestic Agents—Prentiss Tool and Supply Co., New York City, Buffalo, Rochester and Syracuse, N. Y., Boston, Mass., Scranton, Pa. Marshall & Huschart Machinery Co., Chicago, Ill., Indianapolis, Ind., St. Louis, Mo., Milwaukee, Wis. Motch & Merryweather Machinery Co., Cleveland and Cincinnati, Ohio, Detroit, Mich. W. E. Shipley Machinery Co., Philadelphia, Pa. Brown & Zortman Machinery Co., Pittsburgh, Pa. Harron, Rickard & McCone, San Francisco and Los Angeles, Cal. Robinson, Cary & Sands Co., St. Paul and Duluth, Minn. Hallidie Machinery Co., Seattle, Wash. The Hallidie Co., Spokane, Wash. C. T. Patterson Co., Ltd., New Orleans, La. Dewstoe Machine Tool Co., Birmingham, Ala. Kemp Machinery Co., Baltimore, Md. W. H. Petrie, Ltd., Toronto, Montreal and Vancouver, Canada. Zimmerman-Wells-Brown Co., Portland, Ore. Galligher Machinery Co., Salt Lake City, Utah. Erie Mfg. & Supply Co., Erie, Pa. Hendrie & Bolthoff Mfg. & Supply Co., Denver, Col.

THE CINCINNATI BICKFORD

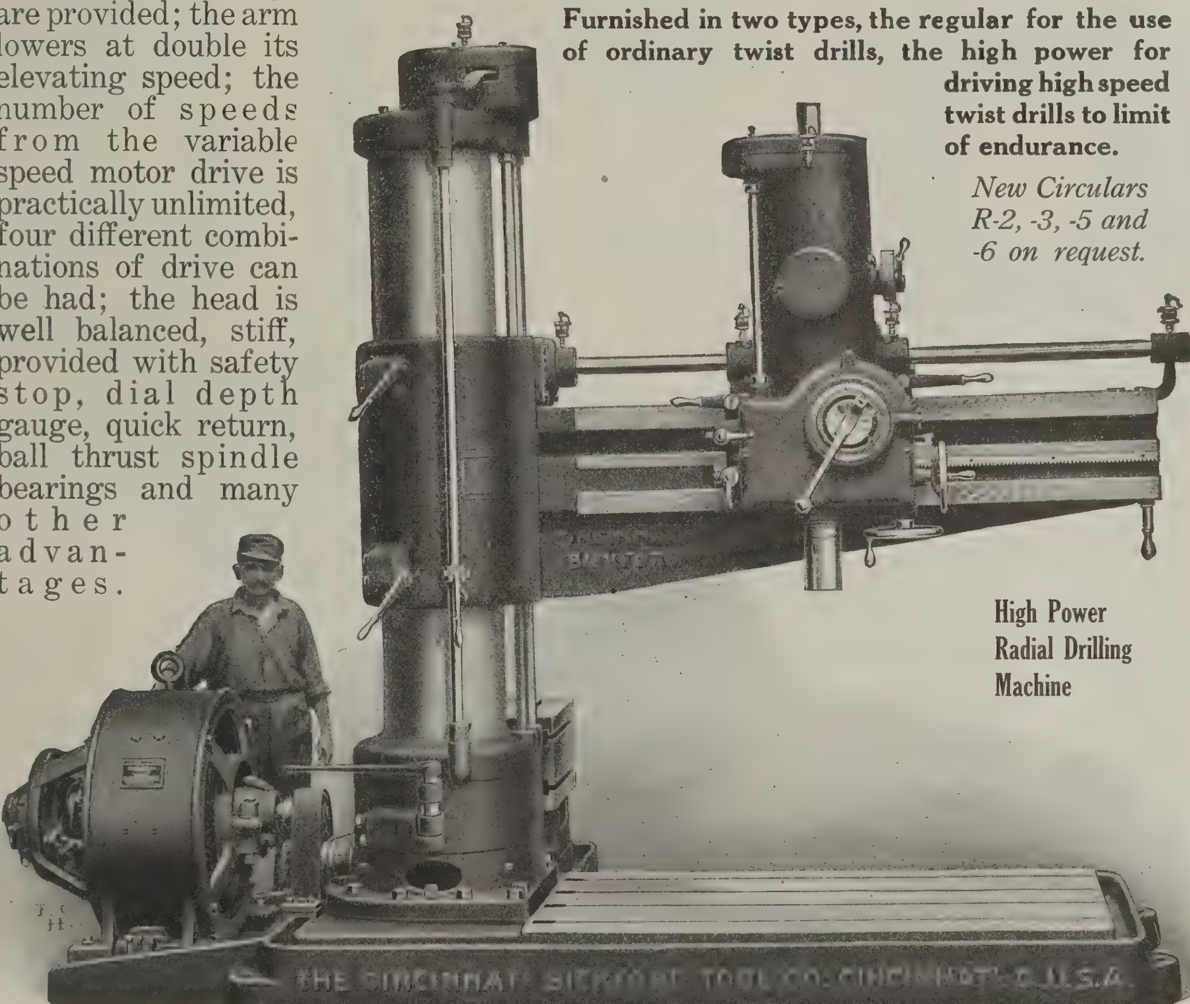
The Buyer of Our Radial Drilling Machines

Gets Every Operating Convenience that Modern Usage Demands in a Machine of this Class

Not only the superficial convenience, the location of control levers where they are handy, but conveniences that go deeper, that are fundamental to really successful, economical operation. The column, its inner trunk and the arm become practically a single number when the sleeve is tightened; ball thrust and annular bearings are provided; the arm lowers at double its elevating speed; the number of speeds from the variable speed motor drive is practically unlimited, four different combinations of drive can be had; the head is well balanced, stiff, provided with safety stop, dial depth gauge, quick return, ball thrust spindle bearings and many other advantages.

Furnished in two types, the regular for the use of ordinary twist drills, the high power for driving high speed twist drills to limit of endurance.

New Circulars R-2, -3, -5 and -6 on request.



High Power Radial Drilling Machine

COMPANY, Oakley, Cincinnati, Ohio

SPEED AND ORDINARY TWIST DRILL USE

Foreign Agents—Alfred H. Schutte, Cologne and Berlin, Germany; Brussels, Belgium; Paris, France; Milan, Italy; Barcelona and Bilbao, Spain; St. Petersburg, Russia; Donauwerk Ernst Krause & Co., Vienna and Prague, Austria; Budapest, Hungary. Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, Eng.; Glasgow, Scotland. Krajewski-Pesant Co., Havana, Cuba. Thomas McPherson & Son, Melbourne, Australia. Andrews & George, Yokohama, Japan. Robert Pusterla & Co., Buenos Aires, South America. V. Lowener, Christiania, Norway. Nienstaedt & Co., Copenhagen, Denmark. Sam Lagerlofs, Stockholm, Sweden. Bartle & Co., Johannesburg, South Africa. David S. Hays, New York City.

A COMBINATION HARD TO BEAT

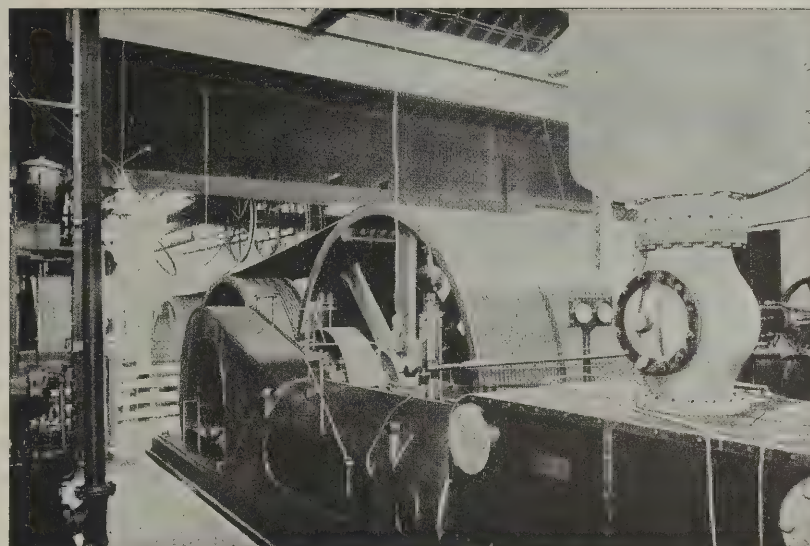
Folder No. 31-M gives complete description with illustrations and prices. We will send it promptly upon your request.

The CLEVELAND Twist Drill Co.

New York CLEVELAND Chicago

DODGE

Efficiency
Economy



Speed
Safety

Dodge Rope Drive in the plant of the Goodyear Tire & Rubber Co., Akron, O.

"Seven Years without a Stop or a Break-down"

THE manager of a well known plant while showing some visitors through the engine room remarked:

"The ropes on these Dodge drives have been doing steady duty for seven years without a stop or a break-down—have never lost a minute in transmitting 1600 H. P."

Listen: The initial cost was $487.20 for the rope, (Dodge "Firmus" Manila) the only wearing part. If the original rope were now a dead loss the net cost per year would be $69.60. To this add interest at 6 per cent, $29.23, a total of only $98.83 for 1600 H. P. per year for rope or a cost per horse-power per year for twenty-three hours daily service of 6 1-6 cents.

These ropes are still doing business and apparently are good for seven years more.

Compare the above with the horse-power per annum cost of any other type of main drive to do this work.

Dodge engineers, with more than a quarter of a century's experience back of them, are ready on call to confer with power users on any changes contemplated in mechanical equipment touching the transmission of power. If you are confronted by a problem put it up to us for solution. **Our business is to make everybody happy, from the chief executive to the chief engineer.**

QUALITY SERVICE

PHILADELPHIA 815 Arch St. | BOSTON 137 139 Purchase St. | CINCINNATI 126 128 W. Third St. | ATLANTA 54-60 Marietta St. | PITTSBURGH 337 Second Ave.

DODGE MANUFACTURING COMPANY
Everything for the Mechanical & Economical Transmission of Power
MISHAWAKA, INDIANA

CHICAGO 208-214 So. Clinton St. | NEW YORK 21 Murray St. | MINNEAPOLIS 202-204 Third St. S. | ST. LOUIS 507 N. Main St. | PORTLAND, ORE. 14th & Lovejoy Sts

QUALITY SERVICE

ESTABLISHED 1872

MANUFACTURING AUTOMATICS

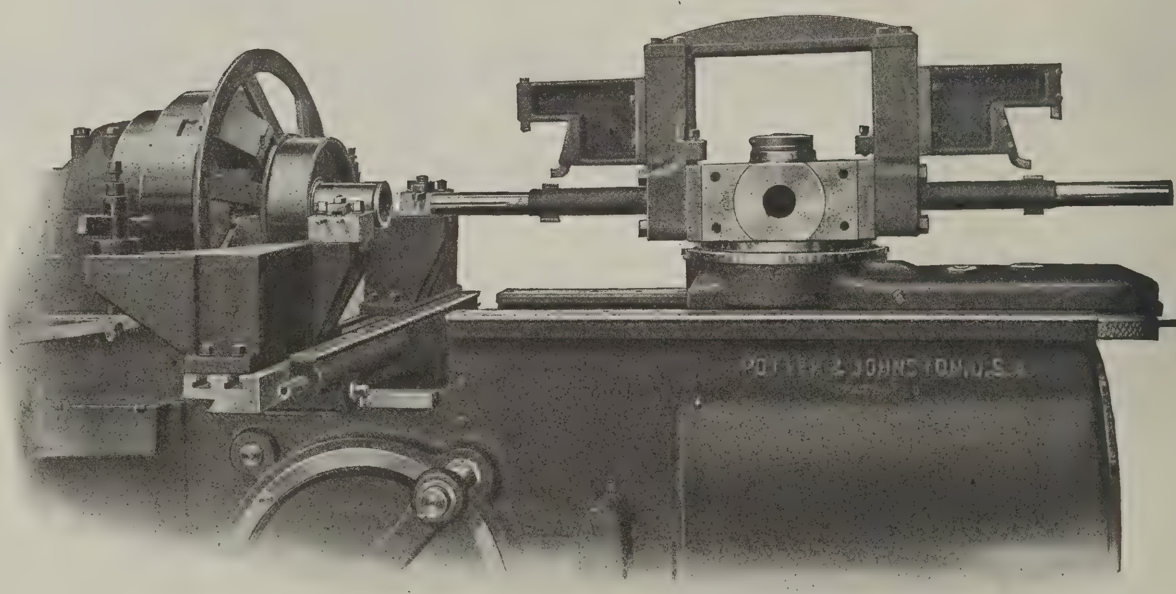
5-A, 6-A, 7-A, 8-A Models

FOR EVERY SERVICE

It matters little in what line of industry you are engaged, if you are machining duplicate parts in quantities coming within the range of the MANUFACTURING AUTOMATICS, they will POSITIVELY SHOW A SAVING OVER THE HAND MACHINES.

Automatically machine work from 1-inch to 40-inches diameter, up to 15-inches long.

One Attendant Operates in Groups of Two to Eight Machines



7-A Manufacturing Automatic

Showing tool equipment for finishing Friction Spider, 27¾ inches diameter, 11¼ inches long. Time to finish one piece 30 minutes.

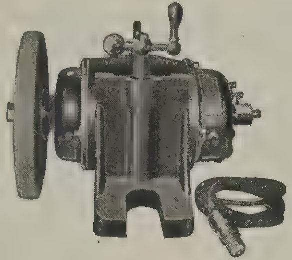
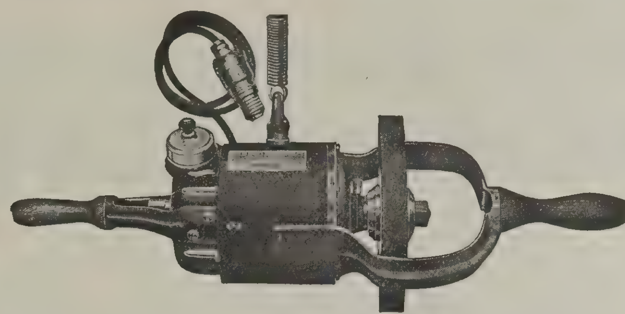
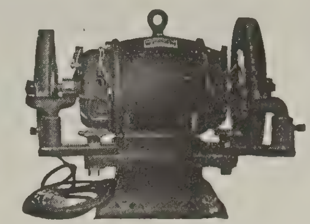
ALL TURRET LATHE WORK IS GOOD WORK FOR THE MANUFACTURING AUTOMATICS

Copy of the book?

POTTER & JOHNSTON, Pawtucket, R. I.

OFFICES AND REPRESENTATIVES—Office for Great Britain and France: 68 Avenue de la Grand Armee, Paris, J. Ryan, Manager. New York Office: Fulton Bldg.. 50 Church St., Walter H. Foster, Manager. Detroit Office: Modern Machinery and Engineering Co., 1514 Ford Bldg., Milwaukee Office: Berlin Bldg., 19th and National Aves., Chas. H. Shaw, Manager.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, England, and Glasgow, Scotland. Alfred H. Schutte, Cologne, Brussels, Milan, Barcelona, Bilbao. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen.

Your Busy Season?

If work is piling up at some one or two points, put United States Electric "Portables" on the job—it is surprising how they will relieve things. Here's an instance. A manufacturer of small machine parts was running behind his orders; he had speeded-up all along the line, but his drilling equipment was not sufficient to meet the increase. It meant either more equipment, or overtime in this one department. He solved the problem with a single U. S. Portable Electric Drilling Machine. The boy who carried the castings to and from the stationary drilling machines drilled two small holes with the "Portable" before stacking the work for the operator. He saved one operation and released one spindle of the machine—and the congestion at this point was over.

The investment cost was low, the labor cost wasn't increased one cent, the relief was quick and the product was not cheapened or slighted in any way.

Not only in emergencies, but for every day use, U. S. Portable Electric Tools will save—on drilling, grinding, buffing, etc.

Made in many types and sizes, for many classes of work.

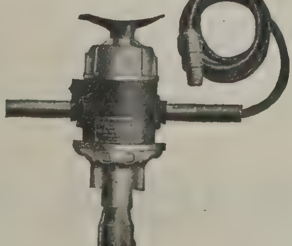
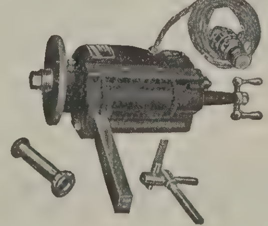
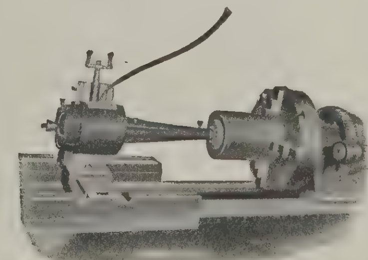
Send for catalog of the full line.

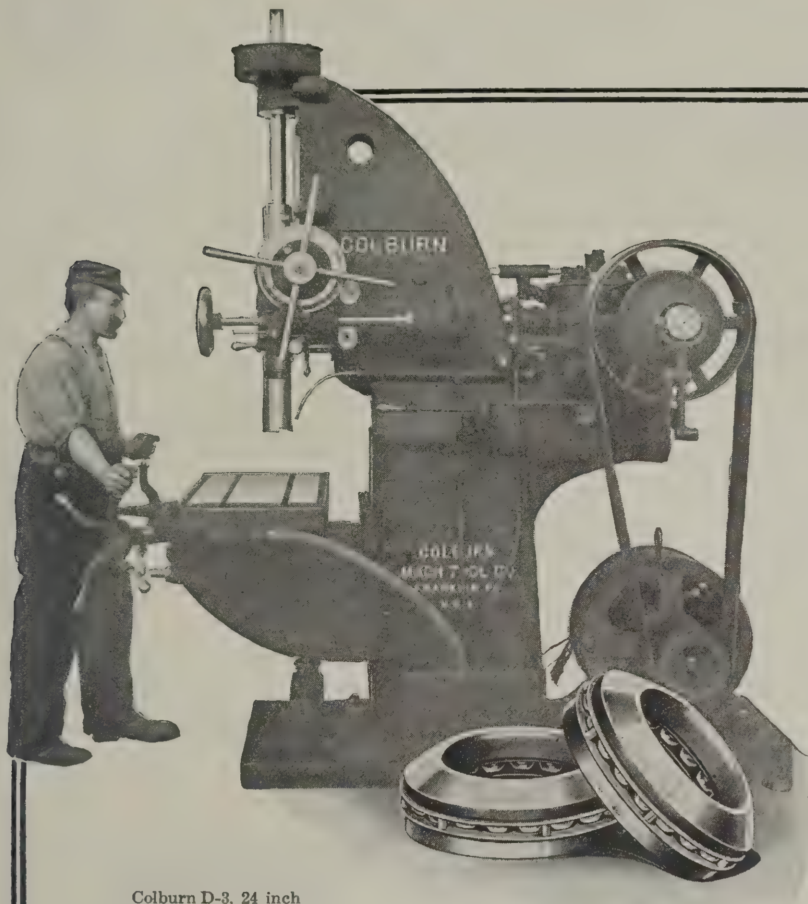
THE UNITED STATES ELECTRICAL TOOL CO.

6th Ave. and Mt. Hope Sts., CINCINNATI, OHIO, U. S. A.

Philadelphia Office, 304 Denckla Building
Chicago Office, 8 E. Michigan Street
Boston Office, 12 Pearl Street
New York Office, 50 Church Street

FOREIGN AGENTS: The Canadian-Fairbanks Co., Ltd., Montreal, St. John, Toronto, Winnipeg, Calgary, Vancouver. Agents for Sweden: Wilh. Sonesson & Co., Malmo, Stockholm and Gothenburg. Agents for Denmark, Norway and Finland: Aktieselskabet Wilh. Sonesson & Co., Copenhagen City and Freeport. Selson Engineering Co., Ltd., London, England. J. S. Cock, Christiania, Norway. Hans Schulze, Bruenn, Austria. Andrews & George, Yokohama, Japan. American Trading Co., Australia, South Africa, South America. Fenwick Freres & Co., Paris, France.



Colburn D-3, 24 inch
Heavy Duty Drill Press

A Drill Press With Ball Thrust Bearings

and its work

The performance of the Colburn heavy duty drill press, first brought out in its present model two years ago, was and still is one of the sensations of the machine tool world.

In a test on a D3 24-inch Colburn drill press, a three-inch drill running 188 R.P.M. in cast iron, drilled through a 4-inch block at the rate of 11.25 inches per minute, using a .06 inch feed. In steel, at 100 R.P.M., a 3-inch drill drilled through a 4-inch block in a trifle less than one minute, using a .041 inch feed. The drills were in good condition after each test.

Unless practically all the power applied at the belt had reached the drill, such results as these tests showed would have been impossible. If the machine had been lightly or unskilfully designed, even with no waste of power, the result would still have been impossible.

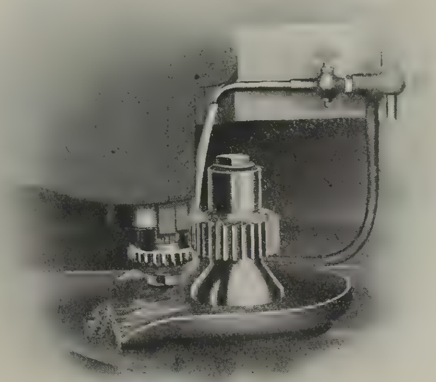
The combination of

HESS-BRIGHT BALL BEARINGS
Built for Endurance

and scientific design produced a drill press that sets a new mark for efficiency and speed.

Our Engineering Department is at the service of manufacturers wishing to improve the bearing performance of their product. Recommendations as to size and mounting will be made, and sketches made without charge from your blue-prints showing how Hess-Brights can be applied.

The Hess-Bright Manufacturing Company
17 East Erie Avenue Philadelphia, Pa.



THE IMPORTANCE OF CUTTER LUBRICATION

FEW mechanics would accept or condemn a machine from the standpoint of cutter lubrication alone; and yet there is no small detail of machine design on which so much depends in the way of accuracy, output and fineness of finish. If the cutting oil or compound is not led properly to the cutting edge, the machine will do less work, and less accurate work; it will show a poorer finish; and the tool will wear out more quickly.

Cutter lubrication is a large matter—not a small one.

Now consider the Gear Shaper. The cutter takes its chip normally on the up- or draw-stroke. The oil falls directly down by gravity onto the advancing cutting edge. That is a simple matter, but no other machine has that simple advantage.

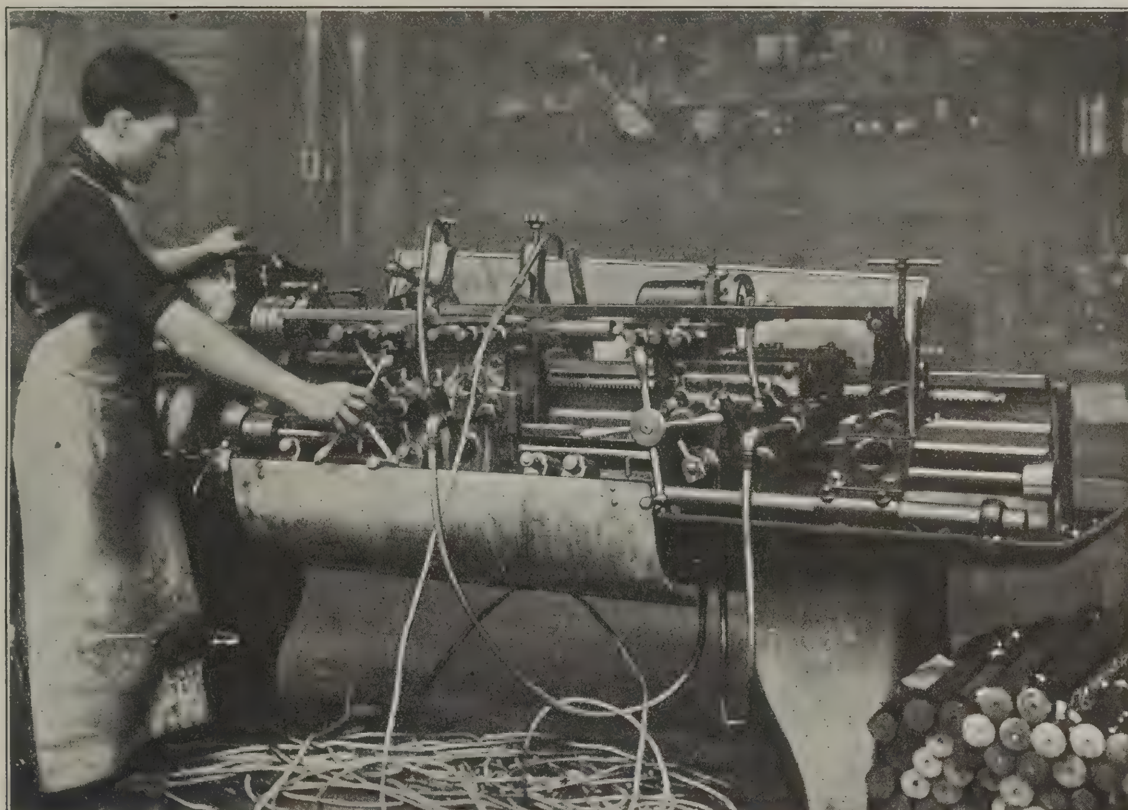
Consider the automatic gear cutter or hobbing machine. The best that can be done with the milling cutter or hob is to wet the teeth before they go into the cut, and wash and cool them off after they come out. Compare this condition with that of the Gear Shaper cutter, which does its actual cutting in a veritable flood of oil.

If the Gear Shaper had no other special advantages in accuracy, output or convenience, it would still be preferred to all other machines on steel work, from the standpoint of cutter lubrication alone.

THE FELLOWS GEAR SHAPER COMPANY

25 PEARL STREET, SPRINGFIELD, VT., U.S.A.

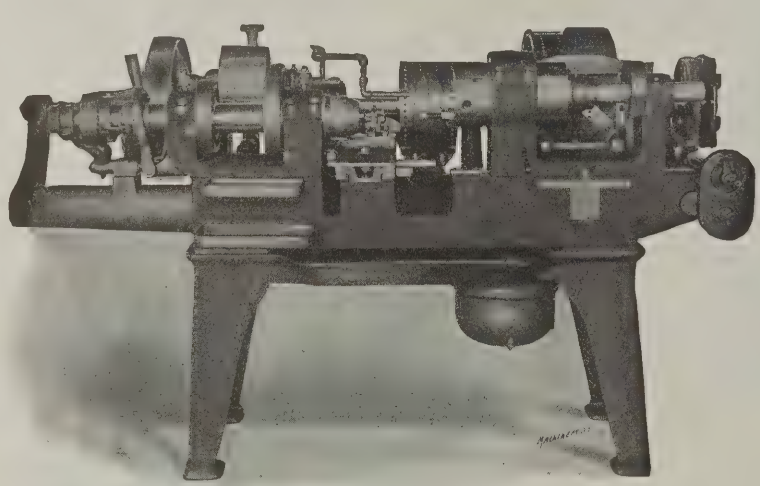
Foreign Agents—Henry Kelley & Co., Manchester, Eng. M. Koyemann, Dusseldorf, Germany. Ph. Bonvillain and E. Ronceray, Paris, France. White, Child & Beney, Vienna, Austria. Adler & Eisenschitz, Milan, Italy. The C. & J. W. Gardner Co., St. Petersburg, Russia.



Another Year of Cleveland Automatic Success

1912 has added materially to the number of "Cleveland" installations—thousands of these machines are now in use. We can name more satisfied customers—concerns using from 10 to 200 "Clevelands"—than any other maker of such machines, anywhere. Many of these are early models, 12 to 20 years old, and it speaks well for "Cleveland" design and construction that these machines are turning out work which is satisfactory in every way, though quantities cannot compare, of course, with that of new model machines.

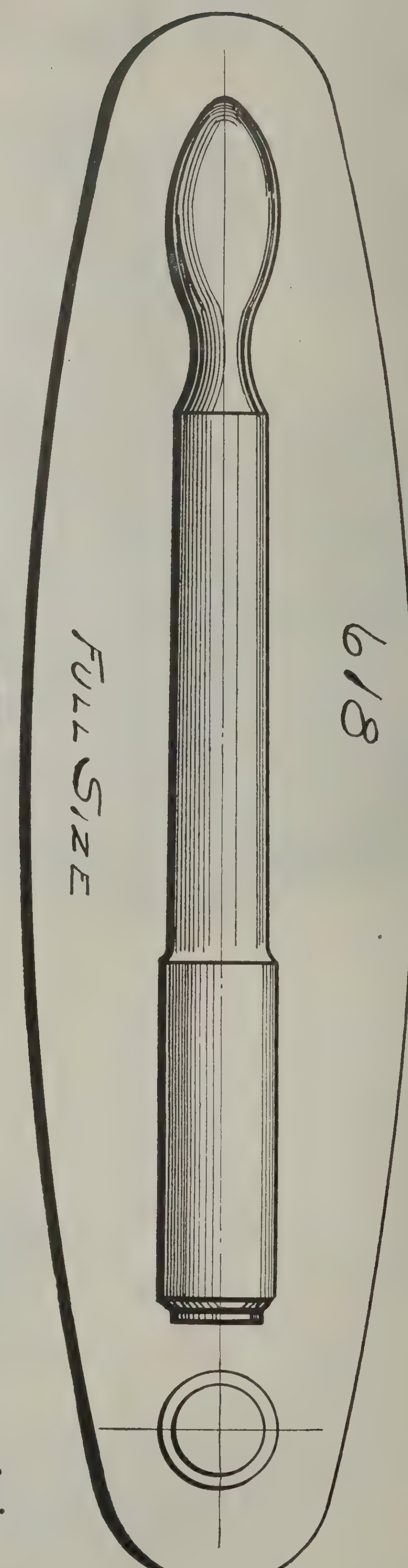
Another point; the cost of maintenance is insignificant. The number of orders we receive for repair parts is less, machine for machine, than for other makes of automatics—and we



make this statement without fear of contradiction. The interchangeability of all parts provides another saving, in case of accident, by which "Cleveland" users benefit.

Other facts of the same nature point the way to highest efficiencies in automatic production. They deserve your most serious consideration. May we send the details?

Piece No. 618. Material, Machine Steel. Made on a 1¼″ Cleveland Automatic Plain Machine. Output, 32 per hour. Send in drawings or samples and we will send you complete specifications, covering outputs, cost of machines, tools, etc.



Cleveland Automatic Machine Co.

CLEVELAND OHIO, U. S. A.

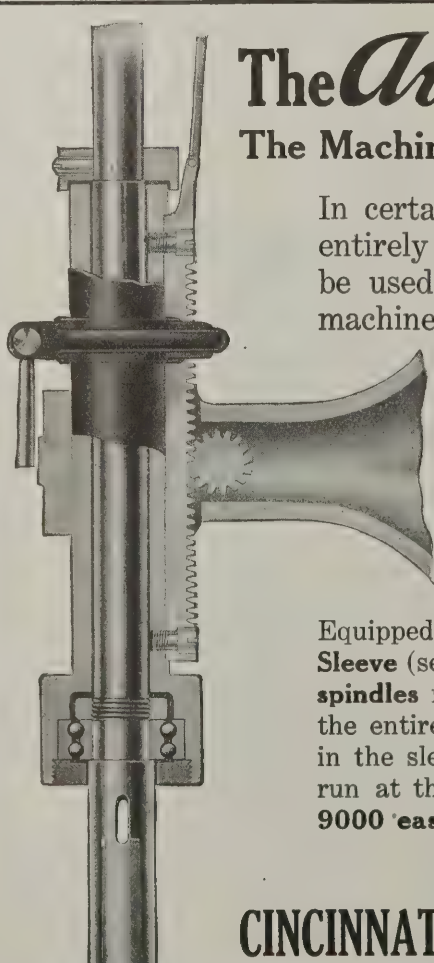
Eastern Representative—J. B. Anderson, 2450 No. 30th St., Philadelphia.
Western Representative—Herbert E. Nunn, 562 Washington Boulevard, Chicago.
Foreign Representatives—Chas. Churchill & Co., London, Manchester, Birmingham, Newcastle-on-Tyne and Glasgow. Alfred H. Schutte, Cologne, Brussels, Paris, Milano, Bilbao and Berlin and St. Petersburg. Donauwerk Ernst Krause & Co., Stockholm, Copenhagen, Austria-Hungary and the Balkan States. Andrews & George, P. O. Box 66, 242 Yokohama, Japan.

Built from Blue Prints of Modern Demand

Three Step Cone and Double Back Gear with Positive Locking Device; Gear Guards; Quick Change Gear Attachment; Double Plate Type of Apron, with reverse feed; Star Feed Knobs and non-interfering device between feeds and screw cutting; Cut-away Tail Stock with split bushing clamping device; Wide Waist Carriage, with bearing on inside front track; Fay & Scott QUALITY.

Ask for catalog **Full line of sizes**

FAY & SCOTT, DEXTER, MAINE, U. S. A.



The *Avey* Ball Bearing Drilling Machine

The Machine that Stands the Speed — Always in the Lead

In certain classes of manufacture where drilling runs almost entirely to the very small sizes, **much higher speeds** should be used than even the ordinary high speeds obtainable on machines adapted to wide range of sizes.

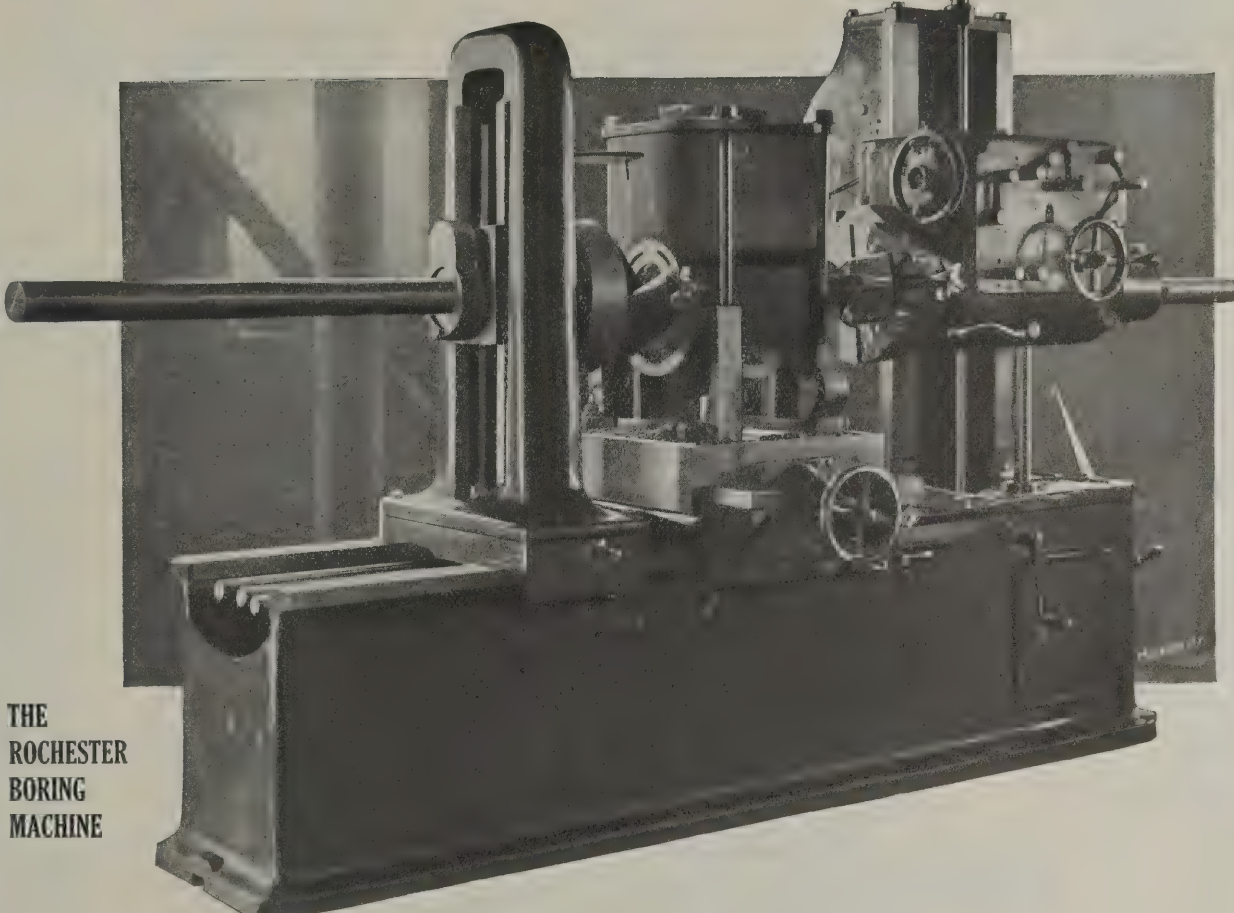
SOMETHING NEW

The Avey Sensitive Drilling Machine No. 1½

Equipped with HESS-BRIGHT bearings throughout, **including** the **Spindle Sleeve** (see cut.) The only sensitive drilling machine on the market with **spindles** running in **Annular** Ball Bearings. Note the clearance of $\frac{1}{32}$" the entire length of spindle sleeve. Note also the Steel Rack inserted in the sleeve. The "Avey No. 1½" is the only machine which can be run at the proper speeds for small drills. **Spindle Speeds of 3000 to 9000 easily obtained,** and can be run at higher speeds if desired.

Write us at once for information.

CINCINNATI PULLEY MACHINERY COMPANY, Cincinnati, Ohio



THE ROCHESTER BORING MACHINE

"The Longer we Run it the More we are Pleased with it"

says this Rochester Boring Machine user. You can see the character of work he is doing; boring large and small gasoline engine cylinders—and gas engine work means straight and accurate boring, always. The letter from the Turner Manufacturing Company speaks for itself, and in a manner peculiar to Rochester users.

Just as this man says, the adaptability of the Rochester is one of its strong points. Why?—Because it has weight, stability, range, every operating convenience, wide spread spindle bearings, continuous traverse of spindle without resetting, and many other details of construction and operation which assure efficiency on various classes of work.

If you do machine work, you do boring, and for your boring you need the "Rochester."

TURNER MANUFACTURING CO.
Established 1872.
PORT WASHINGTON, WIS., U. S. A.
Aug. 17, 1912.

ROCHESTER BORING MACHINE CO., Rochester, N. Y.

Gentlemen:—Replying to your letter of the 15th, we have photographed the machine, working on both the large and small cylinders so as to show its greatest adaptability, which we consider one of the important factors.

As far as the working of the machine is concerned, we can conscientiously say that it is doing all that could be expected of a machine of this kind; in fact, **the longer we run it, the more pleased we are with it, and the more we see its possibilities.**

We have turned out the most perfect 5 H. P. engines with it that we have ever built, and the cylinders were bored with only two cuts, a roughing cut, and reamed with a four blade reamer of our own make. The cylinders were so perfect that the engines tested out in about one-third of the usual time. This is a 5" bore cylinder.

We bored a 12 H. P. cylinder yesterday, 7½" bore, in which there was 1-1000" variation from end to end, and the cylinder was perfectly round so far as we could discover with a micrometer. This was done with a two cutter finishing tool. We expect even better results, both as to output and quality, when we have completed our tool equipment.

You can imagine how well pleased we are with the machine from the foregoing results, especially in view of the unfortunate experience that we have recently gone through with cylinder boring machines. Thanking you for past favors, we are

Very truly yours,
TURNER MANUFACTURING CO.
L. M. Turner, Gen. Mgr.

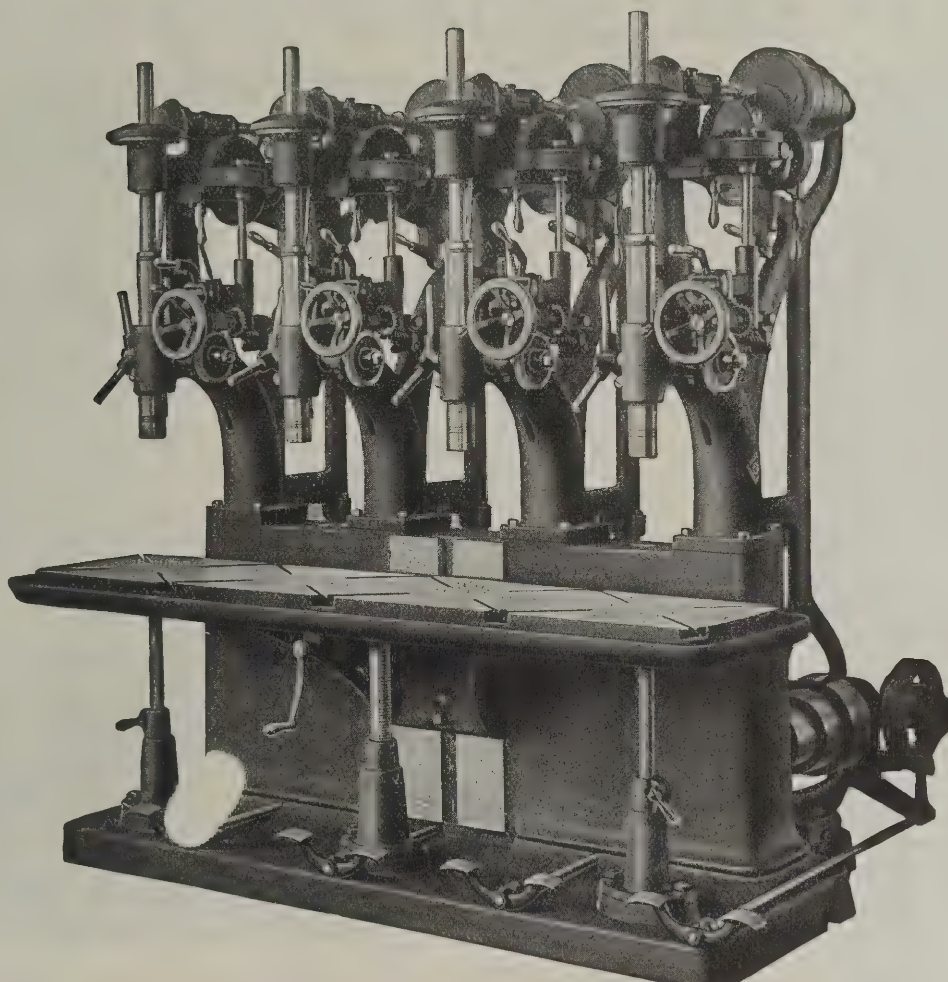
Catalog and full details on request.

ROCHESTER BORING MACHINE CO., Rochester, N.Y.

GANG DRILLS

TRADE W.F. AND J.Co. MARK

We make various sizes, drilling holes up to 2" diameter in solid steel



4 3 or 2 Spindles

22½" Swing Stationary Head Gang Drill (Style B).

LOOK HERE!

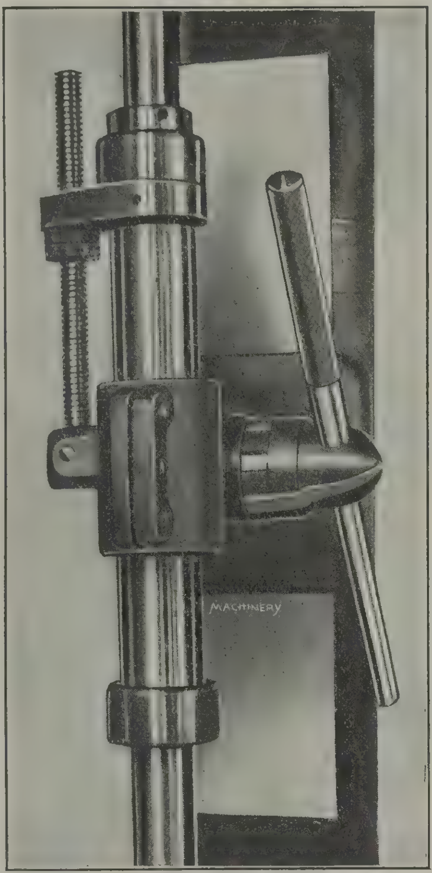
This Gang Drill Has

- Spindle travel of $14\frac{3}{4}$ inches.
- Table travel of $14\frac{1}{2}$ inches.
- Distance from column to spindles $11\frac{1}{2}$ inches.
- Distance between spindles 20 inches.
- A 4-spindle gang weighs 5800 lbs.
- Table measures 17 x 80 inches on 4-spindle gang.

This Gang Drill has driving capacity of a 26-inch swing drill; is equipped with back-gears, self-feed and automatic stop. **Our Geared Tapping Attachment** can be furnished on one or more spindles. Machine is driven by one main driving belt, and yet each spindle can be run separately, or all spindles at one time. We also make other sizes of Gang Drills and complete line of Upright Drills.

231 Ruby Street, Rockford, Ill., U.S.A.

Chas. Churchill & Co., London. F. W. Horne, Yokohama.



Just a Turn of the Wrist

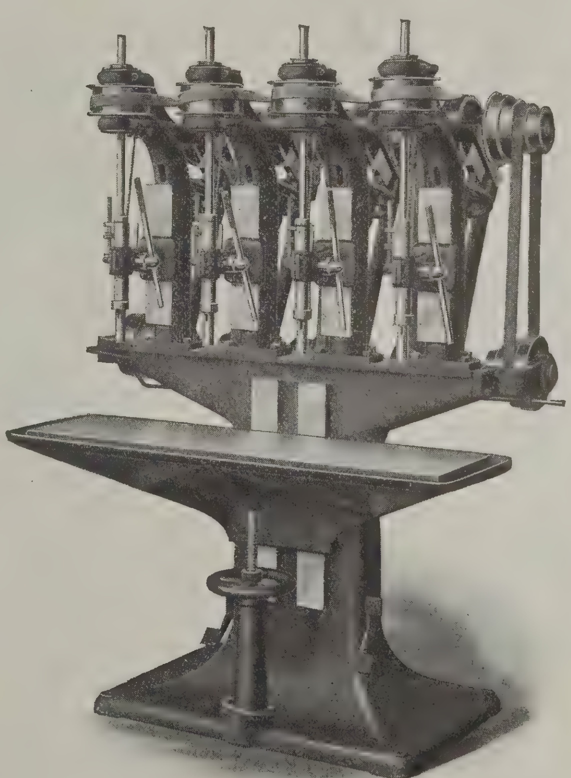
Brings the lever feed to the most convenient operating position—on the **Leland "Sensible Sensitive"** Drilling Machine. This and the positive spindle stop are two of many Leland features which appeal because of their simple effectiveness. The accompanying photographic reproduction of the spindle and head illustrates these points. No more shifting of the head on the column "just a little" to bring the operating lever to a convenient handling position. With the

Leland "Sensible Sensitive"

a simple twist of the wrist upon the knurled section of the lever releases the ratchet pawl so that it may be slipped to the next notch, or brought to any desired position.

The action requires only a few seconds, the pawl springing back into place the instant it is released.

The positive spindle stop is equally efficient. A simple affair, not much of it; but extremely handy when drilling holes to the same depth or counterboring seats for machine screw heads. Just a twirl of the knurled stop collar, followed by the locking collar, completes the adjustment—and no matter where the operator's thoughts are, **he simply can't drill too deep.**



Let us send you Circular R with full details of the

SENSIBLE SENSITIVE DRILL

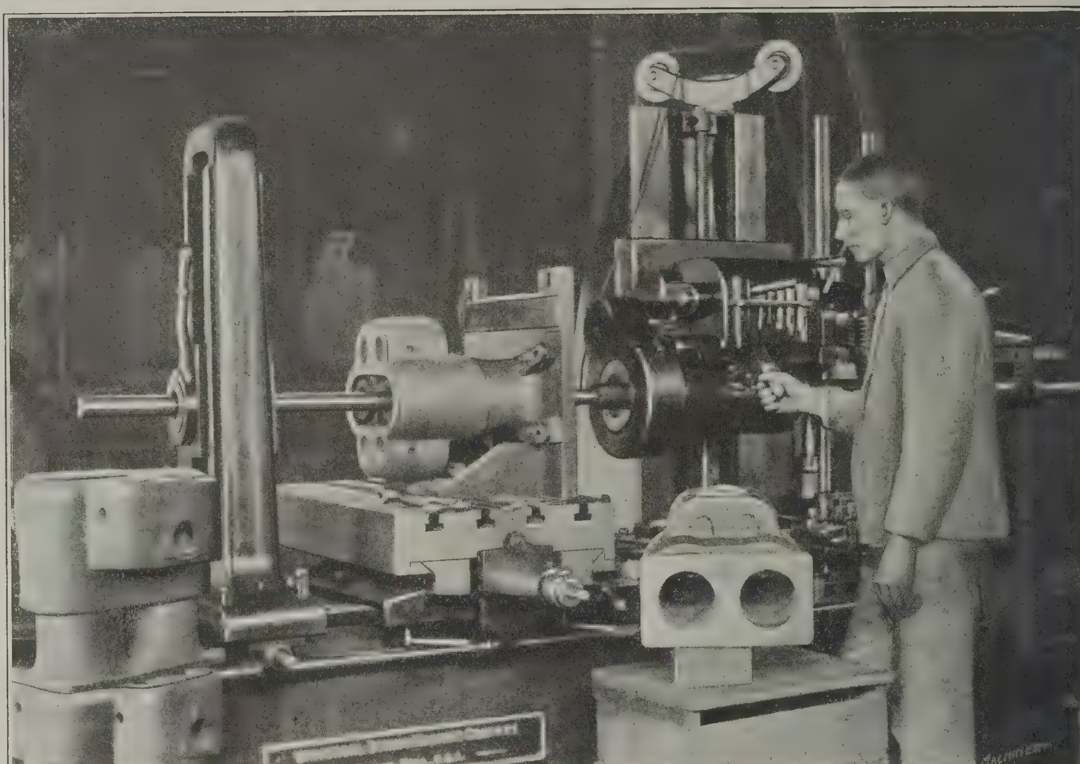
Patents Pending.

BUILT BY

W. H. LELAND & COMPANY

WORCESTER, MASS.

Accuracy is the First Principle of the



THIS principle along with the other "Universal" features goes far to make the machine a power in its field and a prime favorite for modern manufacturing. For instance, in developing, perfecting and building an automobile—a new design, perhaps, which must line up to and pass previous efforts—it is obvious that the highest standards of accuracy must be maintained.

The Brightwood Motor Mfg. Co. of Springfield, Mass.—with just this class of work to handle—have assured themselves that the Universal Boring Machine is the one machine for exact results. They employ the "Universal" for boring gear and crank cases, cylinders, etc., and the machine has proved its efficiency and economy from every standpoint.

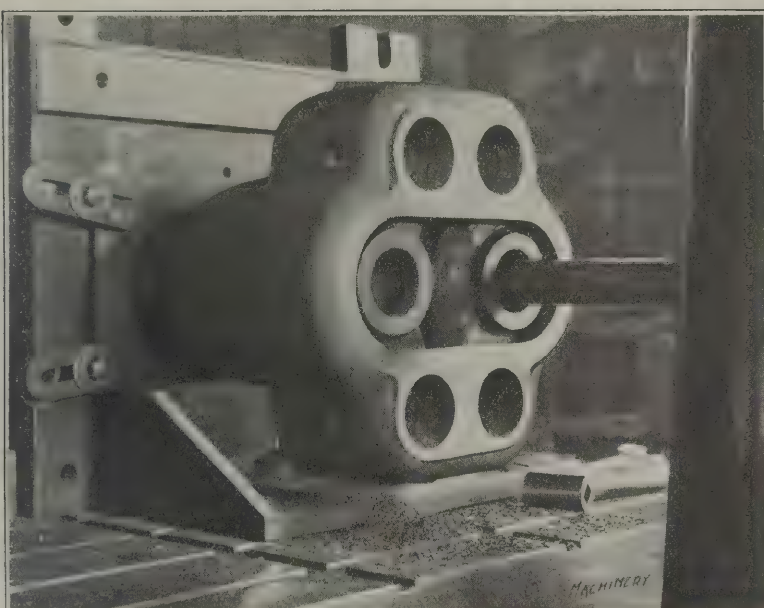
The larger illustration, photo taken at the Brightwood plant, shows the machine boring cylinder castings, one piece in position for working and others piled up in front of the machine. These cylinders, cast "en bloc," are held on the machine in a special fixture, a close view of which is given in the smaller engraving.

UBMCo

UNIVERSAL BORING MACHINE CO.,

AGENTS: Hill, Clarke & Co., Boston, New York, Philadelphia, Buffalo, Cleveland, Chicago.
Brown & Zortman Machinery Co., Pittsburg.
The Mine & Smelter Supply Co., Denver.
Harron, Rickard & McCone, San Francisco, Cal.
Aumen Machinery Co., Baltimore, Md.

Universal (Horizontal) Boring Machine

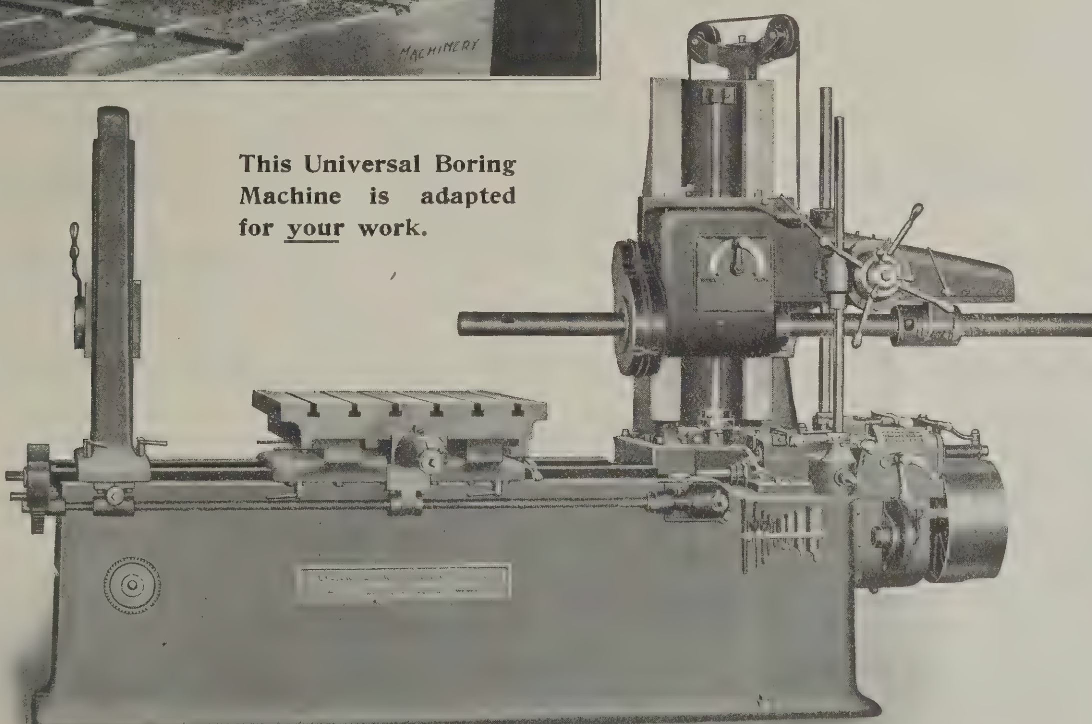


The cylinders are cast from very close grained Vanadium iron, which is difficult to work, and as they do not depend upon grinding for finishing the piece the boring must be accurate—in fact, the limit set for this work is 0.0005″.

Points which make the Universal Horizontal Boring Machine so successful on automobile work, as on other lines of manufacture, are the ease of operation, the wide range of speeds and feeds obtainable, and above all the dependable accuracy which is a recognized feature of "Universal" boring.

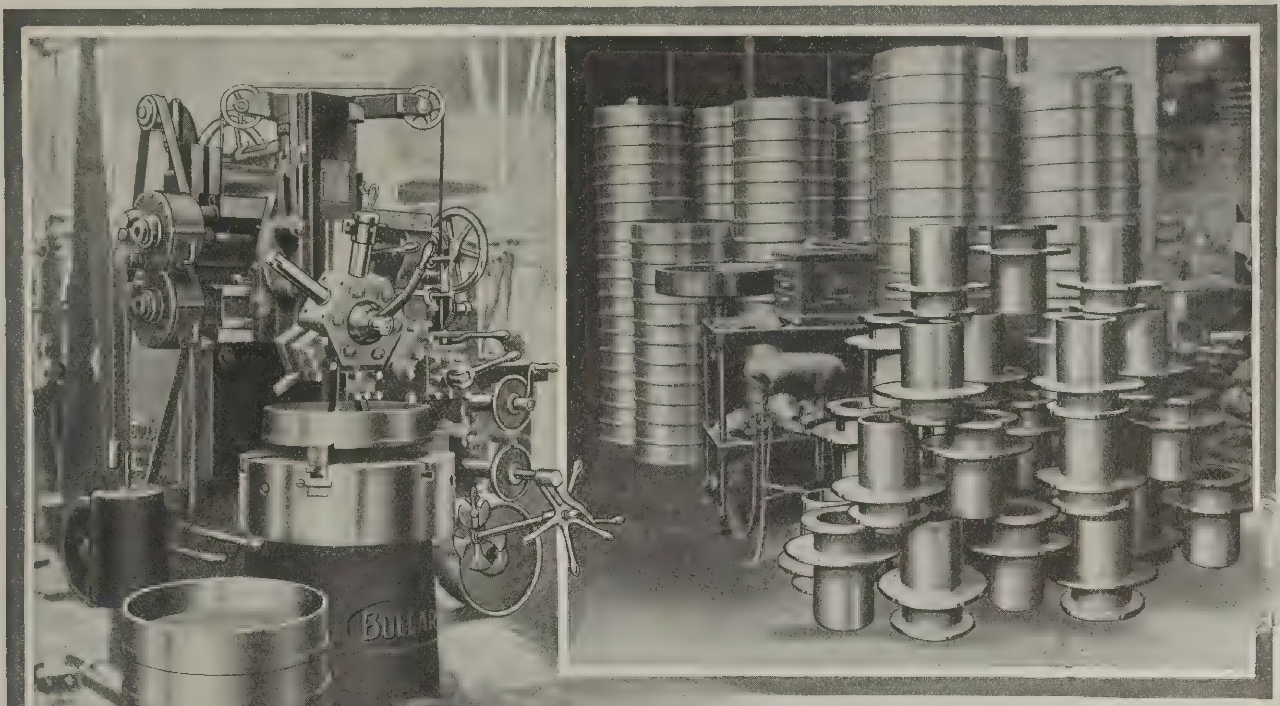
This Universal Boring Machine is adapted for your work.

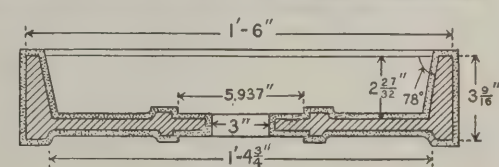
Write for Special Circulars or list of users in your neighborhood.



HUDSON, MASSACHUSETTS, U.S.A.

FOREIGN AGENTS: Alfred Herbert, Ltd., England, France, Switzerland and Italy.
Heinrich Dreyer, Germany and Austria-Hungary.
Allied Machinery Co. of America, Russia.
Wilh. Sonesson, Malmo, Sweden.





Close Limits and Fast Time

are attributes of the **Bullard Vertical Turret Lathe** on automobile work that make it a power in this special line of manufacture. It is not only a pace-maker on production and accuracy, but the machine that stands up on the "long grind"—the machine to assure "results," with the least possible demand on the operator—either mental or physical.

A typical Bullard automobile job is shown in the photograph, taken at the plant of the Pierce Arrow Motor Car Co. at Buffalo—piles of work in the background, the job on the machine.

The 18 inch fly-wheel shown in process is finished all over, as indicated in line drawing, (in two settings) at the rate of thirty-five minutes per piece, averaging sixteen wheels per day for a run extending over several weeks.

Accuracy and high-quality finish are prerequisites in Pierce Arrow work and the results obtained from the first machine warranted the installation of others.

The truck hubs shown in the foreground of the picture constitute another good Bullard job; they are made from steel castings and finished all over; the size limits calling for very accurate work.

The Vertical Turret Lathe

saves time on the single piece or the small lot as well as on the "big run."

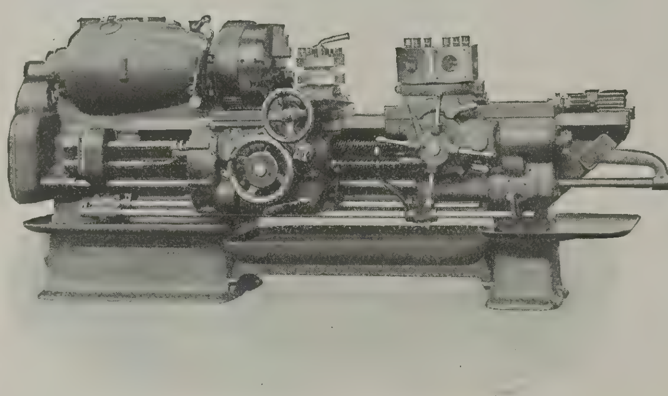
The features which "cut time between cuts" and "cut the cutting time" make proportional savings whether the lot be large or small.

If you are still "without" the Vertical Turret Lathe in your shop, you need our literature —a word will bring it, ask for Catalog MV-22.

THE BULLARD MACHINE TOOL COMPANY

BRIDGEPORT, CONN., U. S. A.

Some of the Libby Turret Lathe Production Records sound like Arabian Nights Tales—But they're Facts!



"Libby" 18" High Power Rapid Production Turret Lathe

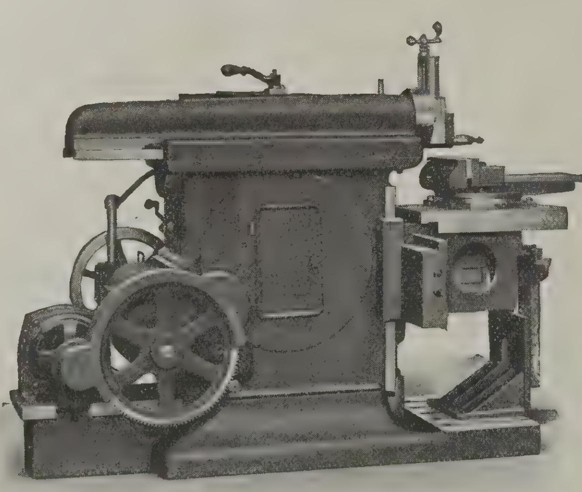
"This job has been taking us **6 hours**", confesses an enthusiastic Libby convert. The Libby Lathe now does it in **17½ minutes.** (This is a double steel ball race.)

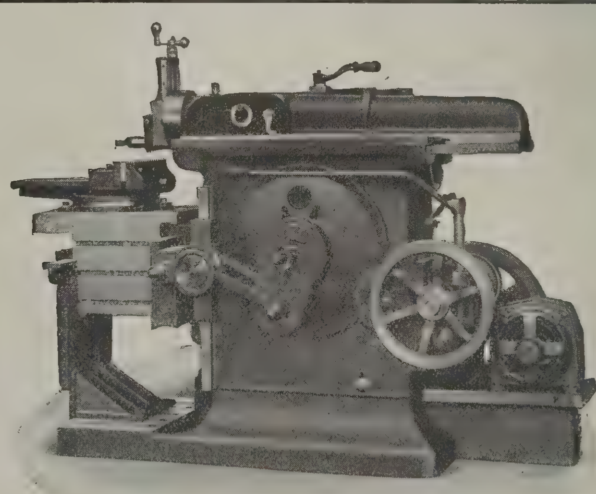
In another shop—a wide-awake one—a Libby Lathe is replacing two "efficiency" machines, and is saving $250.00 a month! How long before it will pay for itself? **These are facts!** We can prove them. These are only two instances. We have many just like them. There are certain fundamental reasons, discussed in our catalog, why the Libby Lathe can do such things. You owe it to yourself to investigate this remarkable machine.

We make estimates on specifed work. The figures may seem phenomenal, but we back them with a definite and positive guarantee to install a machine and meet them or beat them by actual performance in your own shop.

INTERNATIONAL MACHINE TOOL COMPANY, Indianapolis, Indiana

European Agents: Schuchardt & Schutte, Berlin, Vienna, London, St. Petersburg, Budapest, Stockholm, Copenhagen. A. Engelmann & Co., Liege, Belgium.





STOCKBRIDGE TWO-PIECE-CRANK SHAPER

WITH A TEN-CHANGE SPEED BOX GEAR CONNECTED TO MOTOR

Changes of speed can be made instantly. You get just the speed wanted, without engaging intermediate gears. When shaper is stopped, driving shaft is locked; the motor can run without danger of shaper starting up while work is being placed in vise.

Our Two-piece-crank gives results that can be secured with no other shaper.

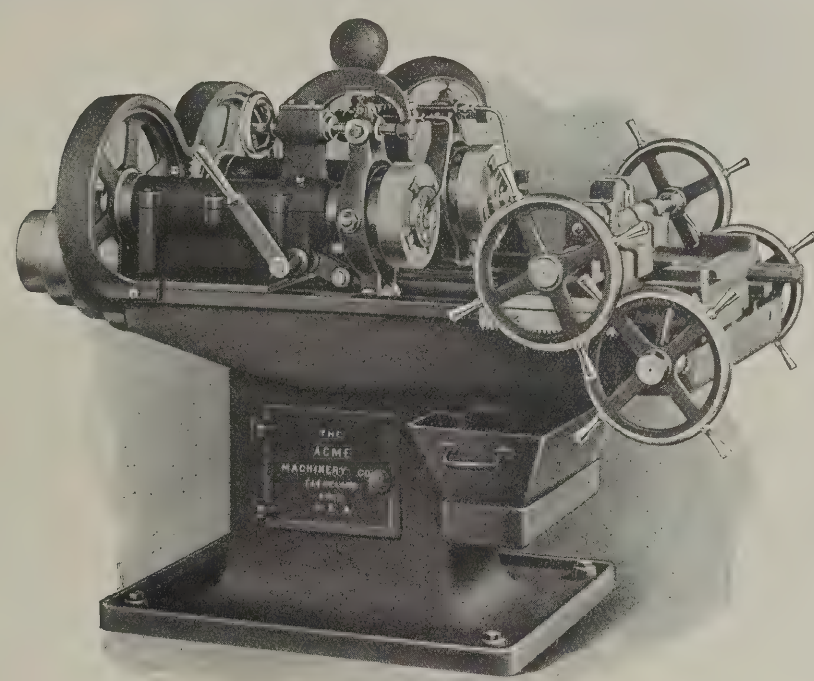
IT IS A TIME SAVER. **Catalog illustrates and describes the motion.**

STOCKBRIDGE MACHINE COMPANY, Worcester, Mass.

New York City Office; Niles-Bement-Pond Co., 111 Broadway; Chicago Office; Niles-Bement-Pond Co., 561 McCormick Building; Pacific Coast Offices; Harron, Richard & McCone, 139 Townsend St., San Francisco and 164 No. Los Angeles St., Los Angeles, Cal.

ACME BOLT CUTTERS

Distinct, positive, money-saving advantages are secured by the use of Acme Bolt Cutting Machinery—advantages that can be figured down to their actual dollars and cents values. The simplicity of the Acme Die Head construction is one of these advantages. There are but three principal parts, all made to standard gauges and interchangeable, with a simple adjustment which cannot shake loose and yet is so fine that threads can be cut to absolute sizes.



There are also the advantages of strength and durability—all parts made of tool steel, hardened and ground to size; designed and assembled to withstand the quick action of automatic machinery; every part exposed to view and impossible to clog up with chips or scale. Years of constant use and the few repair parts ever required prove our durability claims.

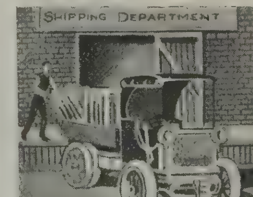
Acme Die Head simplicity lowers manufacturing costs—enables us to market a die of more than ordinary strength and capacity at a comparatively low price, not alone for the complete die but for separate parts as well, and this saving mounts up to a big total during the useful life of a machine.

Acme Bolt Cutters have advantages of their own—if you cut bolt threads, you will be interested in them—may we send the Catalogue of Acme Bolt and Nut Machinery?

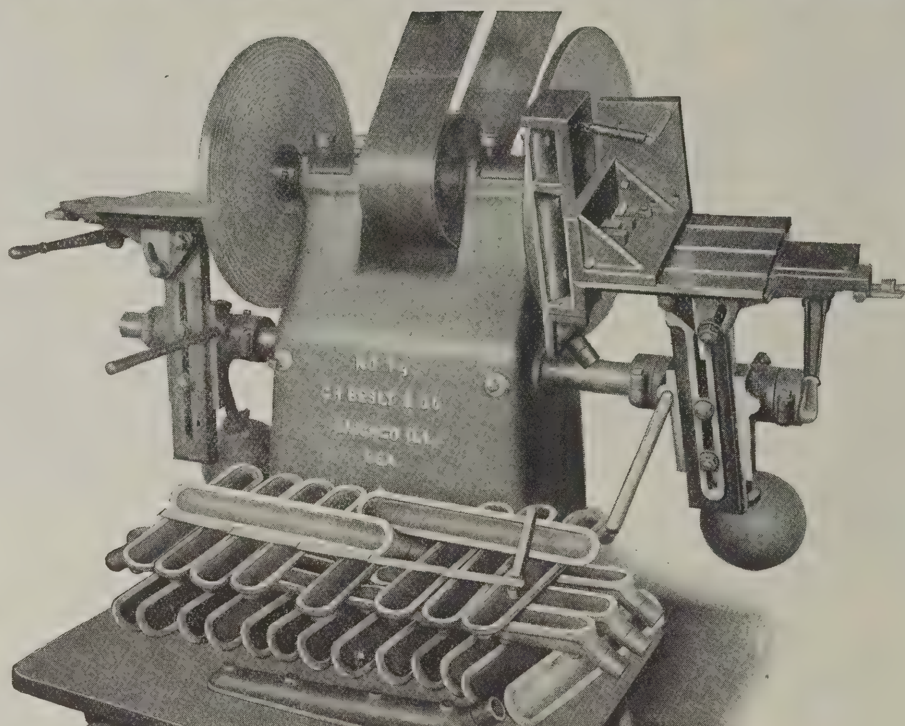
THE ACME MACHINERY COMPANY

CLEVELAND, OHIO

Foreign Agents: A. H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao and Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg. Donauwerk Ernst Krause & Co., (Vienna), Austria, Hungary and the Balkan States. C. W. Burton, Griffiths & Co., London.


SHIPPING DEPARTMENT

HUNDREDS OF OPERATIONS
On Automobiles and Accessories
FOR BESLY GRINDERS



No. 14—30″=L Besly Grinder with floating workholder on Cast Iron Water Jacket Covers for Automobile Engines

WORKHOLDER

Work is supported *without rigid clamping*, by a V faced holder, hinged on geared lever feed table, so work is free to "float" against grinding disc and clean up flat with the removal of the minimum amount of stock.

Workholder is arranged to be held in two positions on geared lever feed table. In rough grinding, the work is held in a horizontal position to reduce travel of grindings and facilitate removal of scale and excess stock. In finish grinding, work is held in a vertical position, so that all of the ground surface is in contact with the disc wheel while grinding.

ADVANTAGES IN NON-RIGID CHUCKING

To remove stock without rigidly clamping the work is a fundamental principle in Besly Grinding Practice. This is one of the great advantages the Besly Grinder holds over all other types of machine tools on a great many flat surfacing jobs.

Rigid clamping of the work should be avoided if possible, because:

First. More time is consumed in clamping and unclamping.

Second. The work is likely to be presented to the disc wheel in an arbitrary position which requires the removal of more stock than if work is allowed to "float" when forced against the grinding disc.

Third. Thin, fragile work is often distorted by rigid chucking so that, regardless of the accuracy of the surfacing, the work is not flat when released from clamping.

INVESTIGATE

Write today for free copy of 1912 edition of "Besly's Modern Disc Grinding Practice," 112 pages, 103 pictures, and study this important subject. This treatise should be in the hands of every machine manufacturer and his assistants, because it shows the way to reduce costs and improve product.

BESLY CHICAGO

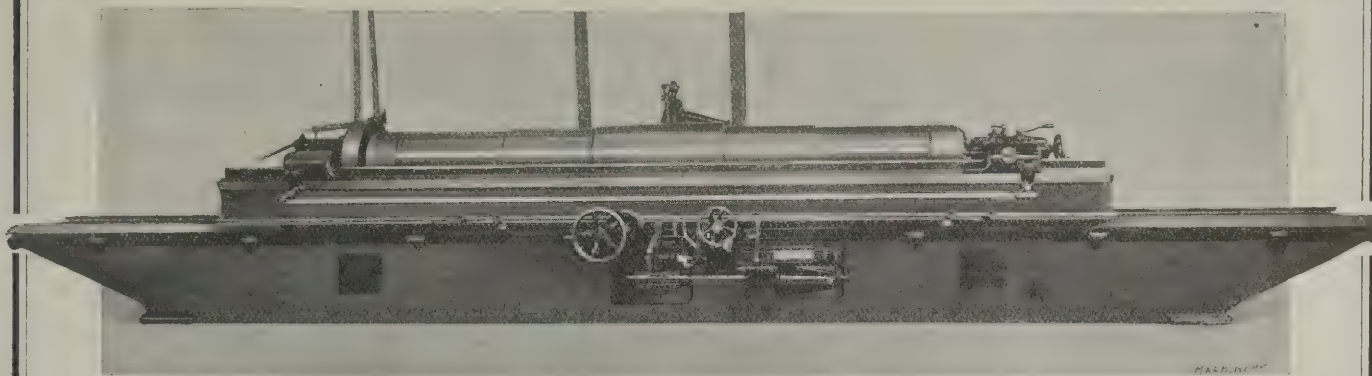
CHARLES H. BESLY & COMPANY

(Originators of Disc Grinders)

CHICAGO U. S. A.

WORKS AT BELOIT, WISCONSIN

BESLY CHICAGO



192 INCHES OF GRINDING EFFICIENCY

are represented in the 20 x 192" Norton Grinding Machine shown above.

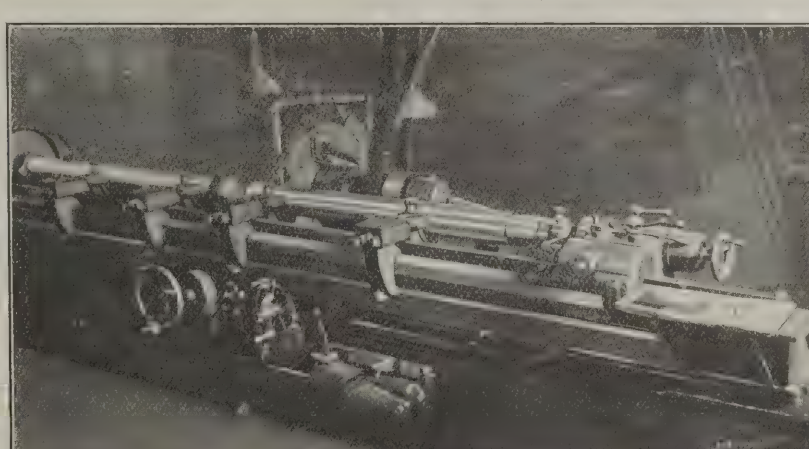
This machine, which has been in successful operation at the plant of the National Transit Company at Oil City, Pa., for over four years, is the largest grinding machine we ever shipped, and one of the examples of the adaptability of Norton Machines for heavy work.

The upper illustration shows the machine in operation on a gas engine shaft weighing over 8,000 pounds, which was finished in 8 hours including handling, and in the lower engraving the same machine is featured grinding another special job.

This particular grinding machine has capacity for work up to 20" diameter and 16 feet long, and with this advantage combines all the good points of design and operation that characterize the little 6 x 32" machine. It will handle work up to 12,000 pounds in weight just as readily, easily and efficiently as the small machine grinds the small work for which it is built and adapted.

Norton Quality—strength, rigidity, accuracy—all the grinding essentials—prevail throughout the entire Norton line of Grinding Machines—if you are contemplating the purchase of such a machine why not secure the one that has proved itself. *Catalogue or a representative sent on request.*

Another Shaft Grinding Job on the 20" x 192" Norton Grinding Machine



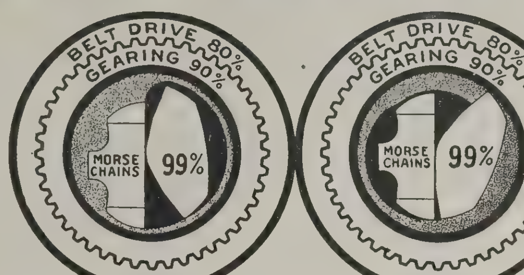
Photographed through courtesy of the National Transit Co., Oil City, Pa.

NORTON GRINDING COMPANY, WORCESTER, MASS.

CHICAGO STORE: 11 NO. JEFFERSON STREET

AGENTS: Vonnegut Machinery Co., Indianapolis. Robinson, Cary & Sands Co., St. Paul and Duluth. Manning, Maxwell, & Moore, Philadelphia, Atlanta. Prentiss Tool & Supply Co., New York, Boston, Buffalo, Syracuse, Rochester, Scranton. Motch & Merryweather Machinery Co., Cleveland, Detroit, Cincinnati and Pittsburg. The Canadian Fairbanks-Morse Co., Montreal, Toronto, Vancouver. Schuchardt & Schutte, Vienna, Prague, Budapest. Alfred Herbert, Ltd., Coventry, Paris, Milan, Zurich. F. W. Horne, Tokio, Japan.

Every Morse Silent Chain Drive is a "Bull's Eye" toward Greater Efficiency and Economy



Efficiency to nearer perfection naturally comes to all machines where the transmission system delivers 99 per cent. of the possible power.

Each machine is then dependable for its full share of work without interruption. Employees can devote their entire time to work in the machine, and as absence of numerous belts makes the lighting conditions better, the work is better done.

Economy is effected:

First—Enormous saving of power (Morse Silent Chains maintain an efficiency of fully 99 per cent).

Second—Less Floor space required. Shortest centers are permissible, and chains average 1-4 to 1-3 the width of belts for the same powers.

Third—Saving of time required to repair broken or parted belts. In a large shop, this saving alone is considerable.

Let us tell you why the exclusive Morse "Rocker-Joint" shown above causes less friction, requires less lubricant, and is more efficient than any other type of joint. You owe it to yourself to know this. Bulletin No. 11 explains in detail.

Morse Chain Company, Ithaca, N. Y.

A-53

TWO TYPICAL DIAMOND CHAIN MOTOR DRIVES

These drives furnish power to automatic screw machines in our own plant. The drive at the right is enclosed in a galvanized iron case, and runs in an oil bath. Motors are each fifteen horsepower. Speed of motors 625 r.p.m. Teeth on motor sprocket 19. Speed of driven shafts 440 r. p. m. Chain speed 990 feet per minute. With all machines running, motors deliver their full horsepower.

These chains have proved eminently satisfactory during four years service. The one which is enclosed is, of course, quieter and less worn than the exposed chain. While for factory purposes, chain cases are not necessary, they protect chain from dust and grit, and provide constant lubrication. A simple, dust proof case without oil bath is of marked advantage.

Power transmission by means of Diamond Chains offers the logical solution on many short, medium and low speed drives, and the economies are too important for you to neglect.

Write for our treatise "Power Chains and Sprockets". If you desire advice about some special drives, our engineering department will recommend.

LOOK FOR THE

TRADE ◇ MARK

ON EVERY LINK

The Diamond Chain & Manufacturing Company

240 West Georgia Street

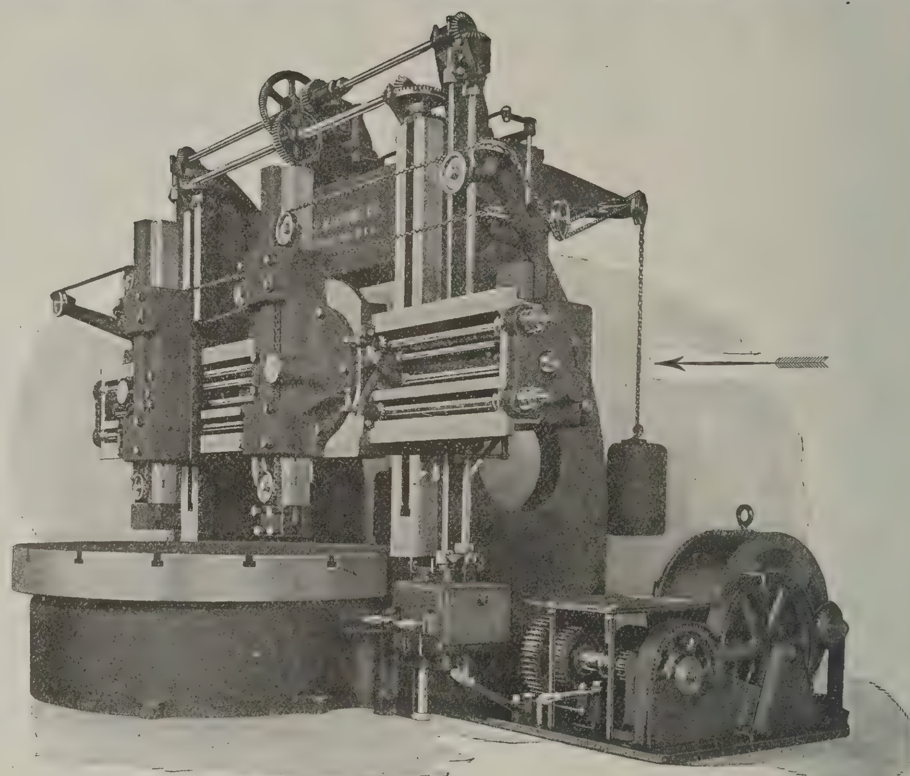
INDIANAPOLIS, IND.

Capacity 8,000,000 Feet Per Year.

130

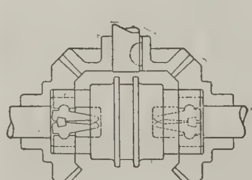
THE JOHNSON FRICTION CLUTCH

in the No. 5 Size, Double, is used on the vertical shafts back of the cross rail on both sides of the Betts Double Drive Boring and Turning Mill, as shown by small cut below with gears mounted on the Clutch Hubs and at point marked by arrow.



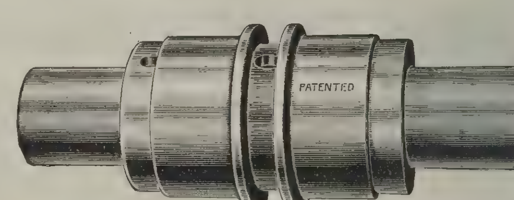
The ease with which this machine is operated is due to the Johnson Friction Clutches, and is another reason why they are being adopted so extensively by the leading Machine Tool Builders.

Our booklet entitled "Clutches as Applied in Machine Building" is of interest to all manufacturers of Machinery and will be sent on application.



CLUTCH IN NEST OF GEARING

Send for our catalog "A," giving complete description of the small compact Clutches for use in feed and speed changes.

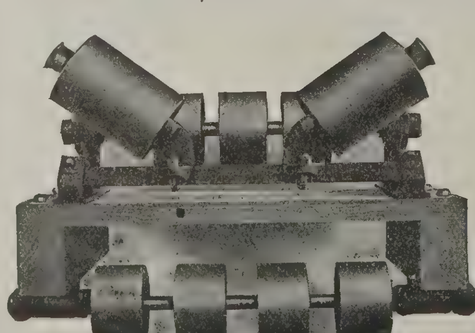


STANDARD DOUBLE CLUTCH (EXTERIOR)

Carried in stock by Strong, Carlisle & Hammond Co., Cleveland, Ohio; The Thomas & Lowe Machinery Co., Providence, R. I.; N. J. Engineering & Supply Co., Passaic, N. J.; Edwin W. Howard, Rochester, N. Y.; The Fairbanks Companies, New York, N. Y., New Orleans, La., Buffalo, N. Y., and Syracuse, N. Y.; The Atlanta Mfg. & Supply Co., Atlanta, Ga.; The Vonnegut Machinery Co., Indianapolis, Ind.

Foreign agents in all the principal foreign countries.

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER CONN.



Improved Belt Conveyers

We manufacture Improved Belt Conveyers of several styles, troughing the belt or running it flat, as conditions may warrant. These conveyers are economical of power, simple in design, capable of running 24 hours per day, and require little time or attention from any one. There's no harm in writing us. *Send for Catalogue No. 34.*

H. W. Caldwell & Son Co. Western Ave. 17th-18th St. **Chicago**

NEW YORK: Fulton Bldg., Hudson Terminal, 50 Church St.

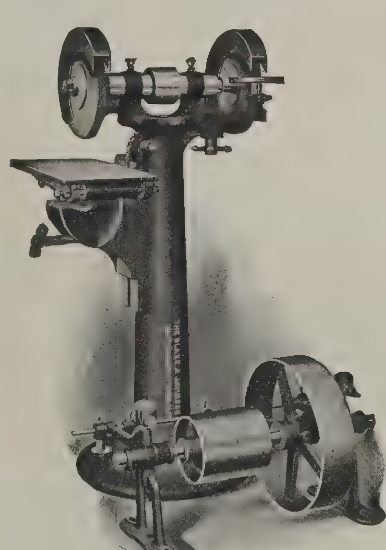
QUANTITY PRODUCTION

PERMITS US TO MARKET WATERBURY GRINDERS

FOR

$50

AND GUARANTEE THEM— "READY TO OPERATE"



10" WHEELS—ADJUSTABLE BOXES

for TOOLS and DIES

BUILT BY
MACHINERY DIVISION

THE BLAKE & JOHNSON CO.
WATERBURY, CONN. Since 1849

All the Way Down to the Core

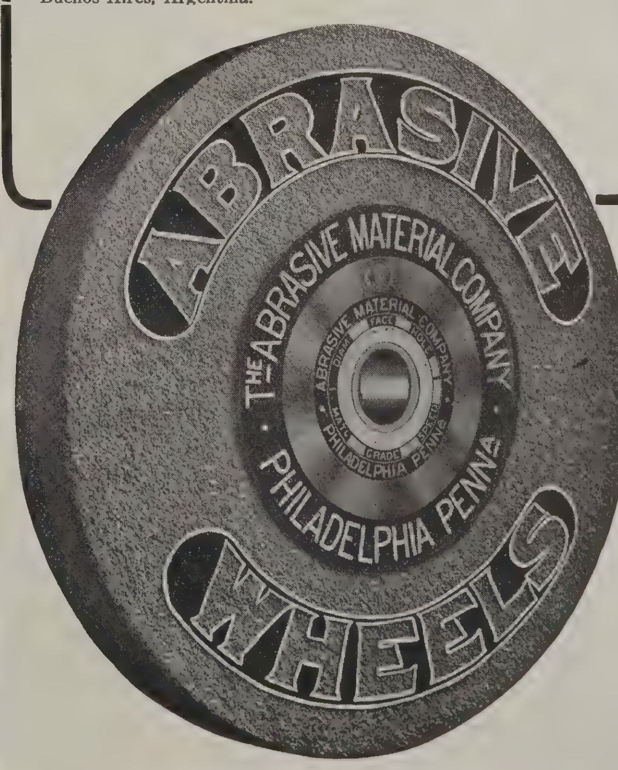
Abrasive Fast Grinding Wheels are composed of fine miniature cutting tools — they are the same throughout. They not only cut fast when new, but when worn way down to the core are still giving the same good service.

Your grinders can therefore turn out more work per day with "Abrasive Wheels" because of their superior cutting qualities.

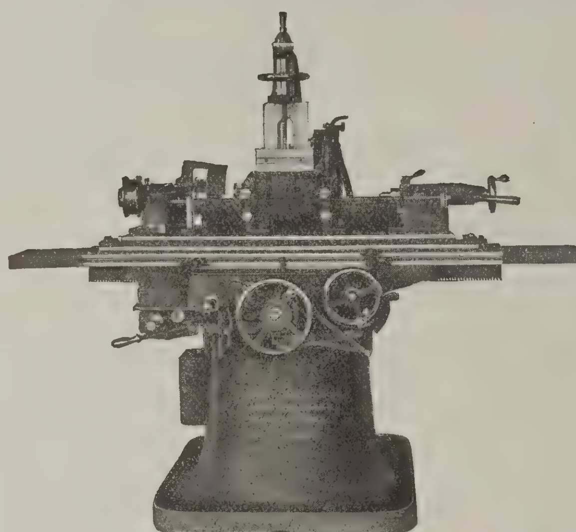
Let us help you solve your grinding problem—we will send you an "Abrasive Wheel" to test in your plant. Write today.

Abrasive Material Company
Philadelphia, U. S. A.

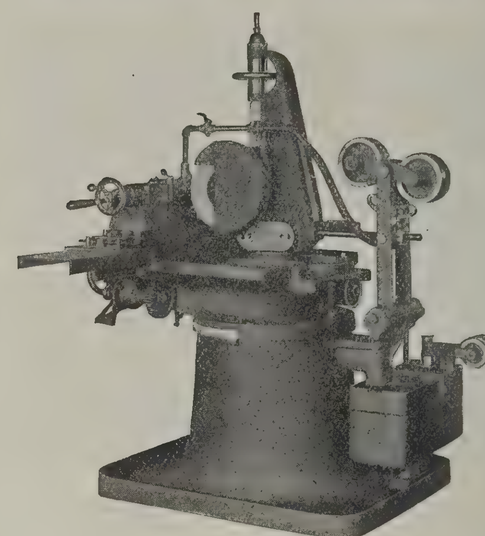
FOREIGN AGENTS: E. Sonnenthal, Jr., Berlin, Cologne and Vienna. Wilh. Sonesson & Co., Malmo and Copenhagen. Alfred Herbert, (France), Ltd., Paris. R. d'Aulignac, Barcelona, Spain. Spliethoff, Beeuwkes & Co., Rotterdam, Holland. R. S. Stokvis & Fils, Brussels, Belgium. Alfred Herbert, Ltd., Milan, Italy. Donnell & Palmer, Buenos Aires, Argentina.



IMPROVED UNIVERSAL GRINDING MACHINE

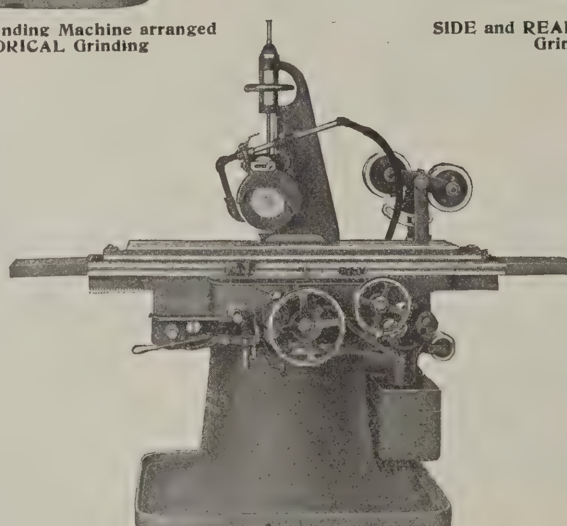


Bath Universal Grinding Machine arranged for CYLINDRICAL Grinding



SIDE and REAR View of Bath Universal Grinding Machine

Five views showing the **IMPROVED** Bath Universal Grinding Machine arranged for a few of the many operations it is adapted for.



Bath Universal Grinding Machine arranged for SURFACE Grinding

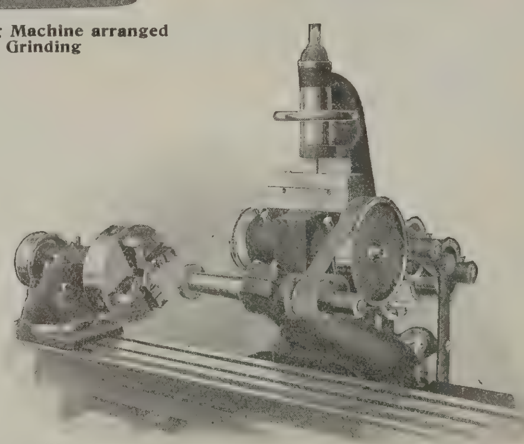
The grinding wheelhead has only one movement, which is Vertical.

The lifting strain of the Wheel Spindle Driving Pulley is taken by the Idler Pulleys.

The Wheelhead Column is stationary.

The Bath Universal Grinding Machine does Cylindrical, Internal, Surface, Disc, Cutter and Reamer Grinding of all descriptions. Accurate and Economical.

Bath Universal Grinding Machine arranged for CUTTER Grinding



Bath Universal Grinding Machine arranged for INTERNAL Grinding

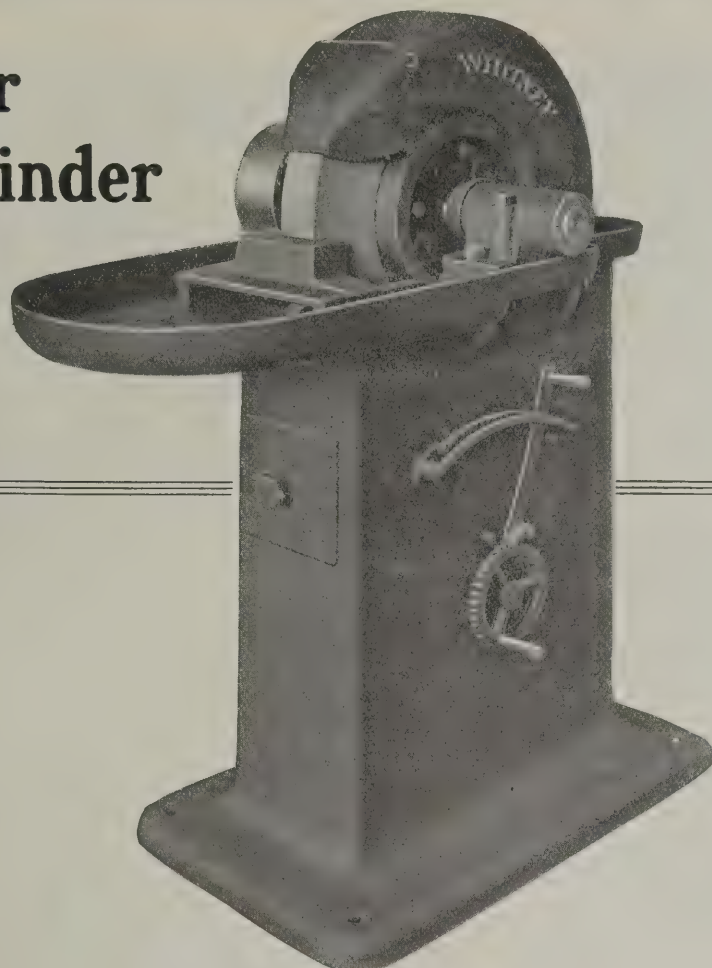
BATH GRINDER CO., Fitchburg, Mass., U. S. A.

FOREIGN REPRESENTATIVES: Schuchardt & Schutte, Stockholm, Berlin, Vienna, St. Petersburg, Copenhagen, Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Alfred Herbert, Ltd., Yokohama. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

DOMESTIC AGENTS: Hallidie Mchy. Co., Seattle, Spokane, Tacoma, Wash. Rumley-Wachs Mchy. Co., Chicago, Ill. Chas. A. Strelinger Co., Detroit, Mich. Laughlin & Barney Mchy. Co., Pittsburgh, Pa. Manning, Maxwell & Moore, Cleveland, O. The National Supply Co., Toledo, O. Vandyck-Churchill Co., New Haven, Conn., and Philadelphia, Pa.

A Water Tool Grinder

"Without a Pump"



The Whitney 20-inch Water Tool Grinder

embraces a number of up-to-date improvements calculated to commend it especially to the favor of discriminating machine tool users. Among the special features of this machine are the following:—

No pump, piping or packed joints to get out of order and leak.

Inside of hood is arranged to catch all water, and keep it from boxes and spindle.

Emery wheel collars are dove-tailed, and fitted with balancing device.

Spindle boxes are self oiling.

Spindle is ground.

Water pan, inside of base, supplies water to the wheel by means of lever, rack and pinion.

Water pan can be easily removed for cleaning.

Machine is simple and cannot get out of order.

Spring lever on side of machine engages with teeth on segment, so that the amount of water supplied to the wheel may be graduated to cover all requirements.

It is impossible for water to escape from pan to the floor.

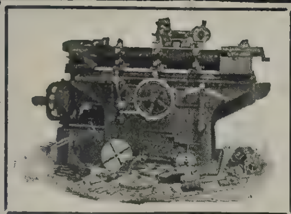
High Grade—Low Price. Ask for Catalog No. 5.

THE WHITNEY MFG. CO., Hartford, Conn.

Manufacturers of Hand and Weight Feed Milling Machines, High Grade Driving Chains, Water Tool Grinders, "The Woodruff System of Keying," Presto Chucks, and Friction Tapping Devices.

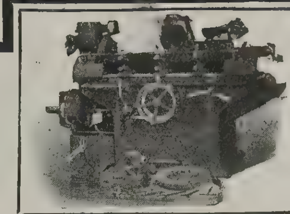
FOREIGN AGENTS:

C. W. Burton, Griffiths & Co., London. Fenwick Freres & Co., Paris. F. G. Kretschmer & Co., Frankfurt, a. M., Germany.

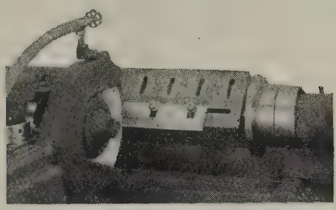


UNIVERSAL

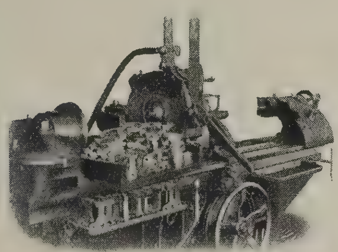
THE LANDIS UNIVERSAL IN THE MACHINE SHOP



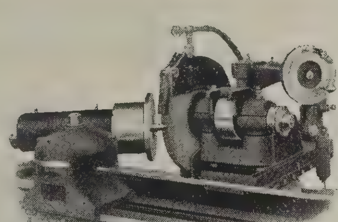
PLAIN

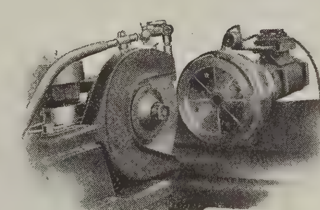


For Doing A Great Variety Of Work At Lowest Cost

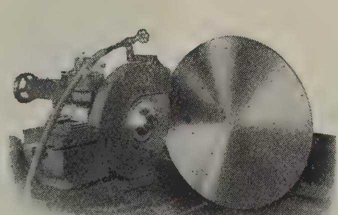


The Landis Universal Grinding Machine fills a very necessary and important place in the machine shop. It embodies many valuable features which enable it to produce accurate and highly finished work both rapidly and economically. In a Landis Universal Grinding Machine are combined the good features and advantages of an external and internal grinder.





There's a place for the Landis Universal Grinding Machine in your shop. Study the examples of Landis operation in the illustrations.

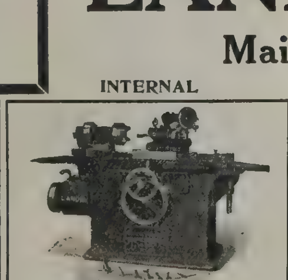


If you are handling jobs similar to these, write and let us send you some very valuable information.

LANDIS TOOL COMPANY

Main Office and Works: Waynesboro, Pa., U. S. A.

INTERNAL



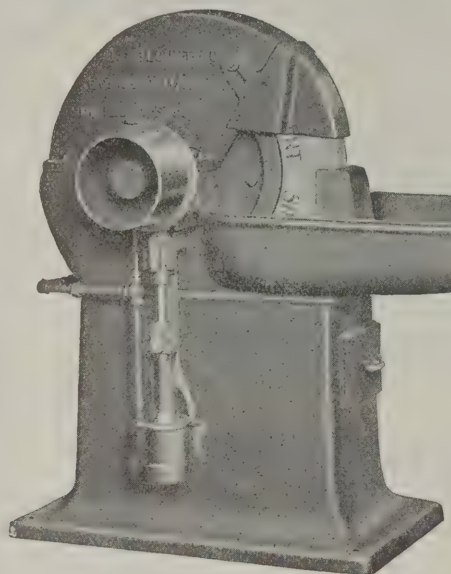
New York Office: Fulton Building, 50 Church St., Walter H. Foster Co., Mgrs.

AGENTS: Dewstoe Machine Tool Co., Birmingham, Ala. Harron, Rickard & McCone, San Francisco and Los Angeles. C. W. Burton, Griffiths & Co., London and Glasgow. Alfred H. Schutte, Cologne, Berlin, Brussels, Liege, Milan, Paris, Barcelona and Bilbao. Donauwerk Ernst Krause & Co., Wien, Prague and Budapest. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Can. Andrews & George, Yokohama, Japan.

CRANK

A NEW 30-INCH BLOUNT TOOL GRINDING MACHINE

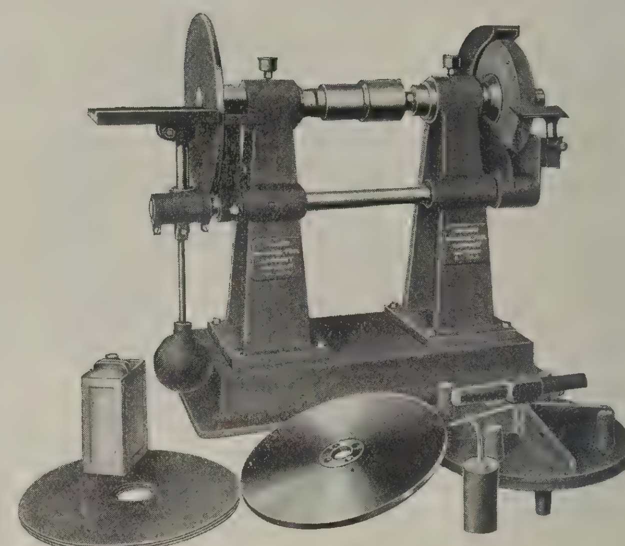
A bigger, heavier, more adaptable machine than our 20-inch Model, with the same successful features—self-oiling bearings throughout, vertical centrifugal pump, guaranteed accuracy, etc.



The supply of water can be regulated to a nicety, pump has no sliding parts to wear out; pump casing extends above the water line and does away with leakage without troublesome packing; other advantages we shall be glad to demonstrate.

Built in quantities—Sold at a moderate price.

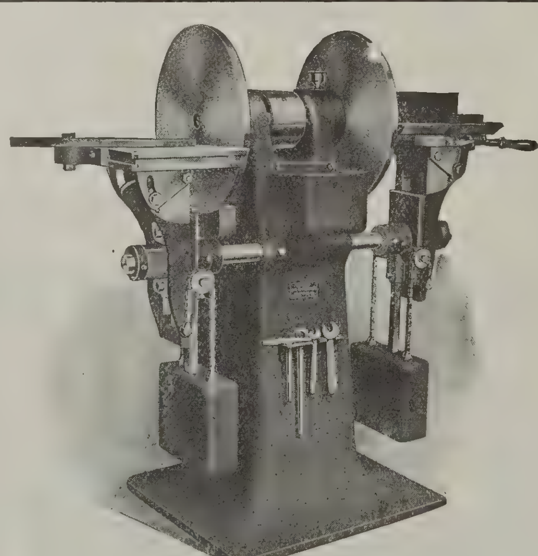
J. G. BLOUNT COMPANY
Everett, Mass., U. S. A.



Note Distance Between Journals
on the Sellew Combination Disc Grinder

See how long we have made the spindle in proportion to the diameter of the disc, and consider how greatly this reduces wear on the journals, eliminates vibration and thereby insures good work. Other advantages are the adjustable support which permits the operator to work at the front as well as the side of the wheel, the Self-oiling Journals, Ball Thrust Bearings and general rigidity of the machine. *Send for full details.*

Sellew Machine Tool Company
Pawtucket, R. I.



A Dependable Grinder
Every user commends the Rowbottom for its perfectly balanced spindle.

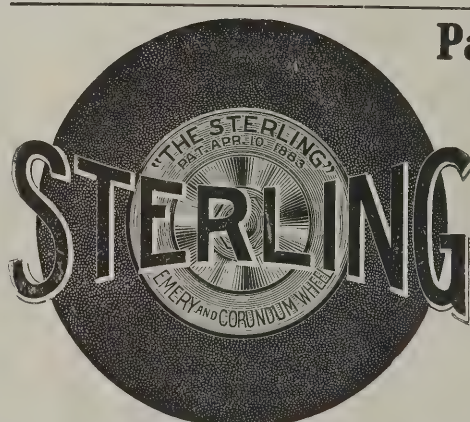
There's no danger of a Rowbottom Disc Grinder getting out of alignment, and no trouble with those easy running Hess-Bright Ball Bearings.

Convenient, too—no time lost placing discs, or adjusting tables.

With an easy running machine, that runs perfectly true, you can always count on **rapid** and **accurate** work. Think what that means.

Special Circular and Prices on request.

THE ROWBOTTOM MACHINE CO.
WATERVILLE, CONN., U. S. A.



Pay More—Get More

Price is relative. You get what you pay for—no more —when you buy grinding wheels, or anything else. Sterling Wheels cost more, are worth more. Would you pay the price in the beginning and save in the end?

Then write us.

THE STERLING EMERY WHEEL MFG. CO., Factories and Offices: TIFFIN, OHIO, U.S.A.

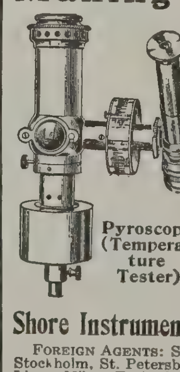
SELLING AGENCIES: New York, 45 Vesey Street. Chicago, 15 S. Clinton Street. San Francisco, 139-149 Townsend Street.

TESTING APPARATUS
Making Sure of Quality

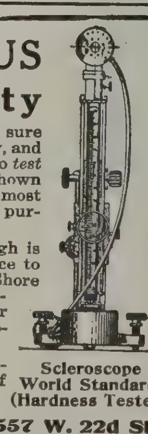
There is only one way to make sure of quality in the materials you buy, and in the products you sell—that is to *test* them. The two instruments shown herewith are the simplest and most economical for their respective purposes.

To determine how hard or tough is any metal—what is the resistance to wear or shock—you need the Shore Scleroscope. For control of tempering, annealing, or any other heating operation, the Shore Pyroscope is the practical device.

Write today for booklets fully describing the uses and benefits of these instruments.



Pyroscope (Temperature Tester)



Scleroscope World Standard (Hardness Tester)

Shore Instrument & Manufacturing Co., 555-557 W. 22d St. New York

FOREIGN AGENTS: Schuchardt & Schutte, Berlin, London, Shanghai, Japan, Vienna, Stockholm, St. Petersburg; Copenhagen, Budapest, A. H. Schutte, Cologne, Brussels, Liege, Milan, Turin, Naples, Barcelona and Bilbao.

BEST BY TEST

The line of machines of which the one shown is representative is the "ULTIMATE" in the floor grinder field.

THEY HAVE:—

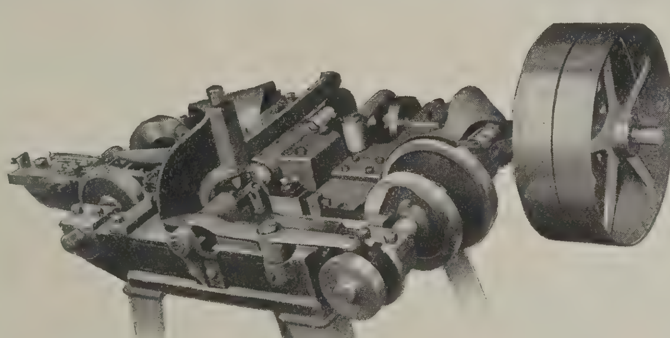
Long Bearings.
Heavy Spindles.
Great Power Capacity.
Heavy Parts Throughout
Best Materials.
Best Workmanship.
Jigged Dimensions Throughout.

THEY ARE:—

Not cheaper but better.
Not light but heavy.
Not short lived.
Best by test.
In stock ready to ship.
Capable of doing the heaviest work.
Guaranteed to be as represented.

These floor grinders are built in 6 sizes, one of which is sure to suit you. There are some manufacturers who try to sell the grinders of their own make from THE SAFETY catalogue and reputation. Beware of these people or you will get STUNG. Give us an opportunity to prove any or all of the above.

The Safety Emery Wheel Co., Springfield, Ohio



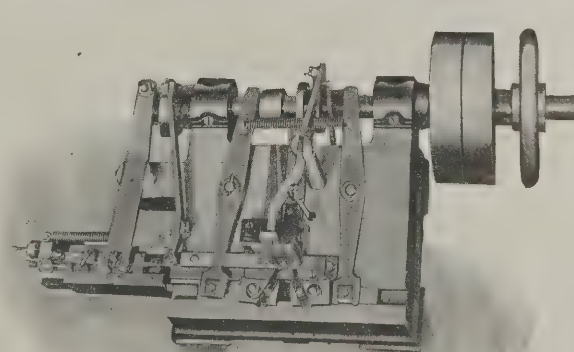
The Profit on Articles Made of Wire

depends largely on the machines used to make them. The experience of our customers shows the necessity of being able to manufacture the article **quickly** so as to keep up with orders.

We build machines that will form and make any special article, of any shape, or size of wire, rapidly, accurately and at a production cost so low that the profit is high.

There is the experience of fifteen years of building wire working machinery back of our machines, and our expert knowledge of conditions is at your service.

Latest Catalogue shows a great variety of wire work handled on our machines and we shall be glad to estimate on your blue prints or samples.

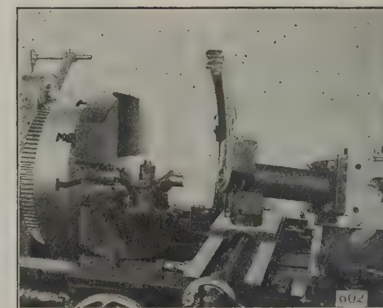


AUTOMATIC MACHINE COMPANY, Bridgeport, Conn.

AGENTS—Alfred H. Schutte, Schuchardt & Schutte, C. W. Burton, Griffiths & Co., of London, England. Marshall & Huschart Machinery Co., of Chicago, Ill., and Motch & Merryweather Machinery Co., of Cleveland, O.

An example of the range of work handled by Gisholt Turret Lathes.

The rough steel pinion is first held in heavy scroll chuck, with jaws fitted to it, and the hole finished. It is afterwards held on an angle plate, centered as shown and the trunnions finished by box tools in turret.



THE GISHOLT PRINCIPLE

Probably every manufacturer recognizes that Gisholt Machines must have merit. But not all manufacturers have tested the Gisholt Principle as applied to their own problems of production.

To those who must reduce the cost and better the quality of their boring, turning and facing work upon medium and heavy castings and forgings, sound judgment suggests a fair consideration of Gisholt Machines.

You can know in advance and without cost whether the Gisholt Principle will apply to your work or not. Twenty-five years of testing Gisholt machines in finishing an infinite variety of parts have taught us what the result will be under specific circumstances.

A corps of trained production engineers, real specialists of long experience, are applying their knowledge to the working out of most intricate problems in chucking and bar work for interested inquirers and customers, prospective or actual. To such of these as have work of the Gisholt type, the results secured are highly gratifying.

It costs you nothing to avail yourself of information which may lead to a definite increase in your production.

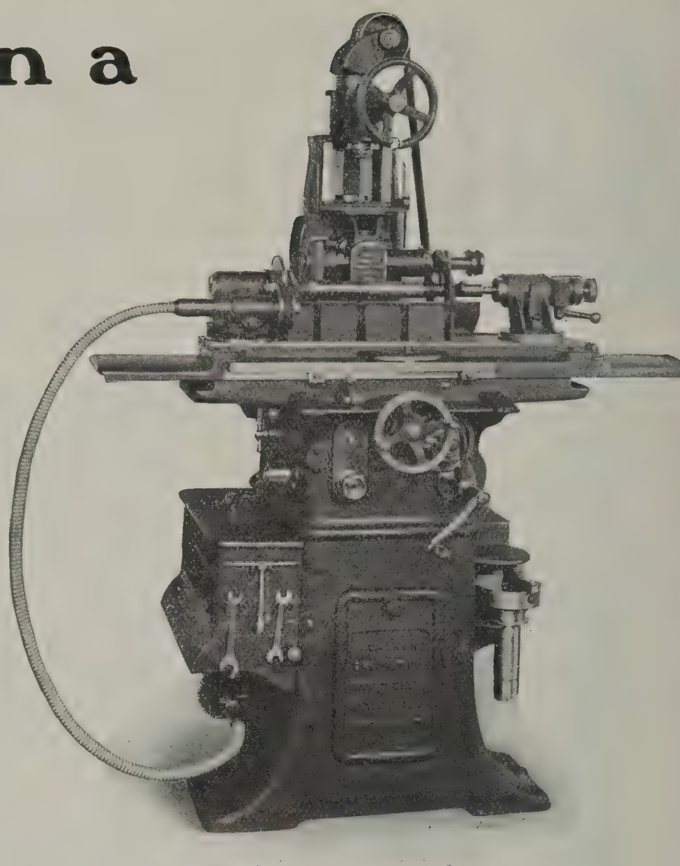
GISHOLT MACHINE COMPANY, Madison, Wisconsin

Manufacturers of Turret Lathes, Boring Mills and other Labor Saving Machines

NEW YORK OFFICE: 50 CHURCH STREET

FOREIGN AGENTS: Alfred H. Schutte, Cologne, Berlin, Brussels, Liege, Paris, Milan, St. Petersburg, Bilbao, Barcelona. Donauwerk Ernst Krause & Co., Vienna, Prague and Budapest. C. W. Burton, Griffiths & Co., London, England. Andrews & George, Yokohama, Japan.

The Coates in a New Role

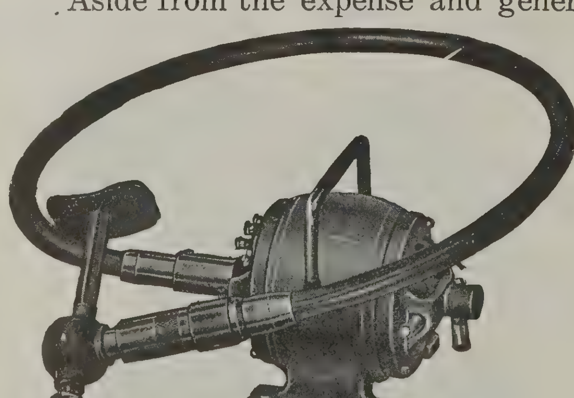


Here's a new application of Coates Flexible Shafts that we want to push home, especially as it is right in the line of machine tool building. The photograph shows the new Walker Grinding Machine, on which Coates Flexible Shaft has been used to drive the work spindle of the machine.

This is an entirely new departure in machine tool operation, embracing the following practical advantages: First, the use of the Coates Shaft keeps the machine a unit, no overhead belt being needed, as the drive is secured by running the "Coates Flexible" from the driving shaft at the base of the machine to the end of the work spindle. This permits motor driven machines to be moved to any position without taking into consideration the numerous overhead belts ordinarily employed on grinding machinery.

Then as the table of a Universal Grinding Machine is used in various angles, the position of the driving head is continually changing, a constant source of trouble if an overhead belt were employed—the Coates Shaft Drive takes care of this feature perfectly.

Aside from the expense and general awkwardness of an off-set drum and driving belt for the work spindle there is an element of vibration present which is detrimental to good grinding. By using the Coates Shaft System of driving this vibration is eliminated, and the operation of the work spindle is smooth and entirely free from shake or jar.



It will pay you to consider the possibilities of applying Coates Shafts to your propositions, whether for grinding machinery or special machinery of any kind. We will be glad to go into the matter at length with you, if you will write us.

COATES CLIPPER MFG. COMPANY

WORCESTER, MASS.

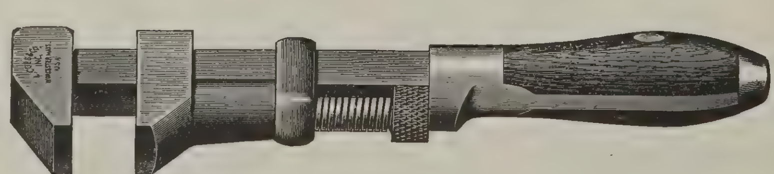
Safe to buy, to Sell and to Use— "COES"—

The Wrench You Can Always Depend On

GET a grip with the "Coes" and the nut must come; pipe the handle six feet if necessary and throw your weight into the balance—"Coes" is the wrench for service, and its 30% greater strength will stand almost any abuse.

Every "Coes" wrench is a wrench of known quality. Sixteen inspections guarantee that quality to maker, dealer and user, insuring maximum service in the hands of apprentice and experienced workman alike.

There is a "Coes" wrench for every service—sizes range from the 4-inch "Steel Handle" wrench to the 72-inch Key Model for the heaviest construction and railroad work.



For more strength, good service and long wear you are safe in trying "Coes".

COES WRENCH CO., Worcester, Mass.

Agents: JOHN H. GRAHAM & Co.
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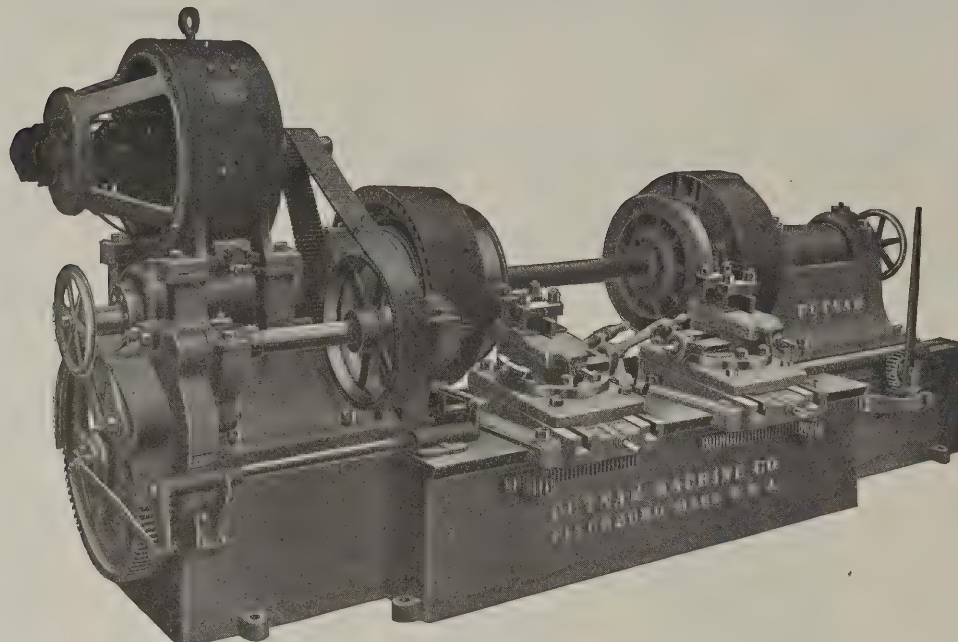
Agents: J. C. McCARTY & Co.
29 Murray St., New York.
438 Market St., San Francisco, Cal.
1515 Lorimer St., Denver, Col.



A 42" **PUTNAM** STEEL TIRE WHEEL LATHE WILL **SAVE YOU MONEY.**

NOTICEABLE FEATURES: QUICK ADJUSTMENT; HEAVY CUTS AT COARSE FEEDS; AUTOMATIC DRIVING DOGS; TAIL STOCK OPERATED BY HAND OR POWER.

Write for Particulars.

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—INCORPORATED—

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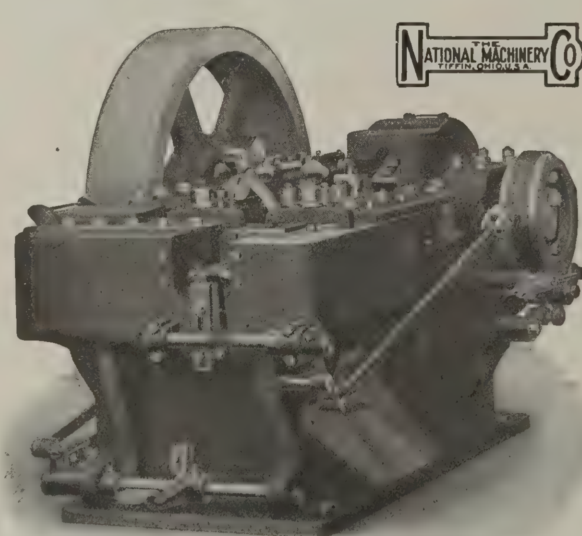
MACHINE SHOP AND FOUNDRY EQUIPMENT OF EVERY DESCRIPTION

111-115 No. Canal St. CHICAGO — 721 Arch St. PHILADELPHIA — 45 Oliver St. BOSTON — Frisco Bldg. ST. LOUIS — Park Bldg. PITTSBURGH — 1262 Ontario St. CLEVELAND

Monadnock Bldg. SAN FRANCISCO — Higgins Bldg. LOS ANGELES — White Bldg. BUFFALO — Majestic Bldg. DETROIT — Merrill Bldg. MILWAUKEE — Yokohama JAPAN

National Wedge Grip Bolt and Rivet Headers

are demonstrating every day in Railroad Shops, Bolt Plants, and General Industrials, that they produce more bolts, rivets and forgings, and cost less for dies and maintenance, that any "toggle" or other type of Header.



Comparative tests show that dies last from 3 to 5 times longer.

The longer die life, advanced features in design, and superior construction of the Wedge Grip Header, eliminate frequent shut-down for die changes, petty machine repairs, etc., making a machine for more constant operation, and increasing the output 15% to 25%.

It will pay you to investigate the advantages secured when using the Wedge Grip Header on your work.

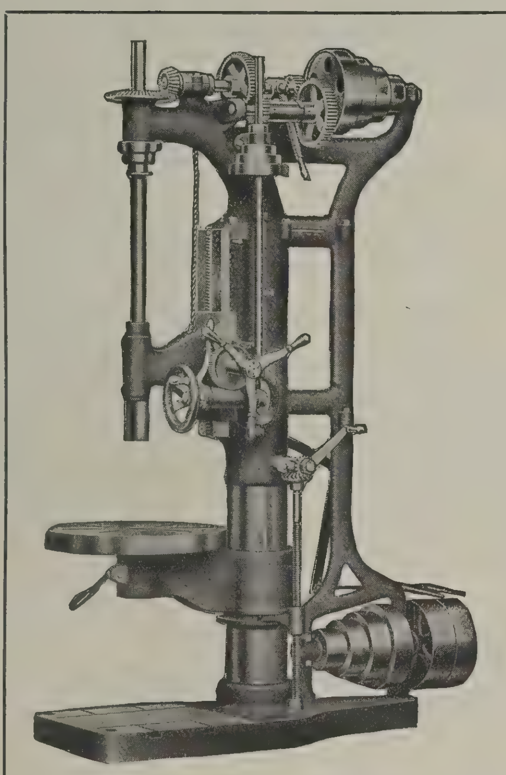
Built in ¾", 1", 1½", 2" and 2½" sizes.

Circulars and full data upon request.

THE NATIONAL MACHINERY CO., Tiffin, Ohio, U.S.A.

Originators of Modern Bolt, Nut and Forging Machinery

DO YOU REALIZE THE IMPORTANCE OF A RIGID BEARING ALWAYS THE SAME DISTANCE FROM THE CUTTING TOOL?



The Entire Head of our 28" Traveling Head Machine feeds down with the spindle and this tool is admirably adapted to boring long holes, cylinders, etc.

SIBLEY MACHINE TOOL COMPANY

8 TUTT STREET, SOUTH BEND, IND.

The Trained Man Has Money

He Can Always Pay His Bills

With the **untrained** man all is different. His wages at the best are small and uncertain. At the end of the month he often finds the pocketbook empty, with the landlord, grocer, butcher, baker, and other tradesmen clamoring for their money. The only difference between the man with ability to command a large salary and your ability is special training—I. C. S. Training.

The International Correspondence Schools have had 20 years' experience in qualifying men for larger salaries and more congenial occupations. It makes no difference how long hours you have to work, or how little schooling you have had, the I. C. S. can train you in your spare time, right in your own home, at small cost.

There is nothing remarkable about it. Simply mark X on the attached coupon opposite the occupation you are interested in, sign your name and address, mail it. In reply you will receive information how you, too, can earn enough money to enjoy every comfort of the man higher up. This is your opportunity to become a trained man, and you will make a great mistake if you fail to grasp this opportunity.

Mark and Mail the Coupon TODAY—NOW!

International Correspondence Schools

Box 980, SCRANTON, PA.

Please explain, without further obligation on my part, how I can qualify for a larger salary and advancement in the position, trade, or profession before which I have marked **X**.

Electrical Engineer	Machinist	Chemist
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Electrician	Stationary Engineer	Architecture
Telephone Expert	Gas Engineer	Contracting & B'ld'g
Concrete Construct'n	Refrigeration Eng.	Advertising Man
Mechanical Engineer	Sheet-Metal Drafts.	Window Trimming
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Name ____________________

Street and No. ____________________

City __________ *State* __________

Present Occupation ____________________

Our Engineer's report proves that hardly half of the power we generate ever reaches our machines for useful work. Think of it, gentlemen, nearly 50% of what we pay for power goes to run the line shafting, belts, idlers, etc.

The Production Manager's investigation shows that without buying a single new machine, but by simply rearranging the ones we have so that the material will pass directly from one operation to another, we will not only lower the manufacturing cost of our product, but speed up production so that we can meet the demands of the Sales Department.

Here are the Purchasing Agent's specifications, guarantees and prices on motors from the leading electrical manufacturers and after carefully considering them all it seems that the Fort Wayne line fills our particular requirements better than any other. Their prices are right; their service in the way of engineering advice and deliveries is not surpassed, and their customers have all told us there is no better concern in the country to deal with. Let's 'phone for their salesman.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

If ***YOU*** are not ready just yet to call for our salesman, but wish to learn more concerning the advantages of motor driven machines in your plant, write for our bulletin, "Motor Drives," which illustrates nearly 200 different applications, many of them in your industry.

FORT WAYNE ELECTRIC WORKS

OF GENERAL ELECTRIC COMPANY

"Wood" Systems

1616 BROADWAY FORT WAYNE, INDIANA

Branch Offices—
All Large Cities

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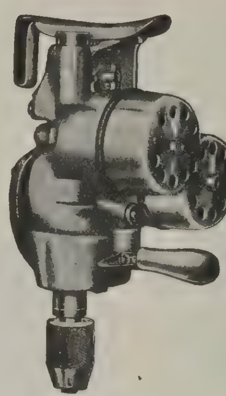


A TRIAL SHIPMENT

Gentlemen:—

Received your Electric Drill and find it very satisfactory. I enclose check for same, and would like you to ship me two more Drills at once.

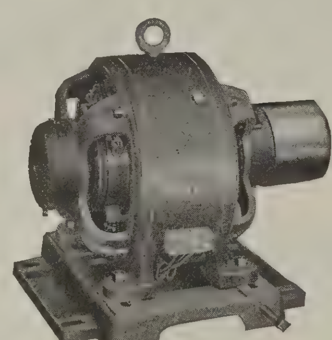
Yours very truly,

We can meet your requirements with a Trial Shipment. Try a Temco Drill and you will want no other.

THE TEMCO ELECTRIC MOTOR CO.
99 Sugar Street LEIPSIC, OHIO, U. S. A.

ROTHMOTORS

are noted for their fine speed adjustments; sparkless commutation; high all-day efficiency; and low maintenance cost—an ideal machine-tool motor. Our grinders and polishers also have many points of superiority.



Write for descriptive bulletins.

ROTH BROS. & CO.

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SAN FRANCISCO, Monadnock Bldg.

"Everything in Blowers and Exhausters"

"Buffalo" Pressure Blowers

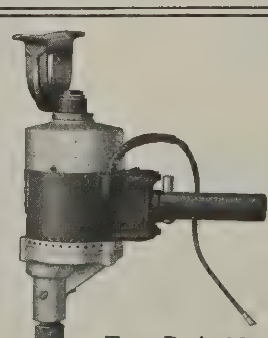
Steam Pulley Electric

Intended for pressures up to 16 oz. Every blower built a little better and stronger than would seem necessary, and tested before shipment. Complete line in stock. The entire fan wheel and shaft can be taken out simply by unbolting one of the side plates. The solid peripheral shell prevents leakage along line of highest pressure.

Catalog No. 178-L 0 on request.

Buffalo Forge Co.-Buffalo, N.Y.

New York Pittsburg Chicago St. Louis Denver



Type D. A. 00 Universal Drill

The PANAMA CANAL is a stupendous undertaking and the work is most exacting. DEPENDABLE EQUIPMENT which will give with long continuous service, the greatest output in the least time at the lowest cost is desirable.

That's why so large a number of our "HARD SERVICE" (portable) ELECTRICALLY operated DRILLS and REAMERS are being employed there day after day in drilling and reaming operations.

Have you read our Pamphlet "REDUCING PRODUCTION COSTS and MANUFACTURING EXPENSES"? Write for it and our Bulletin No. 22, detailing our varied selection of Types, Sizes, etc., of "HARD SERVICE" (portable) ELECTRICALLY operated DRILLS and REAMERS for all classes of work.

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THE VAN DORN & DUTTON COMPANY

General Offices and Factories CLEVELAND, OHIO

District Sales Offices: New York, Baltimore, Boston, Atlanta, Pittsburg, Detroit, Chicago, St. Louis, San Francisco, Minneapolis, Los Angeles.
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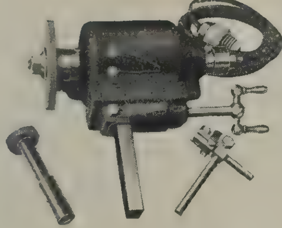
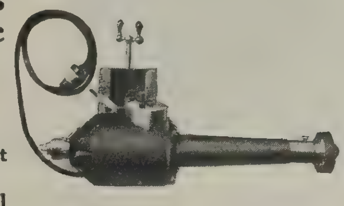
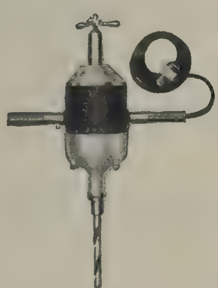
"HISEY"



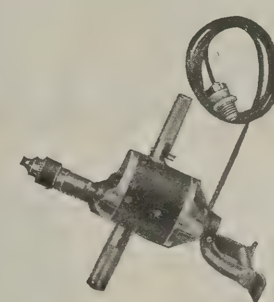
Largest Exclusive Manufacturers of High Grade Portable Electric Tools in the World.



A FEW OF THE TOOLS WE MAKE



- Portable Elec. Flex. Shaft Tool.
- Portable Elec. Hand or Breast Tool.
- Center Drive Hand or Breast Tool.
- Two Speed Hand or Breast Tool.
- Two Speed Screw Feed Drill.
- Two Speed Drill.
- Heavy Duty Drill.
- Combination Hand or Breast and Bench Drill.
- Sensitive Drill.
- Scotch Radial Drill.
- Portable Electric Tool Post Grinder.
- Portable Electric Parallel Grinder.
- Portable Electric Internal Grinder.
- Portable Electric Buffer or Grinder.
- Portable Electric Bench Grinder.
- Portable Electric Pedestal Grinder.
- Portable Electric Aerial Grinder.



The Hisey-Wolf Machine Company
CINCINNATI, OHIO, U. S. A.
NEW YORK OFFICE, 50 Church Street

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BELLEVILLE, NEW JERSEY

Specialists in the manufacture of

ELECTRIC MOTORS

for application to all classes of machinery.

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Tell us your needs.

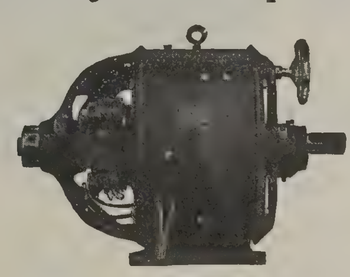
BROWN PYROMETERS

Accurately gauge the temperature of furnaces for heat-treating steel.

It is the Standard Pyrometer where accuracy is essential.

THE BROWN INSTRUMENT CO.
Established 1860 **PHILADELPHIA**
BRANCHES: New York, Pittsburg, Chicago.

Reliance Adjustable Speed Motors



The Ideal Drive for your Machine Tools

These motors give you all the advantages to be obtained with other motors, plus really accurate speed adjustment over ranges as great as 1 to 10. The changes in speed are smooth and gradual—no steps —no jumps. You get the right speed with ample power for every operation on all kinds of work.

Reliance Adjustable Speed Motors can be installed on the ordinary two wire direct current circuit. No electrical controller—no complicated wiring necessary.

Write for our folder 10-M. It tells all about Reliance Motors and explains why they will make your machines do more work.

We can also furnish Reliance Constant Speed Motors for either A. C. or D. C. circuits.

Reliance Electric & Engineering Co.
1056 IVANHOE ROAD CLEVELAND, OHIO

JESSOP'S "ARK" HIGH SPEED STEEL

Has an Unexcelled Record. ARK. **Note the Following Facts.**

In turning 100 railway car wheel tires, Jessop's "Ark" High Speed Steel has the record of losing less steel, due to grinding, than any other make.

The actual amount of steel ground off the tool in turning 100 wheels was 3 ounces. This is an unrivalled performance in steel economy.

We have a large stock of Carbon Tool Steel and High Speed Steel. Write for Catalogue.

WM. JESSOP & SONS, Incorporated

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Boston Warehouse: 163 High Street. Branch Warehouses throughout the United States.

TRADE-MARK "HAWK" BRAND STEEL

REGISTERED U.S. PAT. OFFICE NOS. 50932-61349 CANADIAN PAT. OFFICE NO. 44

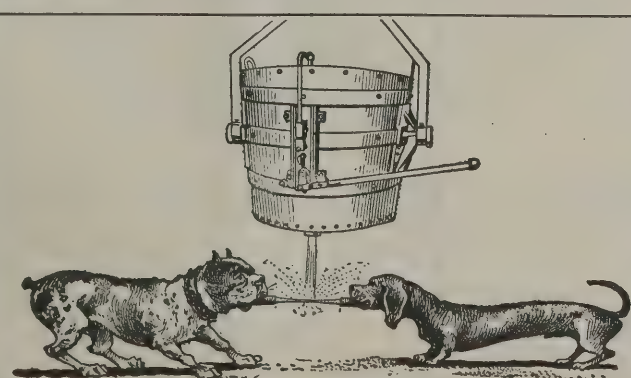
"HAWK SPECIAL" TOOL STEEL Will Give You the Cut You Want

For making a fine finishing cut and taking a light chip, "Hawk Special" is far superior to the best High Speed Tool Steel at one-half the cost.

Where the speed is not excessive, "Hawk Special" will take the place of any High Speed Steel to good advantage.

STEEL OF EVERY DESCRIPTION

HAWKRIDGE BROTHERS COMPANY, 303 Congress Street, Boston, Mass.



Strong STEEL Castings

The Toughest Metal ever Produced

NEW METHODS

You will be interested to learn that by our IMPROVED METHODS in ACID OPEN HEARTH STEEL manufacture, you can purchase GENUINE STEEL castings which are SMOOTH, SOLID, and true to pattern, having EXCEPTIONAL STRENGTH and DUCTILITY, at prices below those asked for inferior steels.

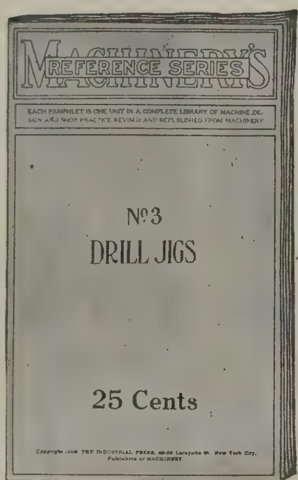
OUR PRODUCT MERITS YOUR INVESTIGATION. Your orders will receive prompt attention.

Send blue prints for estimates

Strong Steel Foundry Company

BUFFALO, N. Y., U. S. A.

Ten 25-cent Books for Toolmakers and Tool Designers



TOOLMAKING and tool designing are becoming more and more important with the growth of interchangeable manufacturing methods. The day of the all-around machinist may have passed, but the all-around toolmaker has taken his place. The toolmaker is the star among mechanics. In no trade are skill, judgment and training of higher value than in his. The tool designers and manufacturing experts of tomorrow are the toolmakers who show their ability today. The ablest men always come from the ranks. The best informed men have the first chance, other things being equal. In the toolmaking trade, as in life, growth is impossible without increase of knowledge. Do you want to increase your ability as a toolmaker and designer? These books can help, and exactly along the practical lines that mean results in the day's work.

A CHRISTMAS SUGGESTION

Give a set of these books to some toolmaker you know, especially some young fellow lining up for his future. Maybe you can tell her what these books may mean to him later, in knowledge, skill and earning power. If she gets that right, she will buy him the books and would do it if the cost were ten times $2.25. Real happiness is measured out to human kind in small, infrequent doses. The largest of these come at Christmastide. Take yours, brother.

CONTENTS

No. 3—DRILL JIGS.—Contents: Elementary Principles of Drill Jigs—Drilling Jig Plates—Examples of Drill Jigs—Dimensions of Standard Jig Bushings—Using Jigs to Best Advantage.

No. 4—MILLING FIXTURES.—Contents: Elementary Principles of Milling Fixtures—Examples of Milling Fixtures.

No. 41—JIGS AND FIXTURES, PART I—BUSHINGS, LOCATING POINTS AND CLAMPING DEVICES.—Contents: Principles of Jigs and Fixture Design—Bushings for Drill Jigs—Locating Points—Clamping Devices.

No. 42—JIGS AND FIXTURES, PART II—DRILL JIGS.—Contents: Design of Open Drill Jigs—Examples of Open Drill Jigs—Design of Closed or Box Jigs—Examples of Closed or Box Jigs.

No. 43—JIGS AND FIXTURES, PART III—BORING, PLANING AND MILLING FIXTURES.—Contents: Principles of Boring Jigs—Boring Jig Designs—Boring, Reaming and Facing Tools—Planing and Milling Fixtures.

No. 21—MEASURING TOOLS.—Contents: History and Development of Standard Measurements—Calipers, Dividers and Surface Gages—Micrometer Measuring Instruments—Miscellaneous Measuring Tools and Gages.

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You may enter my order for the ten Reference Books, price $2.25, described in December MACHINERY, payment for which I agree to send you within 90 days.

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KNOWLEDGE vs. GUESS
Gas Heating Apparatus or the Other Kind

You demand precision in your tools and other apparatus, why not in heating appliances? You demand accuracy of product in other departments, why not when hardening and tempering? The first and biggest step toward this end is the installation of heating apparatus in which the control and regulation of heat is positive. Know the amount of heat you need; know that you get it—and the rest of the process becomes a matter of routine.

"American" Gas Furnaces

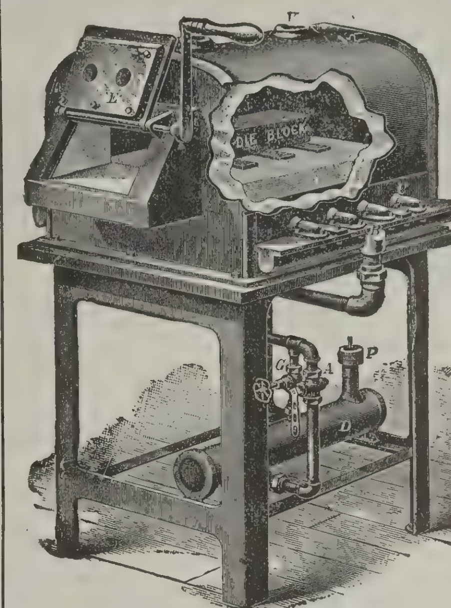
afford absolute even heat distribution and control. Made for all classes of hardening, tempering and annealing.

With our **Heat Regulator and Controller** the temperature can be regulated to within five degrees Fahrenheit.

Write for the complete catalog.

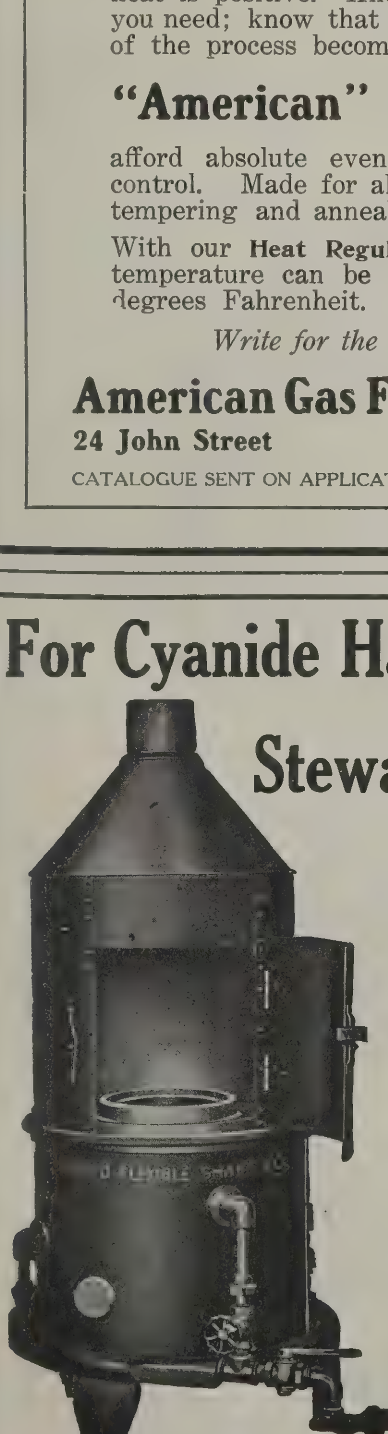
American Gas Furnace Company
24 John Street NEW YORK, U. S. A.

CATALOGUE SENT ON APPLICATION.



Our **No. 1 Oven Furnace** is a popular size for Hardening and Annealing, replacing the "muffle furnace" because of the more direct action of the heat and the presence in the heating chamber of the products of combustion, which prevent oxidation. Muffles exclude these products and are filled with heated air, which promotes oxidation. Let us send you more information on this subject.

For Cyanide Hardening



This
Stewart No. 10

furnace is quite a bit in advance of anything else offered for the purpose.

Bank note engravers, makers of engraved plates, transfer rolls, cutters, dies, springs, chains, etc., where a hard surface without great depth of case is required, find this furnace especially good.

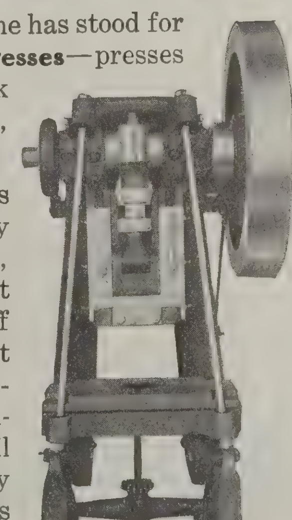
The extreme depth of case can be obtained in 17 to 20 minutes. The cyanide may be brought to a hardening heat in 40 minutes, beginning with a cold furnace.

Write for complete specifications and large general catalogue of furnaces.

Chicago Flexible Shaft Co.
149 La Salle Ave. CHICAGO, ILL.

SWAINE

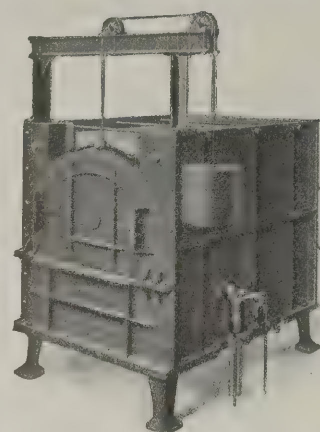
For forty years that name has stood for **dependable power presses**—presses that for speed, good work and operating economy, are second to none.



The Inclinable Press shown, combines many time-saving features, including a shaft that can be hand turned off centers and the dies set without stopping flywheel; a clutch that cannot be "thrown in" until crank is turned back by hand; two locking points in flywheel, giving instant engagement of clutch—and a host of other features.

We make so many different Presses it takes a 200-page Catalogue to describe them—Sent on request.

FRED. J. SWAINE MFG. CO.
7th and O'Fallon Sts., ST. LOUIS, MO.
LARGEST PRESS BUILDERS IN THE WEST



Heat Treatment of Steel is An Art

The operations of annealing, hardening and tempering are the most important, the most delicate and the most difficult of all the manipulations to which steel is subject. The ways of performing these operations are all-important. You have to use modern methods, the right type of furnace, to get modern results. Wherever installed, **Tate-Jones Furnaces** have proven most economical and efficient—in the test of daily service.

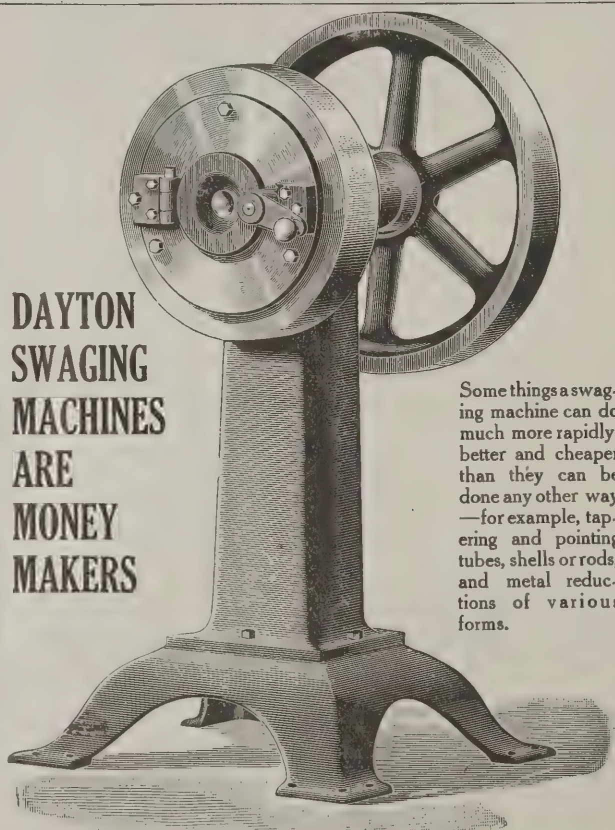
Let us send our Booklet "Heat Treating of Steel"—a treatise on the art, and a catalog.

Tate, Jones & Company, Inc.

Engineers and Manufacturers PITTSBURGH, PA.

F. W. TRIMBLE, 45 Broadway, New York

DAYTON SWAGING MACHINES ARE MONEY MAKERS



Some things a swaging machine can do much more rapidly, better and cheaper than they can be done any other way—for example, tapering and pointing tubes, shells or rods, and metal reductions of various forms.

Write for book "The Modern Art of Swaging."

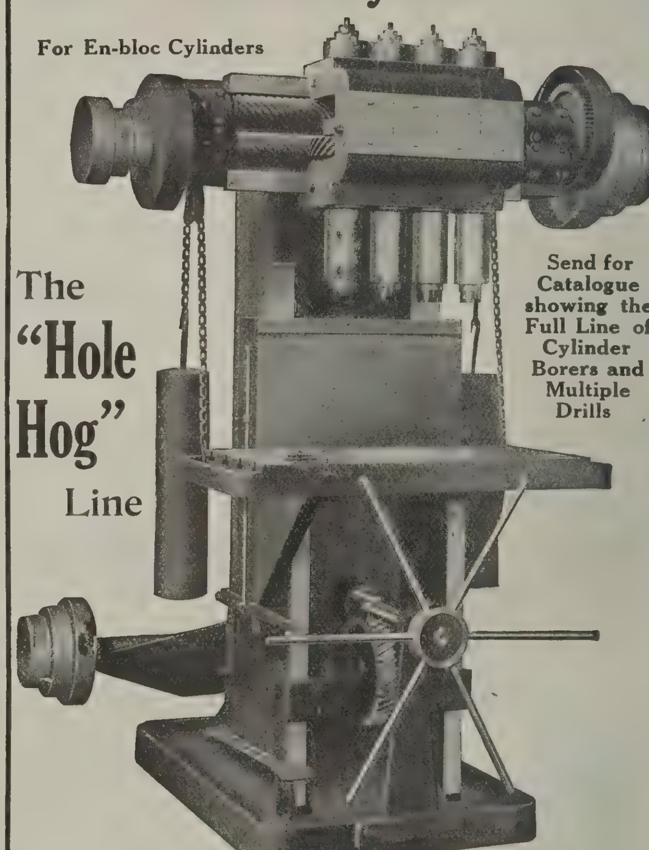
THE EXCELSIOR NEEDLE COMPANY, TORRINGTON, CONN.

Coventry Swaging Co., Ltd., White Friars Lane, Coventry, England, Agents for Great Britain. Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

No. 2 Moline Cylinder Borer

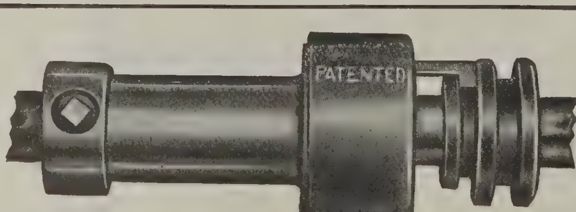
For En-bloc Cylinders

The "Hole Hog" Line



Send for Catalogue showing the Full Line of Cylinder Borers and Multiple Drills

MOLINE TOOL CO., Moline, Ill.



A DURABLE SELF-ADJUSTING CLUTCH

Simple and strongly made—only 16 parts—all interchangeable. Self-adjusting for wear and varying loads. Has frictionless roller grip—can't burn out. When locked can't slip. Ideal for all countershaft use. *Send for full details.*

BICKNELL-THOMAS COMPANY, Greenfield, Mass.

The National Electric Welder Co.

Manufacturers of

ELECTRIC–SPOT, BUTT and SEAM
WELDERS

Special Machines designed and constructed

WARREN, OHIO

HOSKINS

Give Your Tool Hardener the Right Equipment

—an equipment in keeping with the importance of his work. Every time he fails to harden a tool properly, you not only lose the value of the steel, his and the tool maker's time, but you *hold up the job* the tool was meant to do. Don't blame the tool hardener. Instead, help him to

Eliminate Uncertainty

from his work and at the same time save yourself the cost of his unsuccessful efforts. Give him an equipment that will enable him to do good work *all the time,*— to make *every tool* as accurate and long-lived as it is possible to make it. Take advantage of the greater earning capacity and the decreased production costs that only *efficient tools* make possible.

Hoskins Electric Furnaces

—in the hands of competent tool hardeners in many of the country's largest plants—are producing tools that are truly remarkable for their efficiency. They are setting new standards of work and life for cutters, taps, dies, drills and many other tools and are really showing the enormous possibilities in modern tool steels, *when properly heat-treated.*

The item at the left will show you the kind of work the Hoskins Furnace is doing and the little square at the right contains an offer to prove that it is the *right equipment for your tool hardener.*

Two and A Half Years of Better Tools

—is the record of the Hoskins Electric Furnace shown above.

This furnace was installed more than two and a half years ago in one of the tool rooms of a large and well known manufacturer of conveying machinery.

The result was a very great increase in the efficiency of the tools.

So great was this increase in efficiency that it was soon found advisable and economical to ship tools, to be hardened in this Hoskins Furnace, from the Company's two other plants located in far distant cities.

Let Us Give You Proof

- without obligation—that the Hoskins Furnace can produce better tools for you. Let us harden several of your tools, free—to be tested by you against similar tools hardened by your present or any other method. Ask us today for further details and our "Bulletin 10."

HOSKINS MANUFACTURING COMPANY

Electric—Furnaces, Pyrometers and Heating Appliances

"International" Ammeters and Voltmeters

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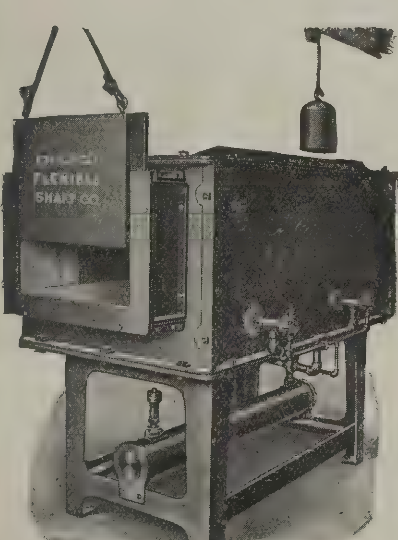
Otis Bldg. CHICAGO — Oliver Bldg. PITTSBURGH — 30 Church Street NEW YORK

376

THE STEWART OVEN FURNACE No. 24



Supplied with burners for oil or gas consumption, whichever is most economical for your locality.

This Furnace has lining heavy enough for

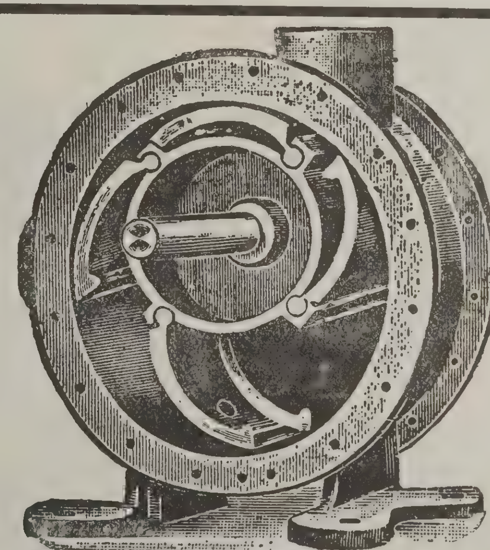
Case Hardening

A popular Furnace with automobile manufacturers.

Illustration shows it fitted with oil burners.

Write for full specifications and large general catalogue.

CHICAGO FLEXIBLE SHAFT CO.
149 La Salle Avenue CHICAGO



LEIMAN BROS.
ROTARY POSITIVE HIGH PRESSURE

BLOWERS

for use with oil and gas appliances. Made in 8 sizes from 2 to 338 cubic feet of air per minute—1 oz. to 10 lbs. pressure.

VACUUM PUMPS

10½ to 338 cubic feet per minute. 1 to 20 inches Vacuum for VACUUM CLEANING. **They take up their own wear.**

Blower Catalog No. 16. Vacuum Catalog No. 17.

LEIMAN BROS. 62 E. John St. New York

21" with Tilting Table

That Tilting Table on "Modern" Drills

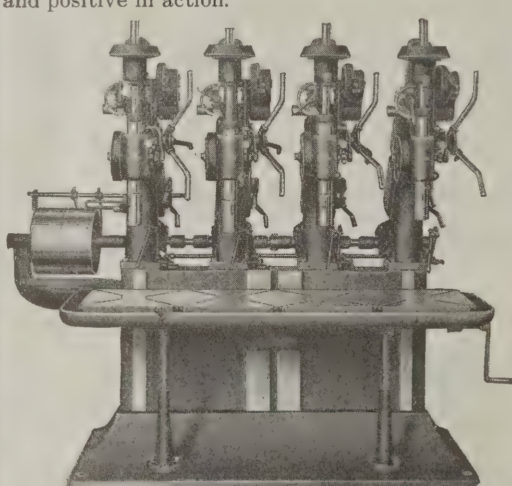
is a wonderful time saver. Take such work as cylinder castings for example, which require drilling at different angles—you can tilt this table **at any angle up to 90 degrees** and place the piece so that it can be worked to advantage. The square spindle you see, through the crown gear, eliminates friction—another good feature. Note, also, how conveniently we have located every lever and handle—no back-breaking reaches, and no stopping work to change from belt driven to back gears—throw a lever and "presto" the change is made. This and our 20" drill are both built to **save time** and they **do it.** *Send for Circular and Prices.*

FRONTIER IRON WORKS, Buffalo, N. Y.

ALSO BUILDERS OF ROYAL POWER SAWS.

Big Savings in Time
Big Increase in Power

And this means an increased output—made possible by our All Geared Gang Drills. No cone or feed belts. No slipping and loss of time. Each spindle has eight changes, each of Geared Speeds and Geared Feeds, all controlled by levers conveniently reached from front of machine. Easy to operate and positive in action.



Our 20 inch gang here shown drives a 1" high speed twist drill at rate of 8 inches per minute in cast iron and 4 inches per minute in mild steel. Built in two to sixspindles and also in 24" and 26" sizes.

Write for Latest Bulletins "M"

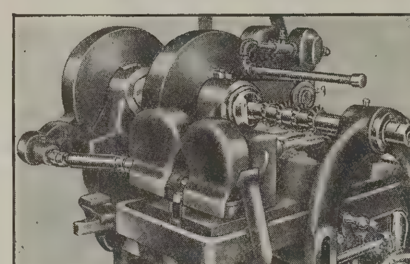
BARNES DRILL CO.

Incorporated 1907

814 Chestnut Street, Rockford, Ill., U.S.A.

Agents for Germany and Austria: E. Sonnenthal, Jr., Berlin, C. 2 Cologne a/Rh. and Vienna. Great Britain: C. W. Burton, Griffiths & Co., London, E.C. Belgium: G. & F. Limbourg Freres, Brussels. Ontario: Kellogg & Co., Toronto. Japan: Roku-Roku Shoten, Tokio.

AUTOMATIC TAP MACHINERY



We are now furnishing complete equipment of automatic and semi-automatic special machinery for tap makers.

Are you interested?

BICKFORD MACHINE CO.

GREENFIELD, MASS.

Ames Precision Bench Lathes

FOR FINE TOOL PRODUCTION

Try Ames Precision Lathes in your tool-room. Accurate production assured on any work within the 8⅜" swing of the machine. Durability and range unsurpassed. Let us send the specifications and other details—facts worth studying.

B. C. AMES COMPANY, Waltham, Mass.

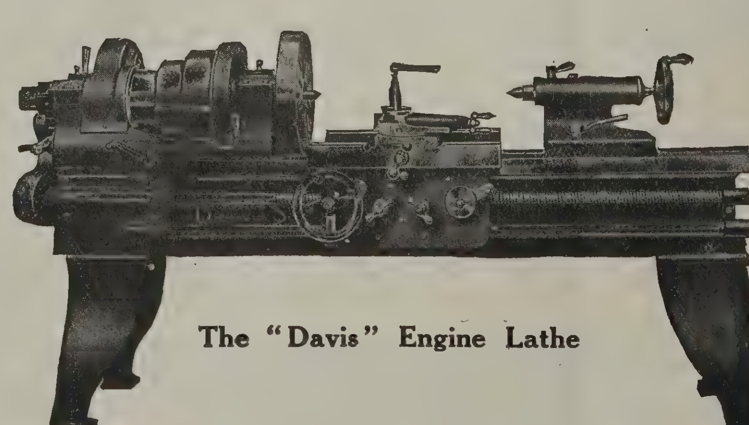
VERY FAST PRODUCERS

Any maker can claim that, but "Davis" Engine Lathes substantiate the claim. Their carefully worked out design, strong and rigid construction, high-grade workmanship and uniform accuracy of product—all spell **very fast production** when put to the test. Besides—they're built to **last.**

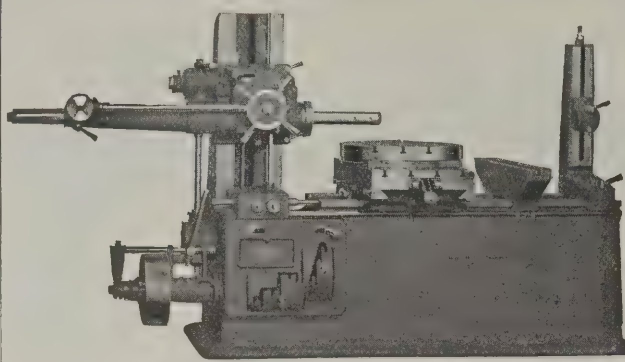
By the way, have you one of our New Keyseater Booklets? A request brings one.

THE W. P. DAVIS MACHINE COMPANY

305 ST. PAUL STREET, ROCHESTER, N. Y., U. S. A.



The "Davis" Engine Lathe



A VERY WIDE RANGE OF WORK

can be conveniently handled on a **Cleveland Horizontal Boring, Drilling and Milling Machine.** One handle only is used to make complete change of speed or feed. All handles are operated from one working position. Slow hand feed and quick traverse of bar are both operated from same pilot wheel. All changes of speed, feed and spindle reverse made without stopping machine. For simplicity, operating convenience and output, you can't beat the "Cleveland."

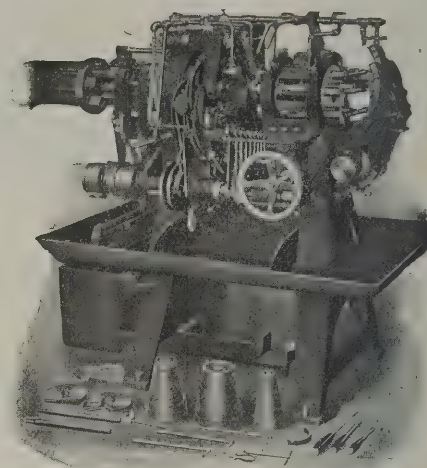
Send for Special Circulars.

Cleveland Machine Tool Works

CLEVELAND, OHIO, U. S. A.

Nine Tools When Required

The Davenport Multiple Spindle Automatic Screw Machine



has five spindles and employs up to nine tools, as required. Within its range of ½-inch x 2 inches it is without equal as a quantity producer of accurate and finely finished screw products. Its many exclusive improvements require your careful investigation.

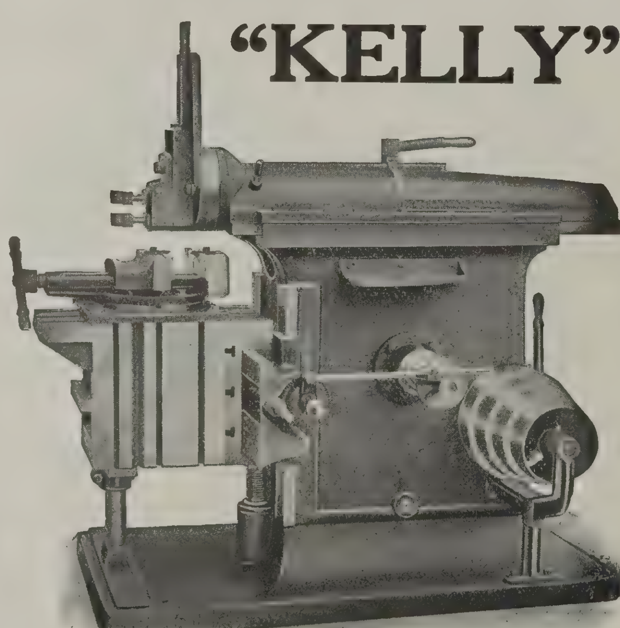
Send for the circulars.

Davenport Machine Tool Company

New Bedford, Mass.

AGENTS—Motch & Merryweather Machinery Co., Cleveland, Cincinnati, Detroit and Pittsburg. Agents for France—Ph. Bonvillain & E. Ronceray, Rue des Envierges, Paris, France. F. G. Kretschmer & Co., Frankfurt, Germany and Wien IX/2 Michelbeurnstrasse, 1A. American Machinery Import Office, Zurich, Switzerland.

"KELLY"



The essential point about shaper work is ACCURACY. Caliper any job done on a "Kelly"—you'll find it true to a **hair line.**

This can't be said of **all** shapers, but its a "Kelly" trait that carries weight. The catalogue goes into details—construction, attachments, sizes—may we mail a copy?

THE R. A. KELLY COMPANY, Xenia, O.

Power—Direct to Drills

Drill power transmission is a great problem. The best drilling machine is the one which transmits the most power **direct to the drills.** Usually the belted types of machines waste a large part of the power they convey to the drills, due mostly to slippage, the breaking of belts, and friction.

With Taylor & Fenn Drilling Machines the power is applied by means of gears and silent chain.

No slippage. No breaking of belts. No needless friction. And best of all, the feed can be operated only, when the spindle is in motion.

Ask for catalogue.

The Taylor & Fenn Co.

HARTFORD, CONN.

HERON MANUFACTURING COMPANY

CASTERS FOR EVERY PURPOSE. WOOD NOVELTIES.

BRANCH OFFICES. 1133 BROADWAY, NEW YORK. 218 SO. WABASH AVE CHICAGO, ILL.

W. S. FOSTER, PRES. J. S. PICKELL, VICE-PRES. R. P. HERON, SEC'Y AND TREAS.

CABLE ADDRESS "HERON UTICA" PRIVATE CODE

UTICA, N.Y. Oct. 21st, 1912.

Mr. George E. Abbott,
Abbott Ball Company,
Hartford, Conn.

Dear Sir:-

Replying to your request, we have no hesitancy in recommending the Abbott Ball Tumbling System. We have had it in use from nine to ten months. Its installation has permitted our doing away with an expensive polishing and buffing equipment as well as the high priced labor necessarily involved. We are to-day producing twice the number of parts at half the cost, getting a better finish and doing away with the expense of cleaning polished work of the rouge that naturally collects in creases and corners.

Very truly yours,
HERON MANUFACTURING COMPANY.

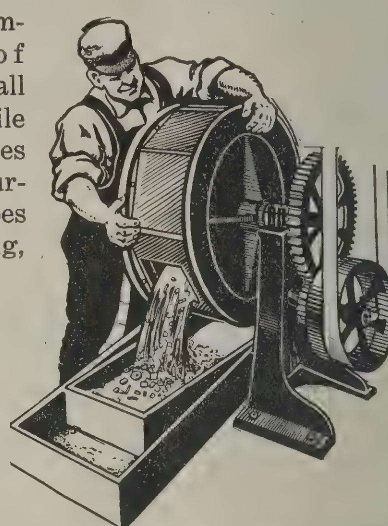
RPH/N

"Twice the Polishing at Half the Cost"

Read this Letter

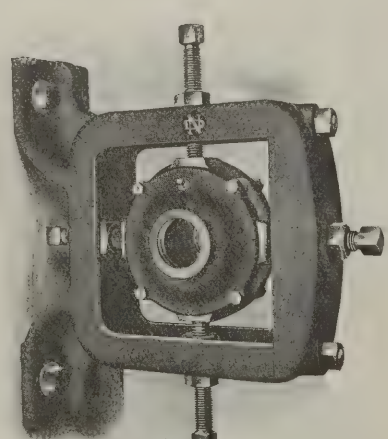
Two facts stand out prominently in this communication; the character of the work and its fine finish, and that the high-priced labor formerly employed for polishing has been done away with entirely.

The Abbott Burnishing Process, by means of the Abbott Barrel and Abbott Balls is the modern, economical method of polishing small metal parts. While the process does not remove surface metal it does produce a polished surface at a fraction of the cost for hand polishing, no matter whether the work is steel, brass or copper.



Send us samples of your work. We'll finish them free of charge, tell you just how long it took to do it, and what it will cost for an installation in your own plant.

THE ABBOTT BALL COMPANY
ELMWOOD, HARTFORD, CONN.



POST HANGER—ONE OF SEVERAL TYPES OF

NEW DEPARTURE
GUARANTEED
BALL BEARING SHAFT HANGERS

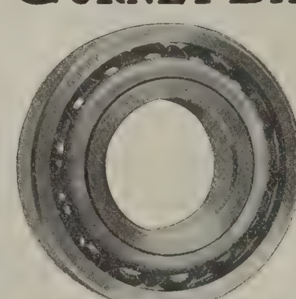
Advantages proved by actual service.
Absolutely self-aligning.
Quick and accurate adjustment.
Lowest in final cost.
Big saving of money.

Write for catalog and data sheets

Factory Equipment Dept.

THE NEW DEPARTURE MFG. CO.
BRISTOL, CONN.

GURNEY BALL BEARINGS



sustain greater loads and outwear all others. WHY? Because they have raceways of more perfect contour than all others. Will take greater thrust load because they have full depth and uninterrupted raceways with full complement of balls. Our Radio-Thrust Bearings will sustain 100% radial or 100% thrust load or a combined radial and thrust load. Something new and valuable.

Write for Particulars.

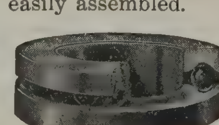
Gurney Ball Bearing Co., Jamestown, N.Y.

Trade Mark

AUBURN
Ball Thrust Bearings

"STYLE T-114" is an excellent bearing for elevator worms, automobile clutches, turn tables, bevel gears and all other end thrust purposes between rotating parts. One piece, self-contained, easily assembled.

are made with Four Point Cone Contact, giving strength and wear. Fine tool steels and high grade workmanship and finish insure success in hard service. Bulletin No. 9 shows the complete line—Four Point and Special Bearings, Steel, Brass and Bronze Balls, etc.



AUBURN BALL BEARING CO.
83 Elizabeth Street
ROCHESTER, N. Y., U. S. A.

Our New Catalog

Just off the press explains in detail the manufacture of

ATLAS BALLS

which are guaranteed round and true to size within

$\frac{1}{10,000}''$

Here is a list of the subjects it treats on:

Foreword
Our Guarantee
The Making
The Steel Used for Atlas Balls
Forging
Annealing
Rough Grinding
Smooth Grinding
Heat Treatment
Hardening and Tempering
Final or Precision Grinding
As Others Do It
As We Do It
Polishing
Final Inspection
Packing
Ball Data
Table of Allowable Loads
Price List
Information for Ordering
Different Grades of Atlas Balls

Fill in this coupon and receive free copy.

ATLAS BALL COMPANY
203 Glenwood Ave., Philadelphia, U. S. A.

Clip, Sign and Return This Coupon Now

ATLAS BALL CO., 203 Glenwood Ave., Philadelphia.
Gentlemen:—You may send one copy of new catalog on Atlas Balls.

Name ....
Address ....
City .... M. 12-12

No Valve Troubles if you Use Dudgeon Jacks

In a recent number of a popular "Weekly," a writer on Scientific Management says he saw screw jacks being used in a locomotive shop, at a terrific cost in time, and a dozen hydraulic jacks piled up on the same floor waiting for valve repairs.

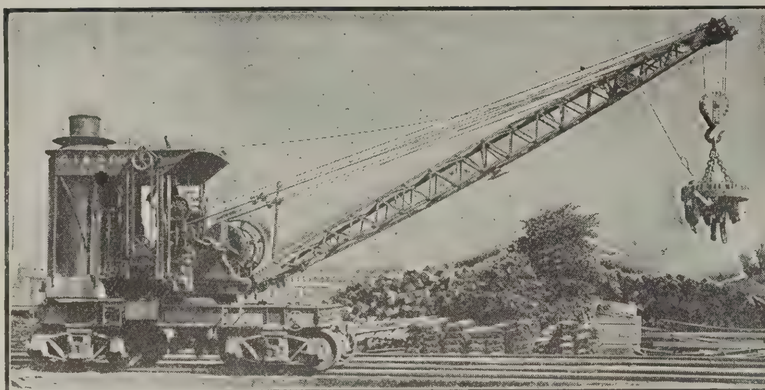
THEY WERE NOT DUDGEON JACKS

A condition such as that couldn't arise if Dudgeon Jacks were the equipment. The single valve chamber construction in our Universal Double Pump Plain Jack does away with the cause of valve trouble. It removes all the objectionable complications of valves and passages which heretofore impaired the double pump jack.

Other double pump jacks require three pressure valves and two suction valves (five valves in all) while the Dudgeon Universal has but one pressure valve and two suction valves (three valves in all), and of the suction valves but one is used at a time. Other double pump jacks have three passages between the pressure chamber and the reservoir, each closed by a single valve, the failure of any one rendering the jack inoperative. The Dudgeon Jack has but one passage, containing three valves, any one of which, alone, can perform the functions commonly shared by the three.

Send for the circulars and more details. They will interest you.

RICHARD DUDGEON
Columbia and Broome Streets NEW YORK CITY



"BROWNHOIST" Locomotive Cranes

This shows a "Brownhoist" Crane equipped with lifting magnet, handling pig iron for Columbus Iron & Steel Co., Columbus, O. These cranes will handle any material, as they are capable of using either the grab bucket, bottom block or lifting magnet.

CATALOGS AND FULL INFORMATION SENT ON REQUEST

THE BROWN HOISTING MACHINERY CO.
CLEVELAND, OHIO.

1 to 15 TONS

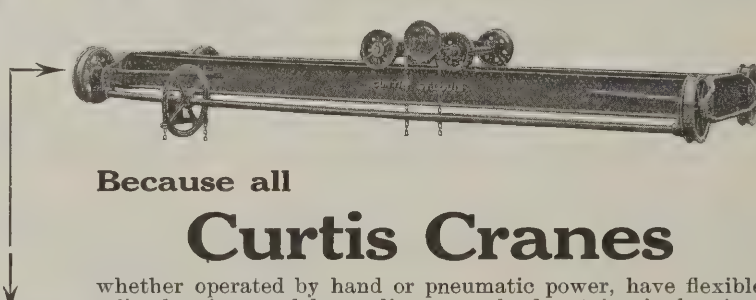
2 to 20 H. P.

PNEUMATIC GEARED HOISTS

PNEUMATIC MOTORS

DETROIT HOIST AND MACHINE CO.
DETROIT, MICH.

EASY TO MOVE EVEN WHEN LOADED TO FULL CAPACITY



Because all

Curtis Cranes

whether operated by hand or pneumatic power, have flexible roller bearings and large diameter wheel, set in single piece crane end. Thus a saving is made of fully 65% in frictional load—less bearing movement, and misalignment an impossibility.

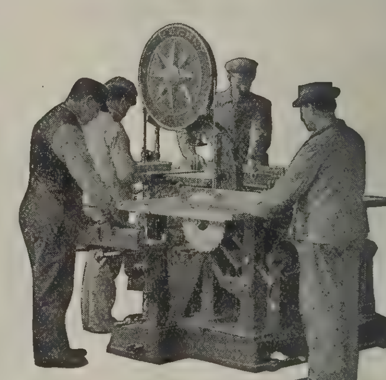
Hyatt Flexible Roller Bearing

Write for circular and prices.

CURTIS & CO. MFG. CO., 1568 Kienlen Ave., St. Louis, Mo.
NEW YORK OFFICE, 30 CHURCH STREET

HOISTS, New Patent Whip

Patent Friction Pulleys
NONE BETTER
MANUFACTURED BY
VOLNEY W. MASON & CO., Providence, R. I., U.S.A.



The Crescent Universal Wood Worker

is a substantial, durable, convenient woodworking machine on which it is possible to do band sawing, jointing, sawing, boring, make mouldings and cut tennons. It is a mortiser, will grind planer knives, can be used for sanding, in fact this one machine furnishes a complete pattern shop outfit for many factories. Ask for special catalog of this machine, also catalog of band saws, saw tables, jointers, planers, swing saws, shapers, disc grinders, variety wood worker and borers.

The Crescent Machine Co.
56 Main Street Leetonia, Ohio, U.S.A.

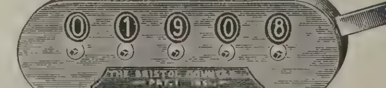
TROLLEYS

MARIS BROS.
PHILADELPHIA
PA.

TAPS, DIES and SCREW PLATES

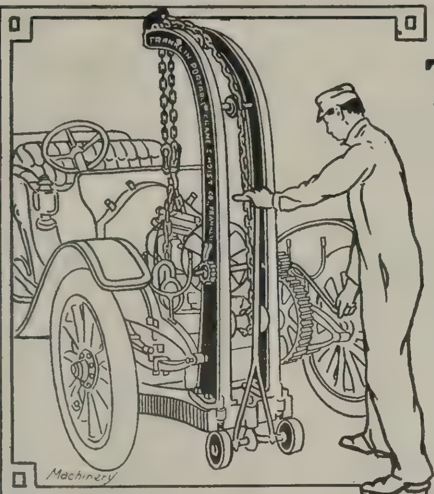
Send for Catalog and Price List.

BAY STATE TAP AND DIE COMPANY, Mansfield, Mass.



TO PREVENT OVERPRODUCTION
on your presses and other manufacturing machines. Our counters will save confusion and disputes. They are adapted to almost any machine.
Catalog "27?"

C. J. ROOT CO., Bristol, Conn.



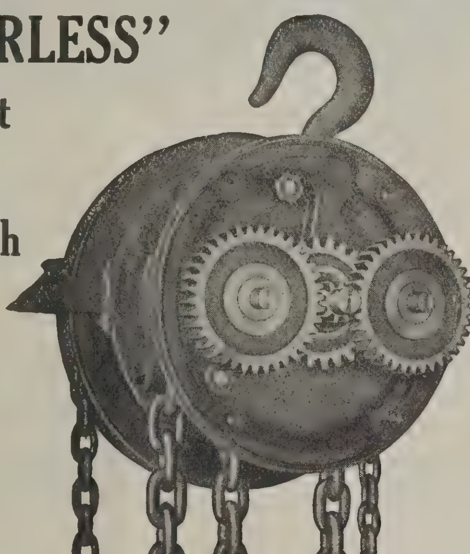
The Franklin Portable Crane and Hoist

When wide diversity of work eliminates most other devices, call on the Franklin "Portable." In the repair shop, for instance, it has a special field, will move weights as rapidly as any overhead system and has the additional advantage of getting into the odd places that trolley or crane cannot reach. It is strong—no hoist more so—and durable. One man, alone, can handle 4000 pounds—pick up, transport, and place it in position. The greatest time and labor saving apparatus any shop can install—One to Three Tons' capacity. Let us show you.

The Franklin Portable Crane and Hoist Company
FRANKLIN, PENNSYLVANIA, U. S. A.

"PEERLESS"

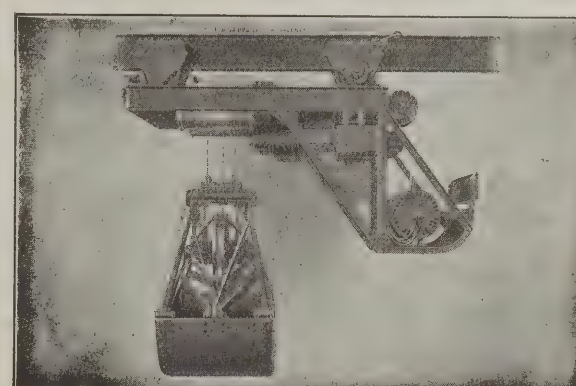
A Giant In Strength and Safe at All Stages



"Without an equal" is the dictionary definition and for all portable, stationary or overhead crane work, indoors or outdoors, **it certainly is.** It engages quickly, operates easily, and automatically holds any load from 500 to 40,000 lbs., according to size. Its perfectly balanced gear train, well-oiled and bronze bushed, reduces operating power to a minimum. To prove how efficiently the "Peerless" will handle your work, we'll send one on 30-days' trial. *Send for Catalogue "H"*, it shows all styles.

Edwin Harrington, Son & Company, Inc.
PHILADELPHIA, PA.

Shepard Grab Bucket Hoist



Fully enclosed, oil bath lubricated gears, brakes, and wearing surfaces, make this machine durable, dependable and efficient. Air laden with coal, ash, or foundry dust will not cause parts to wear. For further information, ask for Bulletin No. 504.

Traveling Cranes,	**Bulletin No. 58**
Electric Hoists,	**Bulletin No. 503**
Monorail Hoists,	**Bulletin No. 504**

Shepard Electric Crane & Hoist Co.
Main Office and Works, Montour Falls, N. Y.
New York Philadelphia Pittsburg Chicago
Toronto Atlanta San Francisco

Two 15-Ton Heavy Service Cranes in Plant of Buckeye Steel Casting Co., Columbus, Ohio.

"Toledo Cranes"

Built for Service

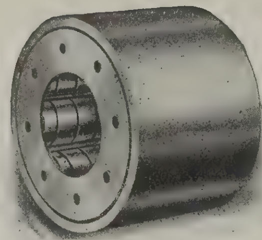
Modern and practical in design, built by experienced mechanics, they stand the test.

You are not serving your own interests if you fail to send us your specifications for

Cranes, Hoists, Grab Bucket Machinery, Coal and Ore Handling Bridges, also Structural Steel for Factory Buildings.

The Toledo Bridge & Crane Co.
Toledo, Ohio

BRANCH OFFICES—Chicago, Milwaukee, St. Louis, New York, Philadelphia, Cincinnati, Cleveland, Pittsburg, San Francisco, Birmingham.



Hyatt High Duty Bushing

No loss of power between driving belt and drill point

The Rockford High Duty Drilling Machine will drive a $3\frac{3}{16}$ inch drill through *seven* inches of .40 carbon steel in *one* minute. The power which is supplied by a *six* inch *single* belt is practically all delivered at drill point because *all* bearings are of the Hyatt High Duty Type. The above record could not be made if plain bearings were used.

The Hyatt is a distinctive type of roller bearing—the rollers are flexible steel spirals, which cushion shock, act as oil reservoirs and oil distributors and under all conditions present a line of contact the entire length of the bearing.

Six to eight thousand Hyatt Bushings are made daily.

Write for bulletins 600A and 305—they are both full of information for the maker and user of machine tools.

HYATT ROLLER BEARING CO.
NEWARK, NEW JERSEY

2031 B

Did you read in "Power" where Mr. A. E. Derby practically specifies Cling-Surface?

In his article "Care of Belting in the Factory" in "POWER," Jan. 9, 1912, this gentleman concludes with these specifications for a preparation usable on belts:

"**It should** soften the pulley side of the belt; penetrate the fiber; lubricate and protect the fiber from crumbling; prevent the generation of static electricity.

It should not decompose; be influenced by moisture; dry up; cause the belt to stick to the pulley when idle, as though glued there and when starting pull off the surface and expose the fiber; leave a film on the surface of the belt; contain mineral acids."

Very good. Cling-Surface easily complies and does even more it penetrates and makes the whole belt pliable. It makes the belt absolutely waterproof. Where Cling-Surface is used in the wettest places, in pulp and paper mills, in laundries, and in very humid climates, it proves itself invaluable for waterproofing and preserves against disintegration.

State your troubles today and let us advise. Our literature is ready for your mailing request.

CLING-SURFACE CO 1018 Niagara St Buffalo N Y

New York Chicago Denver Boston Memphis St Louis Atlanta Toronto Etc
London—Thomas & Bishop 119-125 Finsbury Pavement E C
Paris 74 Rue des Ecluses St Martin 53 Barmen Oskarstrasse 2

Baldwin Drive Chains and Sprockets

are made in all sizes for all purposes, for machine drives.

Years of experience in the art enable us to produce the work, accurate, serviceable, and suitable, for every condition. Send for circulars. Submit sketches for estimates at once.

BALDWIN CHAIN & MFG. CO.
WORCESTER, MASS.

AGENTS:—H. V. Greenwood, 122 So. Michigan Boulevard, Chicago, Ill. C. J. Iven, Rochester, N. Y. M. A. Bryte, 788 Mission St., San Francisco, Cal.

WHY CUT METAL GEARS IN YOUR OWN PLANT?

Metal gear cutting can't be done in short time and at low cost in any shop where the machines must be temporarily rigged up for this work today and for something else tomorrow. Nor can you expect the same accuracy as where the operatives concentrate their entire attention on gear work.

From its beginning, twenty years ago, this company, with a well organized engineering staff, a thoroughly modern shop, and ample capital, has given its attention almost exclusively to gear cutting.

Our service includes designing (when necessary), pattern work, the furnishing of brass, iron or steel castings, forgings, or bar stock as required, and the complete finishing of gears of any standard types.

Our plant contains over 200 special machines, including automatic and engine lathes for turning blanks from bar stock, castings and forgings; milling and hobbing machines for spur, spiral and helical teeth; cutters and planers for blocking out bevel teeth, Gleason generators for cutting bevel gear teeth; grinders for truing up the bores of hardened steel gears, etc. No order is too large, too small, or too difficult. We give you accuracy at low cost and deliver at least as quickly as your own plant. Send blueprints and let us quote on your next rush order.

The NEW PROCESS RAW HIDE Co.

N.P.R.H. Co. TRADE MARK REGISTERED

OFFICE & WORKS SYRACUSE, N.Y.

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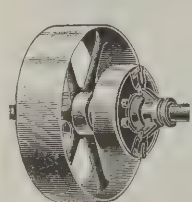
THE A. & F. BROWN CO.

ENGINEERS, FOUNDERS, MACHINISTS AND MILLWRIGHTS

172 FULTON STREET, NEW YORK



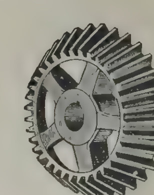
Friction Clutch Pulleys and Couplings

POWER TRANSMISSION MACHINERY

FRICTION CLUTCH COUPLINGS FOR HEAVY WORK

GEARS

MACHINE MOULDED, CUT SPUR AND PLANED BEVEL GEARS OF EVERY DESCRIPTION



Gears of all kinds and sizes

ROPE DRIVES A SPECIALTY **TURNED STEEL SHAFTING**

WE LAY OUT, MAKE THE DRAWINGS, FURNISH THE MATERIAL AND ERECT IT

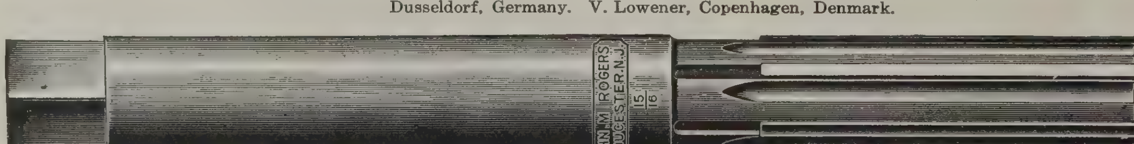
SEND FOR CATALOGUE WORKS—ELIZABETHPORT, N. J.

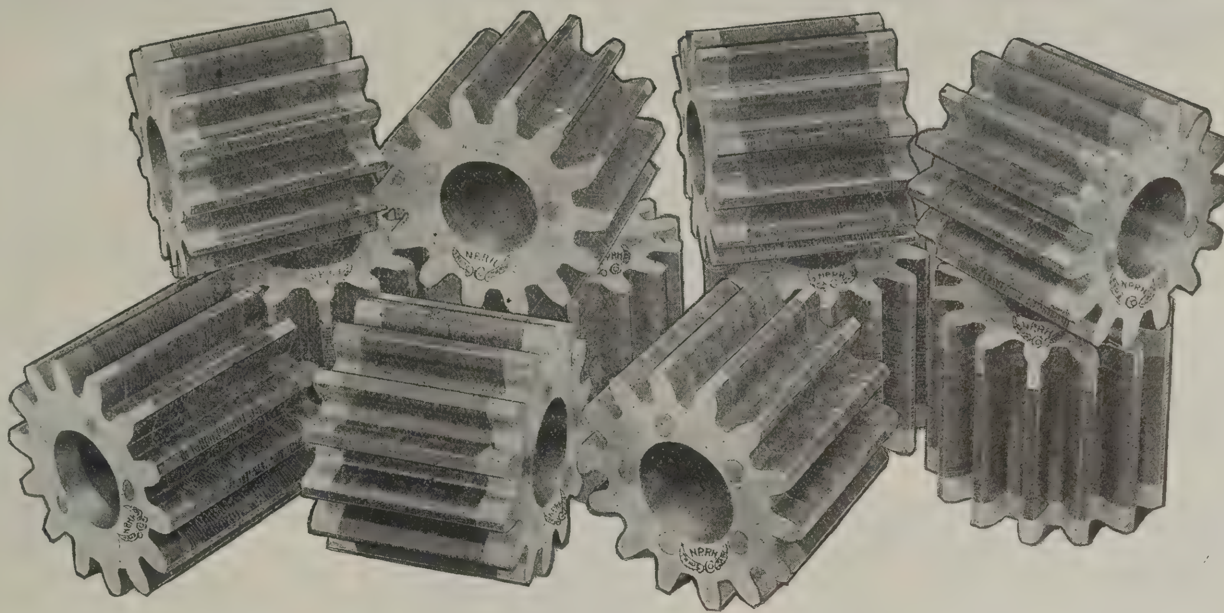
Rogers Reamer Blades are Easily Adjusted to Correct Size

Just drive blades toward shank and cutting edges are expanded to compensate for wear. When desired for bottoming in blind holes, we furnish special blades that drive forward. Rogers Reamer Blades have no screws or delicate parts to get out of order. Materials and workmanship are the very best. *Send for Small Tool Catalog No. 8.*

THE JOHN M. ROGERS WORKS, Inc., Gloucester City, N. J.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, E. C. C. W. Burton, Griffiths & Co., London, E. C. De Fries & Co., Dusseldorf, Germany. V. Lowener, Copenhagen, Denmark.





New Process Pinions are the Strongest Non-Metallic Gears Made

We frankly admit that some kinds of solid metal pinions outlast New Process Pinions, but where prevention of noise and vibration enters into consideration positively no other gears on the market compare with New Process for durability and ultimate satisfactory service. And in almost every instance, a noisy metal to metal gear drive can be **successfully** and **permanently quieted at reasonable expense** by substituting a New Process Pinion for the noisy metal one.

Our new process of treating the rawhide gives it the good qualities of metal without the metallic ring, and only discs blanked from the strongest parts of the hide are used in making gears. These are glued together, dried under heavy hydraulic pressure, the blank faced off and the whole machined just like a solid metal pinion. Hence the rawhide fibers bear end-on against the other gear and being supported by the metal at the sides will stand up without sign of weakness. In fact the teeth wear down to knife edges without stripping or breaking, and are as silent when old as when new.

You would never go back to metal pinions after trying one New Process Pinion on any high speed drive. Their installation not only adds to the comfort of the entire shop force, does much to save time and avoid misunderstandings, but easily repays the expense in reduced breakage of gear teeth and lengthened life of the machines, the latter due to the lessening of vibration.

Your troubles from noisy gear transmission are easily settled and our engineers are at your service. Tell us where you would consider New Process Pinions and we will send literature.

NEW PROCESS IS TO ALL OTHER RAWHIDE AS STEEL IS TO IRON

The NEW PROCESS N.P.R.H. Co. RAW HIDE CO.

OFFICE & WORKS SYRACUSE, N.Y.

REG. U.S. PAT. OFF.

CANADIAN AGENTS: ROBERT GARDNER & SON, LTD., MONTREAL.

54

GEARISMS

Published by the Philadelphia Gear Works
1120 Vine Street, Philadelphia, Pa.

Vol. 1 DECEMBER 1912 No. 3

DEVOTED *to the* INTERESTS *of* GEAR USERS EVERYWHERE
Edited by the Little Gear Man

Over 20 Years Ago

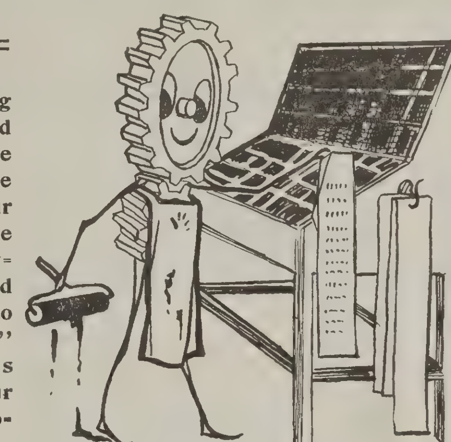
We made the first Philadelphia Gears. They were good gears then; but they are better now, for we have combined experience with theory—and there are kinks that the best mechanics can learn by experience only, as you know. The growth and development of Philadelphia Gears from the beginning of a small business to the occupancy of our own building, with its specially designed machinery and equipment, is an interesting story in itself, and goes to prove that knowledge, experience and square dealing, with a certain necessary amount of push, will win success under any circumstances.

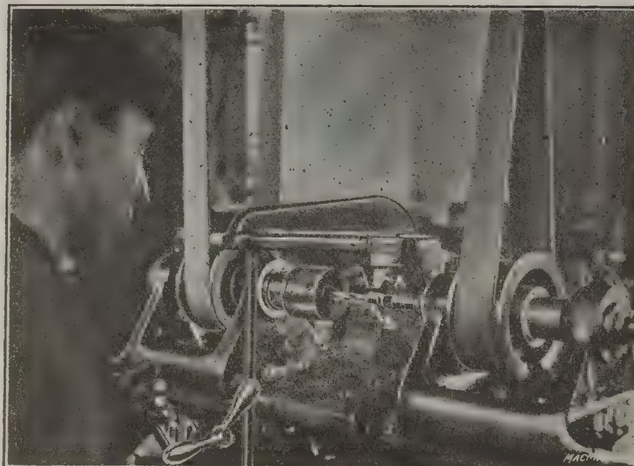
Promptness and square dealing are hobbies with us. We can make *better* gears for you. Try us.

The "Little Gear Man" on Efficiency

The efficiency of a train of gears, or of any other power transmitting mechanism for that matter, is measured by the percentage of the power put into the shaft on which the driving gear is mounted, which is delivered by the shaft on which the driven gear is mounted. In general it may be said that there is no method of transmitting power between two parallel shafts that is more efficient than a pair of well designed and carefully constructed spur gears, working under proper conditions. The highest efficiency is obtainable of course, only at considerable expense. Hence, good judgment is required to decide to what extent refinements in the manufacturing processes of gears are warranted. This judgment comes only by years of experience in the manufacture and use of gearing.

We are getting out leaflets and "flyers" all the time and would like to put you on our mailing list. The catalog, too, showing stock sizes and styles we carry to meet your "rush" requirements should be in your file. Write us today.





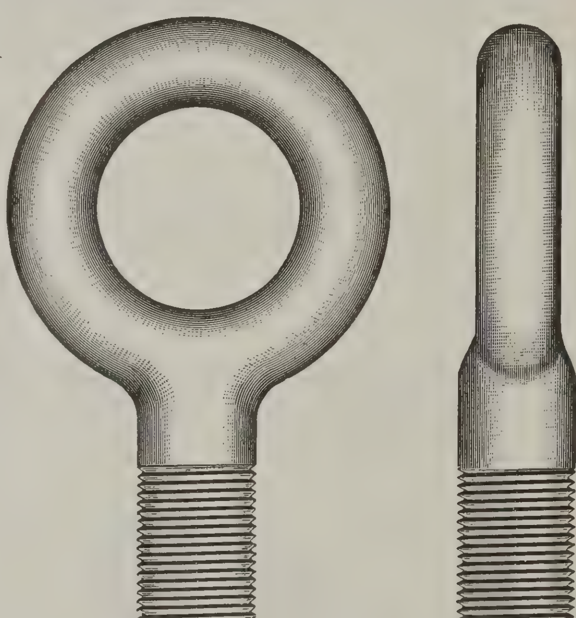
Pointing Foster Set Screws

Foster Safety Set Screws are turned from the solid, the hexagonal hole is broached, and then the burrs are carefully drilled from the bottom of the hole, the blank being held in jaws as shown and the point concaved to the correct angle at the same time. In every detail of manufacture Foster Safety Set Screws show fine finish, close accuracy and great strength, as well as safety.

Dependable Safety Set Screws. Try them. Circular?

New Haven Machine Screw Co.
New Haven, Conn., U. S. A.

Straight Shank Eye Bolts



Drop Forged without Welding. All Sizes.

THE EUREKA COMPANY
Formerly
EUREKA TEMPERED COPPER WORKS
NORTHEAST, PENNSYLVANIA

Locker Your Factory

Not with shoddy looking lockers made of wood—breeders of disease germs and uncleanliness, but with Terrell's Steel Lockers—safeguards against conditions cited above.

Terrell's Steel Lockers not only provide a clean, safe place for your employees garments, but teach workmen to be neat and systematic: "A place for everything and everything in its place."

Even should fire occur—they cannot burn. Being indestructible—first cost is last cost. No repairs.

Steel Equipment Catalogue on request.

Terrell's Equipment Company
NORTH GRAND RAPIDS, MICHIGAN

An Ideal Hand Reamer

For maintaining smooth, standard size holes at low cost. A fine positive adjustment can be made in a few seconds. They are fitted with carbon steel or high speed steel blades as preferred. The blades are made interchangeable and can be ordered from stock at any time. Try one of these and be convinced of their superiority. All sizes carried in stock.

Our catalogue, which tells about our full line of reamers, will be sent upon request.

THE SCHELLENBACH-HUNT TOOL CO., Cincinnati, Ohio

THE AMERICAN SPECIALTY CO., Chicago, Ill., Agents for the Chicago District.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England. Markt & Co., 193 West St., New York; Germany and Italy. New York Export and Import Co., 133-137 Front St., New York; China, Japan and Australia. Williams & Wilson, Montreal, Canada. J. S. Cock, Christiania, Norway.

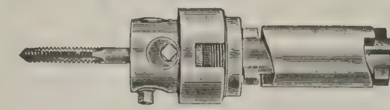
Graduated Adjustable Friction Self-Centering

TAP HOLDER FOR TURRET LATHE

ERRINGTON

41 CORTLANDT STREET, NEW YORK

TAPS STEEL as Safely as Cast Iron



Double-Clutch Sleeve

Regulates the Whole Power of Machine to Just Drive, but Cannot Break Tap. When Tap Sticks (or Strikes Bottom,) the FRICTION SLIPS, and Tap can thus be Run In and Out until the Toughest Metal is Quickly Tapped

Interchangeable Spring Shank for Rough and Finish Taps Occupying One Turret Hole

Especially Good for Roughing and Finishing Taps, Running Solid Dies Up Against a Shoulder, etc.

Deutsche Katalog von Arthur Kayser, Berlin, S. W., Alte Jacobstrasse, 24.
Catalogue Francais : Edgar Bloxham, Paris, 12 Rue du Delta.

"CUSHMAN" CHUCKS AND FACE PLATE JAWS

Drill Chucks
Lathe Chucks
Centering Chucks
Portable Face Plate Jaws

Iron Bodies Steel Bodies

Many styles and sizes
All designed for hard and exacting Service

Catalog Free

THE CUSHMAN CHUCK CO.

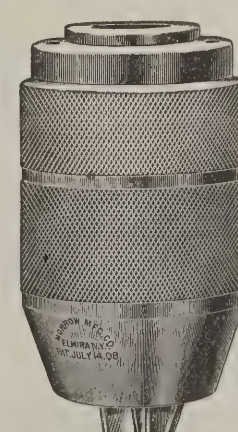
Hartford, Conn., U. S. A.

DRILLS RUN TRUE

when held by the automatic, positive grip of the Morrow Drill Chuck—no slipping—good work always.

No key to carry—no wrench to lose—your hands are the only tools you'll need, and these only to operate the chuck—not to make repairs.

MORROW DRILL CHUCKS



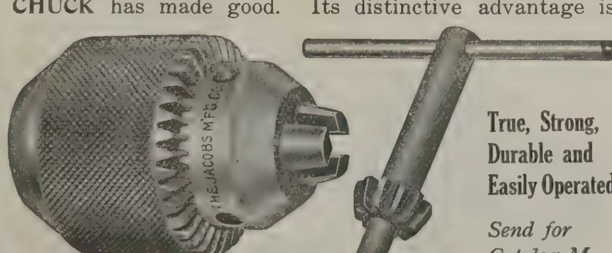
have no exposed threads to catch waste or collect dirt and grit. Jaws are made of crucible steel, hardened and ground to give lasting service; bearings, also, hardened and ground—and the entire chuck made to outwear all similar tools.

Morrow Mfg. Co.

Elmira New York

150,000 In Use

Proof conclusive that the **JACOBS IMPROVED DRILL CHUCK** has made good. Its distinctive advantage is



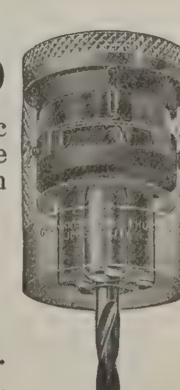
True, Strong, Durable and Easily Operated

Send for Catalog M.

enormous gripping power—the teeth on the extreme circumference of the sleeve give greatest possible leverage.

THE JACOBS MFG. CO. Hartford, Conn.

DRILL SHANKS CANNOT BE INJURED



with the Grönkvist Automatic high speed drill chuck, because the jaws are 3 perfectly smooth rollers.

Bear this in mind when you find drills with cut up shanks in your shop.

GRÖNKVIST DRILL CHUCK CO.

20 Morris Street, JERSEY CITY, N. J.

Agents for Canada—The Stevens Company of Galt, Ltd., Galt, Ont.

CHUCKS

We Make the Lathe Chuck You Need!

No matter what your lathe chuck requirements are—no matter what type of chuck you need—no matter what your problem—we make a chuck which will suit your particular needs.

SWEETLAND CHUCKS

are replacing all others with hundreds of users, because by test they make good. If you demand strength and durability of your lathe chucks, you should investigate the Sweetland, and learn why so many other chuck users will take no other.

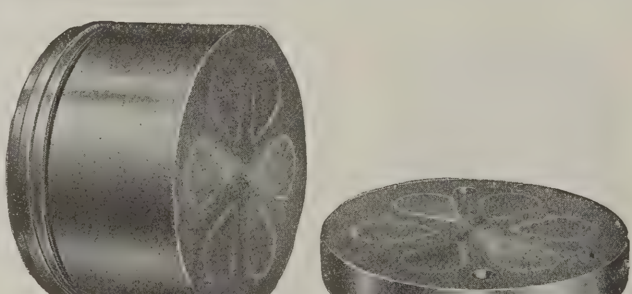
Write us today and we will send you full data regarding the Sweetland, and we'll give you sound reasons for their superiority—reasons you can't afford *not* to know. Write today—a postal will do.

Hoggson & Pettis Manufacturing Company

New Haven, Conn., U. S. A.

103 Chambers Street, New York

CHUCKS



SPECIFY "D & W" MAGNETIC CHUCKS

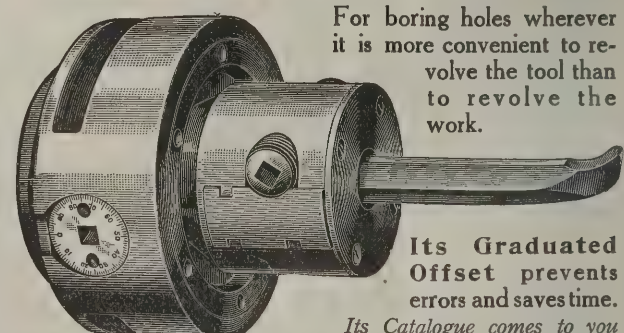
when you buy new tools. Take grinding machines, for example; we furnish water proof, oil proof, heat and dust proof chucks of unusual holding power and instant release. Arranged with auxiliary plates as jigs or fixtures to hold odd shaped work, and the time saving will be almost as great as on flat work that can be placed directly on the chuck.

Send for Bulletins and more "Reasons Why"

D & W FUSE COMPANY
PROVIDENCE, R. I., U. S. A.

The Casler Offset Boring Head

For boring holes wherever it is more convenient to revolve the tool than to revolve the work.



Its Graduated Offset prevents errors and saves time.

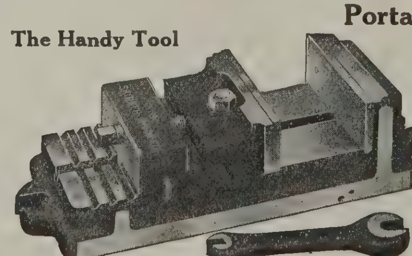
Its Catalogue comes to you for the asking.

Marvin & Casler Co., Canastota, N. Y.

SKINNER DRILL PRESS VISE

The Handy Tool

Portable, Convenient and Durable



Will soon pay for itself in any machine shop.

Made in three sizes.

Always in stock.

Illustrated catalog of Lathe and Drill Chucks sent upon request.

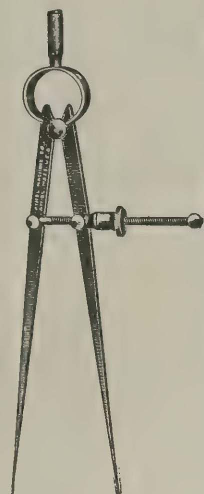
THE SKINNER CHUCK COMPANY

New York Office
94 Reade St.

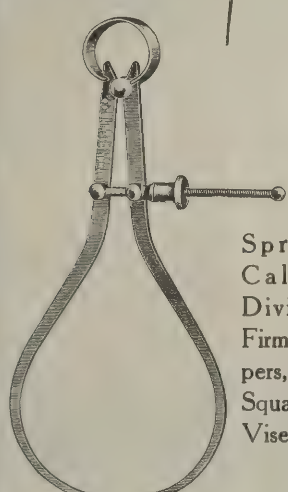
Factory and Main Office
New Britain, Conn.

Like all precision tools that bear our name

"Premier" Spring Dividers and Outside Spring Calipers



are extremely accurate and dependable.



Complete line of Spring Joint Calipers and Dividers, also Firm Joint Calipers, Steel Rules, Squares, Bevels, Vises, etc.

Ask for Catalog 31.

Athol Machine Co., Athol, Mass.

Established 1902

MOBERG DIE CASTINGS

We do not claim to be the only die casting concern in the country, but have customers who say we are.

C. J. MOBERG, Inc.
Beach Street, Mount Vernon, N. Y.

"Safety Lathe Dogs"

Built by a mechanic, for mechanics' protection. Made of drop-forged, high grade steel, just as efficient and convenient as the old style dog, and **safe to use**—the guarded set screw reduces danger to the minimum.

Patent Applied For

Get "Safety" Dogs for your own protection. Write for details.

ELMER J. MICHAUD
20 Worth St., WILLIMANTIC, CONN.

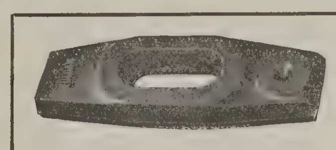
"Vulcan"

Drop-forged Strap Clamps

"They stand the strain"

Made from a carefully selected tough steel and submitted to a special process after forging, which increases their strength and stiffness.

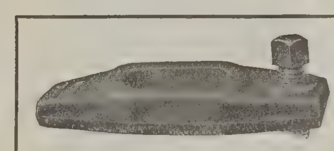
A "Better Buy"



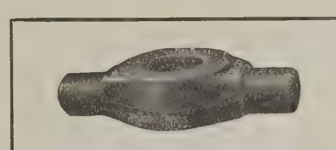
Plain Slot Pattern

Because it can't pay you to produce such things by hand.

Because, product compared, our price will be less than your cost.



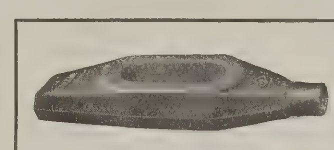
Adjustable Step Pattern



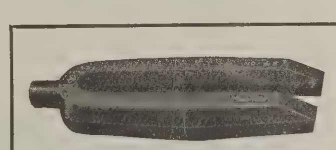
Double Finger Pattern

Because they will eliminate the time *wasted* in the Blacksmith shop.

Because they are symmetrical and interchangeable.



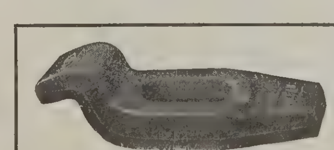
Single Finger Pattern



"U" Pattern

Because they will serve you for a life time.

Because they will be part of an orderly equipment instead of junk—an asset.



Goose Neck Pattern

Your dealer will serve you!
Get free, just out, catalogue of tools.

J. H. WILLIAMS & CO.

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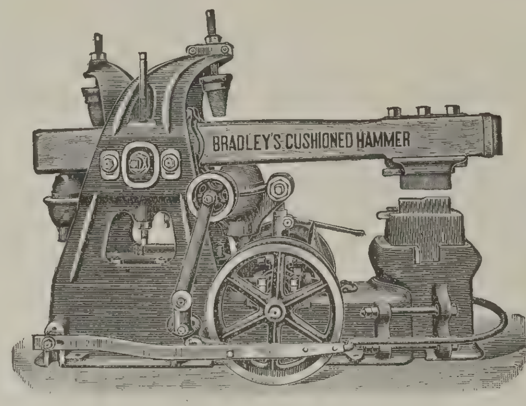
Western Warehouse, 40 South Clinton Street, Chicago, Ill.



THE BRADLEY
Cushioned Helve Hammer

is in a class by itself. There is no other Cushioned Helve Hammer.

If your work is continuous, like plating, drawing, swaging, collaring, welding or spindle making, with infrequent changes in size of material, or if it is die work where perfect accuracy and the finest finish are imperative, there is no other Hammer made that can compare with it in quality of output, durability, controlability or any other feature. Made with heads weighing from 15 to 200 lbs.

More Bradley Hammers are sold each year than of all other power Hammers combined. Send for circulars.

WE MAKE

The Bradley Cushioned Helve Hammer. **The Bradley Upright Helve Hammer.**
The Bradley Upright Strap Hammer. **The Bradley Compact Hammer.**
Forges for Hard Coal or Coke.

C. C. Bradley & Son, Syracuse, N. Y.

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The Beaudry Champion Power Hammer

Simple
Durable
Efficient
Economical

Adapted for every description of forging

Send for circular

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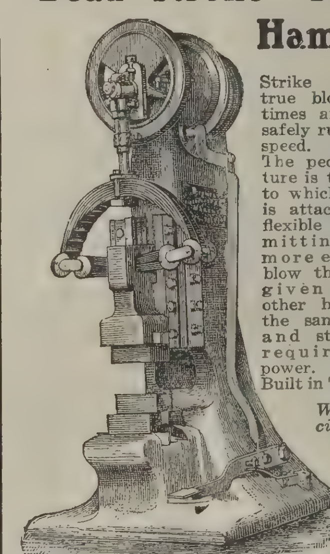
SPECIAL
DIE, JIG AND FIXTURE WORK
SOLICITED
ACCURACY GUARANTEED

The Columbus Die, Tool and Machine Co.
COLUMBUS, OHIO

"Dead Stroke" Power Hammers



Strike a square, true blow at all times and can be safely run at high speed.
The peculiar feature is the spring, to which the ram is attached by a flexible belt, permitting a far more effective blow than can be given by any other hammer of the same weight and stroke, and requiring less power.
Built in 7 sizes.

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Dienelt & Eisenhardt, Inc.
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CHAMBERSBURG STEAM HAMMERS

3300 lbs. Railroad Pattern

"All sizes for every class of work"

Economical — Reliable — Efficient

Our hammers are double acting, and have most simple valve gear, giving operator perfect control. Write us for any data needed as to your requirements in this class of equipment.

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CHAMBERSBURG ENGINEERING CO.
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The
HIGLEY
COLD METAL SAW

Catalog furnished by

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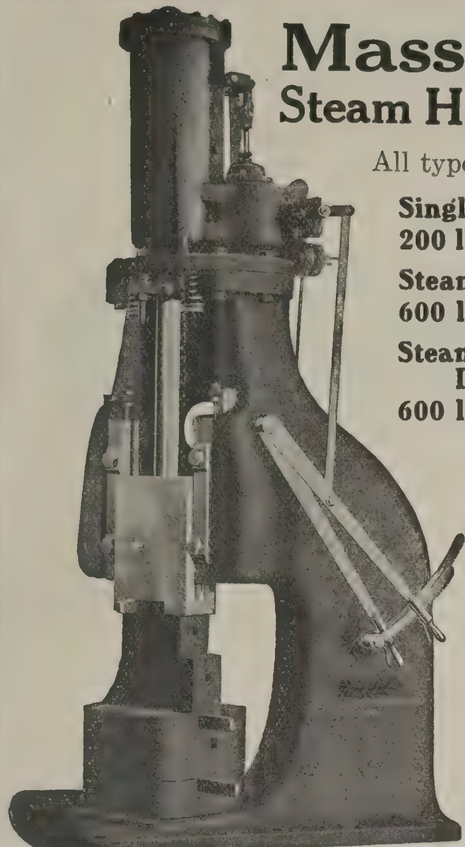

Massillon
Steam Hammers

All types and sizes.

Single Frame—
200 lbs. and up

Steam Drop—
600 lbs. and up

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600 lbs. and up

Also special hammers for forming steel wheel-barrow trays, drag scrapers, etc., etc.

Send for new Catalogue.

THE MASSILLON FOUNDRY & MACHINE CO., Massillon, Ohio

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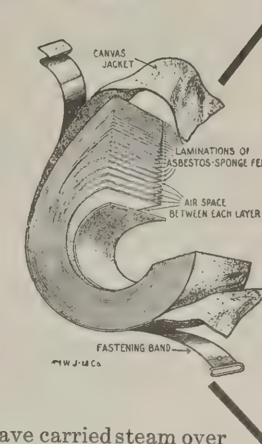
Which Would You Rather Do—Buy Additional Machinery or Protect Your Steam Pipes?

It is remarkable how many leave long systems of steam piping bare or poorly insulated. In plants where such is the case the apparatus receives steam in a state of about 40 per cent efficiency, and oftentimes twice the number of machines are used than would be necessary if the steam pipes were properly insulated with



J-M Asbesto-Sponge Felted
Pipe Covering

Pipes insulated with this covering have carried steam over 5000 feet with practically no loss. Unlike other pipe coverings, it will not crack, break or lose its insulating value through vibration or rough usage. It has been found in perfect condition after more than 15 years' service on underground pipes.

If you value economical plant operation, write our nearest branch today for Sample and Catalog No. 100.

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DIXON'S
Graphite Lubricants

Dixon's Flake Graphite No. 1.
This is the standard size of Dixon's Ticonderoga Flake Graphite, and is recommended for general lubricating requirements.

Dixon's Flake Graphite No. 2.
A more finely ground graphite than No. 1, though of the same stock. This is adapted to close-fitting bearings and delicate mechanism.

Dixon's Flake Graphite No. 635.
This is a selected grade of Dixon's Ticonderoga Flake Graphite ground even finer than the No. 2 Flake. It is widely used in stationary gas engines. This grade of graphite is also used on type-setting machinery.

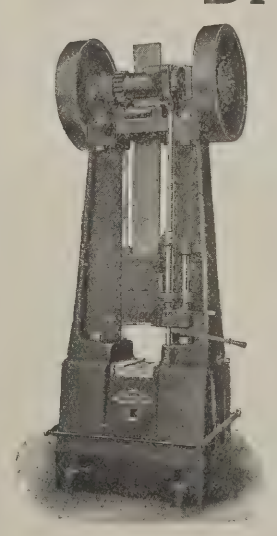
Dixon's Waterproof Graphite Grease.
A strongly adhesive grease of heavy body; cannot be washed off by fresh, salt, alkaline or acid water. Especially adapted for wire rope, gears, slides, chains, elevator-ways, mining and quarrying machinery, and generally on machinery exposed to water or the weather.

Write for "Graphite as a Lubricant" and free sample 80 C.

Joseph Dixon Crucible Co.
JERSEY CITY, N. J.

SPEED AND ACCURACY
Keynotes of

Moline Board Drop Hammers



Ease of operation, accuracy and efficiency, coupled with freedom from repairs, make our Drop Hammers the best on the market. The "Moline" line of Power Forging tools includes Bulldozers, Crank and Board Lift, Drop Hammers, Upsetting and Forging Machines, Multiple Punches, Gate Shears, Yeakley and Justice Hammers, Eye Benders, Taper Rolls, Punches and Shears, etc.

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Williams, White & Co.
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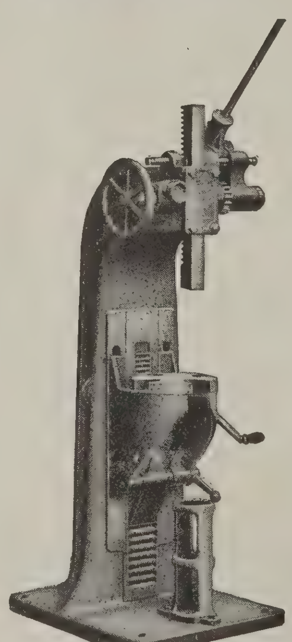
FERRACUTE PRESSES

Photographs and full information on request.

Hundreds of sizes and styles for cutting and forming metal.

FERRACUTE MACHINE CO.
Bridgeton, New Jersey

EAMES MANDREL PRESSES


No. 4 Press

are all fitted with the Eames Compound Leverage System. Leverage Power can be increased to five times simple leverage force by the simple pressing of finger on a 1″ pin.

For power ease of operation, in broaching, placing bushings, bending, straightening, and similar shop jobs, Eames Mandrel Presses are many times more powerful than any other like machine on the market.

Cut shows our No. 4 Press upon which a pressure of from 8 to 10 tons may be easily obtained.

Ask your dealer or write us for detailed information.

THE G. T. EAMES CO.
KALAMAZOO, MICH., U. S. A.

"For Your Pressing Needs"

HYDRAULIC PRESSES

Portable Crank Pin Press

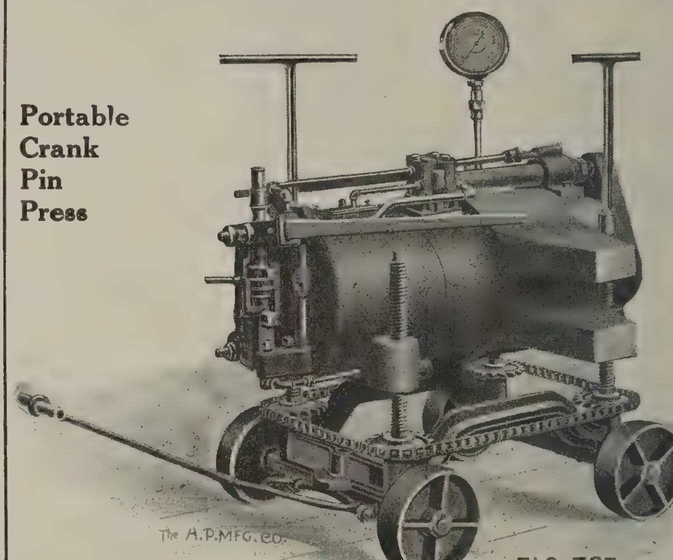


FIG 797

WE KNOW THEY WILL DO THE WORK because they have been tested. This is just one of the many kinds of presses we make. We can make presses to press in any direction for you, and to press just as energetically as you desire. 35 years in this same business have established our prestige.

Full information upon receipt of request.

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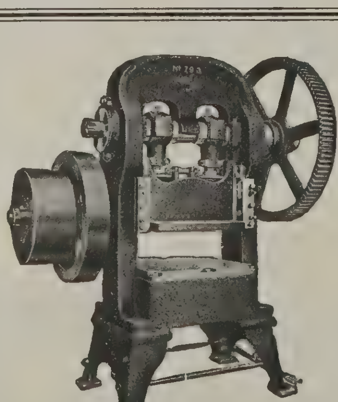
84 Lincoln Ave. Mount Gilead, Ohio
EASTERN OFFICE: Room 1105-I, 39-41 Cortlandt St., New York City.
CHICAGO OFFICE: 162-166 N. Clinton Street.

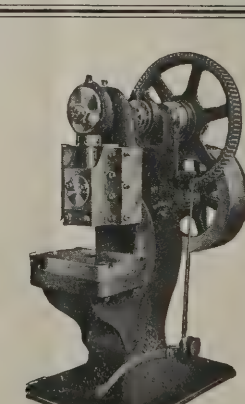

Double Crank Press

PERFECT CONTROL OF MOTION

is the first essential for a power press. The Niagara Presses are equipped with Clutches of the most improved types, reliable in action, powerful and durable. On ordinary presses a clutch of the sliding key type is used; on larger and heavier machines Jaw and Friction Clutches are provided to suit the nature of the work.

Catalogue sent free on request.

Niagara Machine and Tool Works
Buffalo, N. Y.


Geared Punching Press

General Duty Presses

"Bliss" Arch Power Press No. 30

BLISS ARCH PRESSES are designed for varied and heavy work, where factory space is limited or where conditions require a press to do general work.

The shape of the frame gives maximum rigidity between die and punch. All parts are well proportioned with regard to strength, simplicity and convenience.

They economically handle such work as stamping petroleum can sides; cutting and stamping coal hod bottoms, fire shovels, metallic shingles; operating combination and large lettering dies. Fitted with removable front piece as illustrated, they are also suitable for horns, forces and wiring dies. Write for further details.

"Bliss Presses for Every Requirement"

E. W. BLISS CO.

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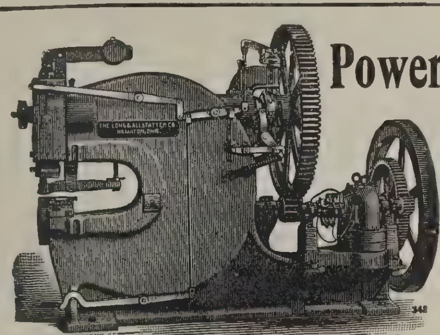
BLISS



Power Punching and Shearing Machines

Belt, Steam and Electrically Driven

LONG & ALLSTATTER CO.

HAMILTON, OHIO, U. S. A.

Our machines are made in over 350 sizes and varieties.

SINGLE,
DOUBLE,
UPRIGHT,
HORIZONTAL,
GATE,
MULTIPLE,
FOR
Railroad Shops,
Locomotive Shops,
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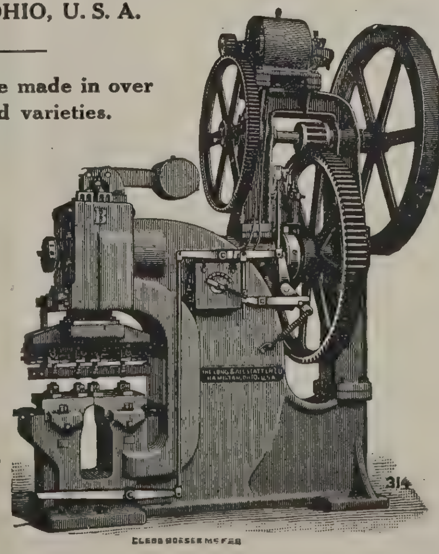
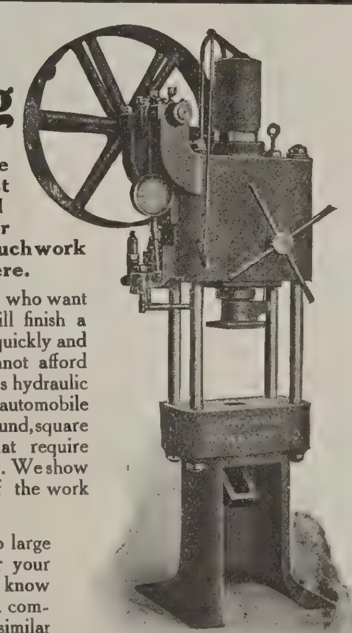
Etc.



Hydraulic Broaching

is by far the best and most economical method for machining such work as shown here.

Manufacturers who want a tool that will finish a machine part quickly and accurately cannot afford to overlook this hydraulic press already used by many automobile manufacturers for broaching round, square and irregular holes in parts that require extreme accuracy. We show a few samples of the work it does.



Hydraulic Broaching Press 60 Tons Capacity

If this tool is too large or too small for your purpose, let us know and we'll send a complete list of our similar broaching tools. Or, if you do not want a broaching tool at all, but need a hydraulic bender, jack, shear, punch, accumulator, press or pump, let us know. We build over 4000 types and sizes of hydraulic machines.

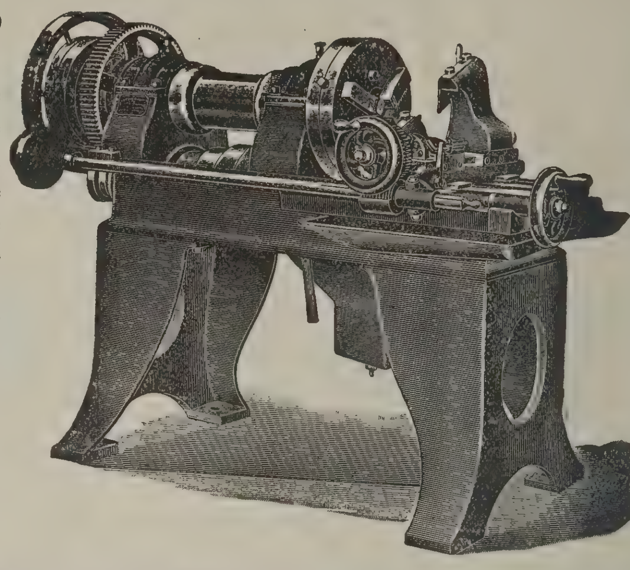
ENGINEERS AND BUILDERS OF HYDRAULIC TOOLS

THE WATSON-STILLMAN COMPANY

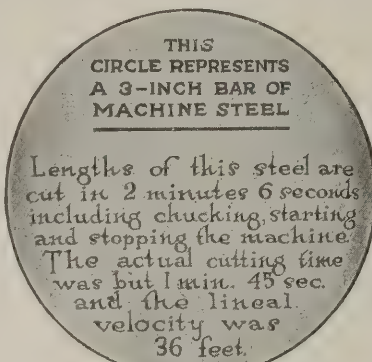
192 FULTON STREET, NEW YORK

113

Past Performance, or Future Promise?



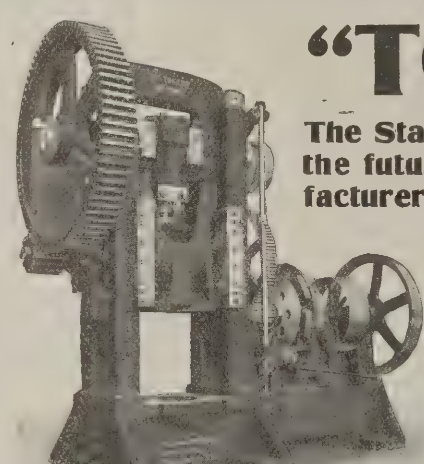
The evidence of what a machine has done is more convincing than a promise of what it may do. Note actual cutting time of 3-inch bar of machine steel on a Hurlbut Cutting-Off Machine. Compare time with present method. The fast time on our machine is due to the use of **two** cutting tools, each tool assisting the other—one pressing **up** the other **down.** Besides being fast, Hurlbut machines are accurate.



Sizes: 2" to 10" capacity.
Send for "more evidence".

HURLBUT-ROGERS MACHINE COMPANY, So. Sudbury, Mass., U.S.A.

"TOLEDO"



The Standard of the present and the future for progressive manufacturers of sheet metal products.

No. 59¼ is fitted with powerful gearing, massive connection, high carbon steel shaft, patented friction clutch with automatic release.

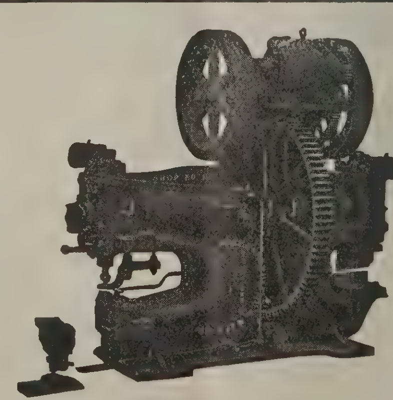
Adapted to drawing, reducing and swaging steel stampings for brake drums and other heavy steel auto parts, as well as other stampings in hot or cold pressed work.

The Toledo Machine & Tool Co.
TOLEDO, OHIO, U. S. A.

I. P. RICHARDS CO.

PROVIDENCE, R. I.

THE SCHWERDTLE STAMP CO.,
STENCILS—BURNING BRANDS
STEEL STAMPS & DIES
SEALS—MACH. PLATES—CHECKS
BRIDGEPORT, CONN.

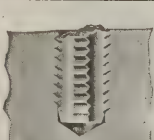


ROYERSFORD PUNCH AND SHEARS

None better—few as good. Just the machine for Boiler Shops, Railroad Shops, Structural Works and Machine Shops. Machine is right; so is price.

Ask for the New Catalogue.

Royersford Foundry & Machine Co., Inc.,
ROYERSFORD, PA.



We Make a Device for Removing Broken Taps

Write for particulars.

THE WALTON CO., HARTFORD, CONN.

TWENTIETH CENTURY BALANCING TOOL

Always level and ready for use no matter where or how you place it.

A practical tool for balancing pulleys, cones, armatures, polishing wheels, etc., requiring no leveling or adjusting, it embodies great labor-saving features. No machine shop or polishing room can afford to be without this tool.

Made in four sizes to swing from 22" to 8-ft.

Write for descriptive circular.

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ROCKFORD TOOL COMPANY, Rockford, Ill.

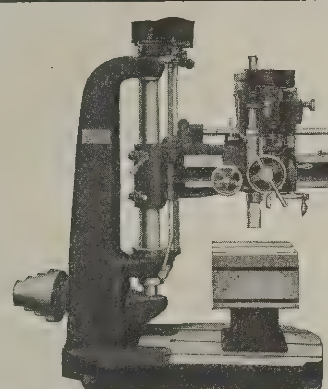
It's Easier to Push than to Carry

Instead of lugging heavy work and tools from one department of your shop to another—try a New Britain Truck Base Rack.

The large wheels and ball bearing casters make it easy to transport loads over uneven floors and sills. The middle shelf may be adjusted up or down to make spacing suit requirements. It's convenient for many uses and like all New Britain "Shop Furniture" it's built to last. We make a wide variety.

Complete Catalog of "Shop Furniture" sent on request.

The New Britain Machine Company
64 Bigelow Street New Britain, Conn.



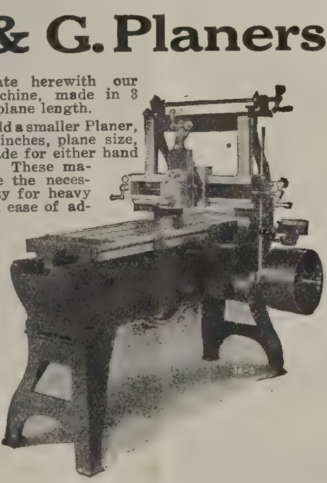
Morris Plain Radial Drills

Base and main housing one massive casting; box section, exceptionally rigid. Column swings with arm in very large bearings. Every convenience—depth gauge, automatic stop, safety trip, etc. Strength and rigidity strongest points.
2½, 3 and 3½-foot sizes
Ask for latest circular

THE JOHN B. MORRIS MACHINE TOOL CO.
Cincinnati, Ohio, U. S. A.
Also Manufacturers of MORRIS Engine Lathes

S. & G. Planers

We illustrate herewith our 16x16x3 Machine, made in 3 and 4 feet plane length.
We also build a smaller Planer, 10x8 1-2x20 inches, plane size, which is made for either hand or power. These machines have the necessary rigidity for heavy cuts and an ease of adjustment and sensitiveness that make small jobs profitable.



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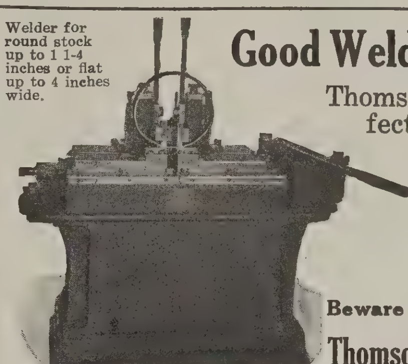
The Schneider & Goosmann Machine Co.
CINCINNATI, OHIO.

OUR SPECIALTY:

Automatic Machinery for making Wood Screws

Asa S. Cook Co., HARTFORD, CONN., U. S. A.



Welder for round stock up to 1 1-4 inches or flat up to 4 inches wide.

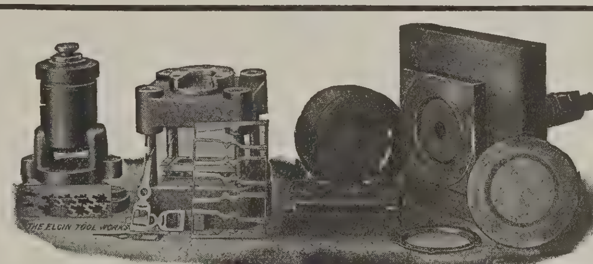
Good Welding at Rock Bottom Prices

Thomson Electric Welders make perfect welds, fast. Spot, jump, lap, seam and all other welds. Heat is concentrated, no waste—therefore lowest cost per piece. We job weld also.

Send for Catalog E.

Beware of infringers and their misleading statements.

Thomson Electric Welding Company, Lynn, Mass.



We Build to Order
JIGS, DIES and TOOLS
as well as
Elgin Precision Bench Lathes and Attachments
The Elgin Tool Works
ELGIN, ILL.

HIGH GRADE DIAMOND POINTED TOOLS

For dressing and shaping Emery, Carborundum and all abrasive wheels. Carefully selected diamonds possessing both hardness and toughness and securely mounted with the grain in the proper relation to the wheel, make all the difference in the world with the wearing qualities of Diamond Tools. These features are guaranteed. Write for Circular and prices.

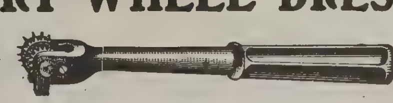
KEEN EDGE DIAMOND TOOL WORKS
242 Griswold Street Detroit, Mich., U. S. A.

Grinding Machines

Different Styles and Sizes for Floor and Bench.

EMERY WHEEL DRESSERS

No. 1 For Regular Shop Use



No. 2 For Large Wheels

These Dressers in connection with our Cutters make a most powerful and efficient tool especially our No. 2 which is made proportionately larger and stronger for large wheels.

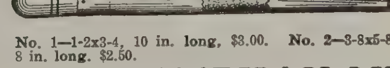
CUTTERS

We make the regular "Huntington" (pattern) Paragon Cutter and Roughing Cutter for Dresser No. 1, and the "Huntington" (pattern) and Roughing Cutters for Dresser No. 2.

Let us send you descriptive circular and prices.

GEO. H. CALDER, Lancaster, Pa., U. S. A.

The Star-Carbon Emery Wheel Dresser

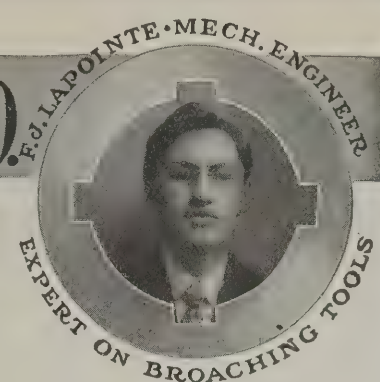


No. 1—1-2x3-4, 10 in. long, $3.00. No. 2—3-8x5-8, 8 in. long, $2.50.

The great substitute for the Black Diamond. Has advantages over the Black Diamond for shaping and truing up wheels. Our circular will explain why. Have your dealer furnish one, or order one on ten days' trial.

C. H. STEPHAN MFG. CO., Springfield, O.
AGENT: Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao and Barcelona.

The Heads of the
J.N.LAPOINTE CO.



NEW FACTORY
NEW LOCATION

Having moved into our new factory at New London, Conn., the largest, most up-to-date, practically constructed, and most completely equipped plant devoted exclusively to the manufacture of

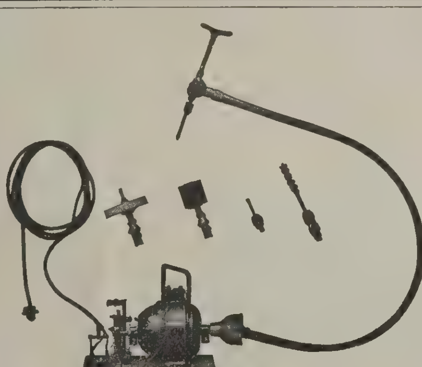
Broaching Machines and Broaching Tools

we are prepared to offer to our friends—both old and new—a service in this particular line of industry that is entirely without equal.

The organization is headed by the originators of the present commercial type of broaching machines and broaching tools, and the staff is made up of men who have become experts in this special line. Added to these are improved machinery, latest methods, facilities for increased production, a stock in trade that cannot fail to assure results. Write us for details.

THE J. N. LAPOINTE CO., New London, Conn., U.S.A.

If It's An Original Stow



It's A Time Saver

Cut Down the Working Time

and save money with a Stow Portable Flexible Shaft Outfit. Style shown is for light metal drilling, grinding, brushing and polishing. It is completely equipped ready for work as soon as connected to any lamp socket. The motor is a ¼ H.P. "Ready" Electric Motor—a little beauty.

We make Flexible Shaft Outfits for every requirement. Send for Illustrated Catalog.

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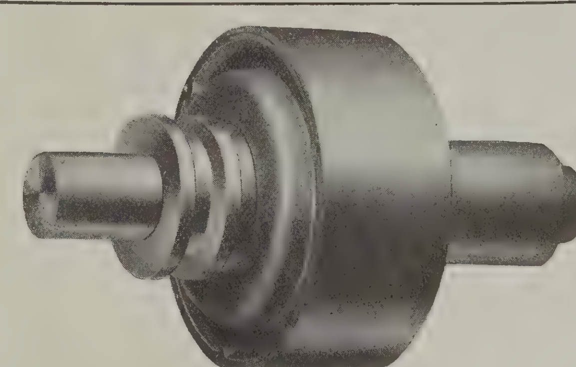

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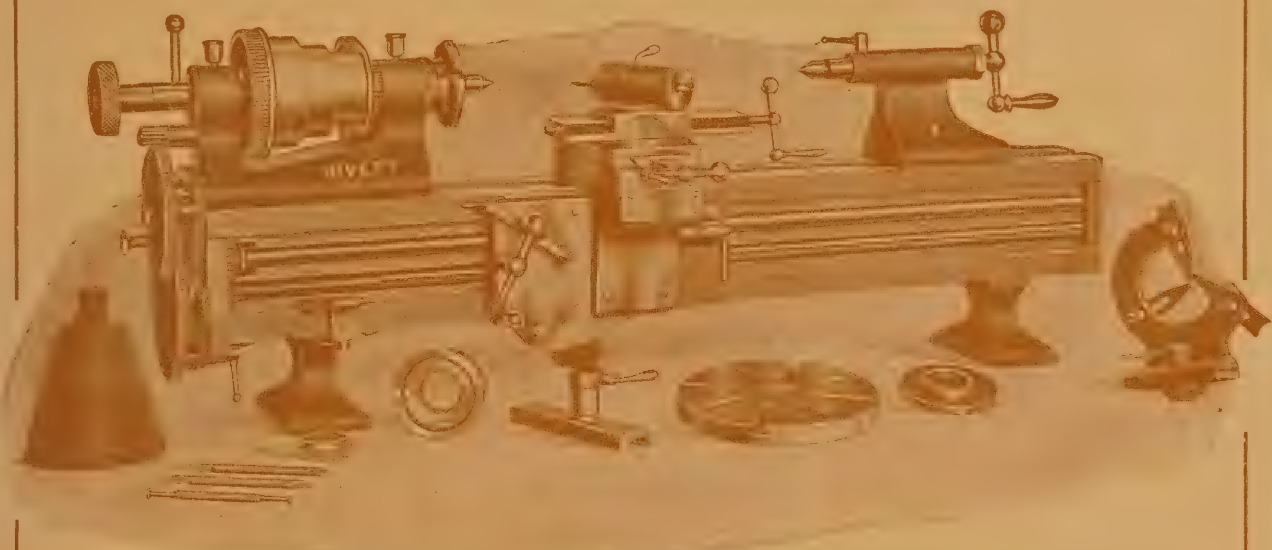

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